ILRI Genebank Review 2012

Programme: Genebanks CRP		
Genebank reviewed: ILRI	**Site visit Dates:**	27 Nov 2012 - 01 Dec 2012
	Review report Date:	
	Center and Crop Trust responses:	19 Feb 2014
Place: Addis Ababa, Ethiopia		
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RESEARCH PROGRAM FOR Managing and Sustaining Crop Collections

CGIAR

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ILRI 2012 Genebank Review: recommendations and responses

	Recommendation	Responses by ILRI	Responses by Crop Trust
1. Merging CG Forage Collections	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.	ILRI strongly agrees with the need to continue close linkages and expand mutual activities while maintaining a decentralized CGIAR forage collection. In additional to on-going collaboration on the Crop Genebank Knowledge Base, crop registries and validation of passport data (including GENESYS), safety back-up and capacity development. This ongoing collaboration will form the basis to identify additional areas of common interests and work.	We are satisfied to see that this recommendation is given high priority and that ILRI is making plans to act on the advice provided by the reviewers. This recommendation relates strongly to recommendations 6, 8 and 10, determining the scope of the ILRI collection and the plans for regeneration and viability testing. We would like to see some recognition by ILRI of the potential need for rationalization and realignment of the collection, with the potential elimination of genera and accessions that are held in other CGIAR Centres or national institutes and an overall reduction in current accession numbers.
2. Facilities	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.	ILRI supports the recommendation on improving the infrastructure and storage facilities to reduce risks to conserved materials.. All short term actions to address the issues raised are already in progress. The issues of the prefabricated building and older cold storage unit require considerable investment with careful planning for the long term growth of the collection and have potential to result in disruptions and negative effects on core genebank activities during the construction period. In order to properly address these challenging issues, ILRI is having a full technical assessment of the condition of the infrastructure and cold-room insulation, as well as developing options and timeframe for their replacement. ILRI will assess the cost, implications for the long-term and feasibility of options in line with long-term requirements, priorities and predicted future	We are very happy to see this comprehensive response to an important recommendation.

	Recommendation	Responses by ILRI	Responses by Crop Trust
		development of forage diversity activities in ILRI.	
3. Human Resources and Succession Planning	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 genebanking 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.	ILRI strongly agrees with this recommendation to hire an additional staff member and has already defined the profile of the position and hopes to advertise in mid-2013. We also support developing capacity of staff to share responsibilities and tasks to reduce risks in succession planning. Staff will complete the documentation of local procedures and standard operational procedures (SOPs) for different work flows as soon as possible.	Again an important recommendation that ILRI is appropriately considering to be of high priority.
4. Risk assessment of collection	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 labeled in order to allow rapid extraction from storage. Regular data back-up transfers to Nairobi need to be confirmed.	ILRI supports the requirement to complete a full risk assessment of the forage genetic resources activities. Assistance is being sought from the ILRI internal auditor and occupational health and safety officer to ensure a thorough and complete assessment during 2013 to determine critical risk mitigation actions.	We suggest also the risk assessment tool in CGKB is used even if just as a reference tool. The Trust takes a real interest in the outcome of your efforts to assess and manage risk more comprehensively as it will be relevant to other genebanks.
5. Seed Storage	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	ILRI agrees that improved efficiency resulting from increased seed longevity should be pursued. This will be addressed as part of the risk assessment and implications and changes in procedures and workflows to accommodate the proposed changes in storage temperature and consolidation of lots are being considered. A study of the quality of the current bags is proposed using the newly acquired non-destructive seed moisture determination equipment.	We see that ILRI is taking initial steps to address this recommendation and we look forward to hearing more concrete plans. It is important to consider new procedures and possibilities within the framework of quality and risk management but equally there may be some urgency here and it would be good to take advantage of easy wins – such as bringing the cold room temperature

	Recommendation	Responses by ILRI	Responses by Crop Trust
	rooms currently running at 8ºC, to -5ºC. 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.		down asap.
6. Regeneration	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.	ILRI is addressing the needs for regeneration as part of the Genebank CRP targets and will continue to explore new approaches to reduce the backlog. The forage collection maintained at ILRI presents several challenges related to the large number of genera, limited research and information on many of the species, long generation intervals and large growth forms of fodder trees, generally outbreeding reproductive systems and species-specific regeneration requirements. These challenges make it difficult to develop accurate and realistic timeframes to reduce the backlog.	We are happy to see that ILRI is considering this recommendation as a high priority. We also would like to point out that the regeneration plan is contingent upon rationalization and a clear understanding of the alignment of international collections. ILRI's plans need to be drawn up with recognition that similar/same materials may be being regenerated elsewhere.
7. Database/ Documentation	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.	ILRI appreciates the recommendation that supports on-going efforts to move to a new database management platform. Compatibility with CIAT and ICARDA data management systems will be an important activity to strengthen linkages (ILRI recommendation 1). Experiences with GRIN-Global currently being tested in CIP and CIMMYT will be taken into account before a final decision is made.	We look forward to hearing this final decision early in 2014.
8. Seed Viability and Germplasm Health	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	ILRI appreciates the support for our retesting plan to better determine longevity and monitoring intervals in forage species and has already made contact with the Millennium Seed Bank for	We are pleased to support both recommendation and response.

	Recommendation	Responses by ILRI	Responses by Crop Trust
	may help cut down on testing 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.	technical support on viability testing and moisture content determination.	
9. Germplasm Characterization	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.	ILRI will address this issue as part of the decision on the new database management system to ensure that characterization data can be easily accessible to users in the new system. Grin Global has a module for characterization data were data can be uploaded. Genesys will be used for publishing.	We are satisfied with this recommendation and response.
10. Collection assessment for gaps/redundancy and acquisition priorities	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.	ILRI strongly supports the need for a global forage crop implementation strategy developed in close collaboration among CIAT, ICARDA, ICRAF and relevant national institutions working on forages to better understand the content and gaps in existing collections and agree priorities and focus for a more coordinated effort to conserve forage diversity in Africa. The forage register developed under the Global Public Goods Project was an important step to collate information on germplasm available in some major forage collections and identify duplicates within and between collections. ILRI has already engaged a consultant who is continuing working on the forage registry. A detailed assessment of the forage collection content will be done as part of the forage conservation strategy (detailed in the response to recommendation 1). The acquisition strategy will follow the conservation strategy recommendations.	Some investment has gone into the crop registry process already and at least one previous review also gave strong recommendations on this issue of scope. We believe there is enough data and past experience to articulate at least some initial thoughts on the scope of the collection at ILRI. It's important that ILRI actively pursues this issue and doesn't just await yet more assessment and recommendations.
11. Distribution	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	• ILRI agrees with the need to enhance the use of the collection for smallholder livestock production, especially in sub-Saharan Africa.	Again this recommendation relates to scope and focus. Here we are glad to see the focus on Napier grass.

	Recommendation	Responses by ILRI	Responses by Crop Trust
	document including improved dialogue with African user community.	• ILRI is focusing on generating knowledge tools to make information from the forage collection more widely available to users. • ILRI is exploring the opportunities to assess the impact of distribution from the forage collection. • An impact assessment is being implemented in 2013 to determine the adoption and impact of disease resistant Napier grass from the collection maintained at ILRI and will guide future forage development and distribution. • ILRI is also exploring the use of biotechnologies to support gene discovery and identify adaptive traits in forages as part of its Feed and Forages Biosciences Programme (FFBP). • Through existing projects implemented through CRPs (Livestock and Fish, etc.) and other donors, the Feed and Forages scientists will use NGO partners to strengthen forage seed systems to support dissemination and adoption.	

ILRI appreciates and expresses its gratitude to the Global Crop Diversity Trust and the review team for the comprehensive external review of the ILRI tropical forage genebank and for the useful discussions and suggestions provided during this process.

ILRI endorses all the pertinent review recommendations and comments and is taking actions to address them, establishing priorities according to the needs and current capacities.

We strongly agree with the need to continue close linkages and expand mutual activities while maintaining a decentralized CGIAR forage collection. In addition to the on-going collaboration with CIAT and ICARDA, we have identified several areas (especially the forage conservation strategy) where collaboration will result in increased efficiencies. We also acknowledge the urgent need to address risk assessment issues and upgrade/improvement of the current genebank infrastructures as well as human resources and staff succession pertinent issues.

ILRI is looking at the financial implications of these recommendations and proposing covering some of the costs from other sources, while preparing a budget that will be necessary for the execution of the additional genebank core activities. Aspects of this will require additional human resources and upgrade of some key equipment/infrastructure (namely the genebank cold rooms and building).

A detailed response is presented to each recommendation, including the additional needs to follow up each recommendation; timeline proposed and estimated budgets and priorities.

ILRI is fully committed to support, monitor and facilitate the improvement of efficiencies and upgrade of the forage genebank activities and strengthen its collaboration with other CRPs, and other relevant genebanks to enhance the use of the forage germplasm.

The Trust appreciates the seriousness of ILRI's response and their efforts to finance subsequent actions from multiple sources.

External Review of the ILRI Tropical Forage Genebank Commissioned by the Global Crop Diversity Trust

Stephanie Greene, Simon Linington

November 27-December 1, 2012

Addis Ababa, Ethiopia

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Abbreviations and Acronyms

ATFGRC	Australian Tropical Forage Genetic Resources Centre of the CSIRO
CBD	Convention on Biological Diversity
CCER	Center-commissioned external review in the CGIAR system
CGIAR	Consultative Group on International Agricultural Research
CIAT	International Center for Tropical Agriculture
CRP	CGIAR Research Program
CSIRO	Commonwealth Scientific and Industrial Research Organisation, Australia
DBMS	Database Management System
ECP/GR	European Cooperative Programme for Crop Genetic Resources Networks
ELISA	Enzyme Linked ImmunoSorbent Assay
EMBRAPA	Empresa Brasileira de Pesquisa Agropecuária (Brazilian Agricultural Research Organization)
FAO	United Nations Food and Agriculture Organization
GCDT	Global Crop Diversity Trust
GENESYS	Gateway to Genetic Resources
GG	Grin Global
GIS	Geographical information systems
HSU	Herbage Seed Unit
IBC/E	Institute of Biodiversity Conservation, Addis Ababa, Ethiopia
IARC	International agricultural research centers of the CGIAR
ICARDA	International Center for Agricultural Research in the Dry Areas

ICRAF	World Agroforestry Centre (WAC)
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ILRI	International Livestock Research Institute
ISC	ICRISAT Sahalian Center
LTG	Long Term Grant
LTS	Long Term Storage
MOS	Most Original Sample
MSB	Millennium Seed Bank, Royal Botanic Gardens, Kew
MTS	Medium Term Storage
NARS	National Agricultural Research Systems
NIRS	Near infra-red reflectance spectroscopy
NGO	Non Governmental Organization
PGRFA	Plant genetic resources for food and agriculture
QMS	Quality Management System
SINGER	System-wide Information Network of Genetic Resources of the CGIAR

Executive Summary

This review was conducted to assess the basic operations of the ILRI genebank over the past five years, consider the role of the ILRI genebank within a global system for forage conservation and recommend modifications in the work program for inclusion in the current five-year work plan.

Overall, the ILRI Genebank is a well run facility with highly motivated staff. All the changes that need to be made are ones of degree only. Over the coming few years the ILRI genebank has a number of challenges. Maintenance and replacement issues of the prefabricated genebank building and one of the seed storage units need to be addressed, since both are aging. Staffing structure needs to be examined to ensure that the genebank manager is not stretched too thin, and local detailed SOP's and on-the-job training need to be completed to ensure a smooth succession between the former and current genebank manager. A risk assessment of the collection needs to be carried out to ensure the collection is secured, especially from fire. Efficiencies can be gained in seed storage by moving towards LTS for all seedlots, and limiting the number of seedlots that are associated with individual accessions. The germplasm that ILRI manages is particularly difficult to regenerate, and the genebank has a regeneration backlog that needs to be addressed. The collection is well documented in a customized local DBMS, however the genebank is being challenged to migrate to a new platform, since their current software is no longer supported. Options to ensure characterization data is available to users need to be explored. The ILRI collection has not grown in recent years. Efforts need to focus on defining the scope of the collection in terms of taxonomy and geography, and an acquisition strategy developed driven by user and conservation needs. ILRI can set itself apart from other forage CG genebanks by focusing on forage grasses and legumes that are native to Africa. The ILRI collection contains valuable germplasm but is underutilized compared to other forage collections. Genebank activities that enhance collection use would be beneficial.

The ILRI genebank rightly has a strongly positive international reputation for the conservation of forage germplasm. Under Jean Hanson's (and subsequently Alexandra Jorge's) guidance, it has helped to develop crop genetic resource protocols used by the international community and has trained a significant number of scientists. The bank appears to stand at a cross-road. A successful future depends on it being used to its maximum potential. The continued support through the GCDT of the Genebank CRP is essential if this globally important facility is to thrive.

Background

ILRI's forage genebank was established in 1983 and is located in Addis Ababa, Ethiopia. Since 1994, this material has been held in trust under the auspices of FAO. As part of this agreement, ILRI has agreed (a) not to claim legal ownership over the designated germplasm, nor seek any intellectual property rights over germplasm or related information, (b) to manage and administer the designated germplasm in accordance with internationally accepted standards, including ensuring the material is duplicated for safety and (c) to make small quantities of germplasm and related information freely available for the purpose of scientific research, plant breeding or genetic resource conservation, under a standard Material Transfer Agreement that is used by the CGIAR for all in-trust materials. In 2006, ILRI signed the International Treaty on Plant Genetic Resources for Food and Agriculture. Since 2007, ILRI has received a long-term grant (LTG) from the Global Crop Diversity Trust to support the long-term conservation and sustainable utilization of the forage germplasm held by ILRI. Under the approved Genebank CGIAR Research Programme (CRP), the Trust has taken up a leadership role in managing the funding of CGIAR genebanks. This review of the ILRI genebank will, therefore, be undertaken within the framework and context of the monitoring and financing mechanisms of the CRP.

Aim of this review

The aim of this review is to:

- Assess the outputs and outcomes of the LTG provided by the Trust;
- Review the role of the genebank within a global system for forage conservation.

More specifically to:

- Assess the basic operations of the genebank over the past 5 years;
- Assess the linkages between the work funded within the framework of the LTG and the rest of the genebank's activities, and the overall impact and efficiencies of the genebank within the context of a global system for forage conservation;
- Review the budgeting and management of funds provided for genebank operations and, if necessary, additional activities that have been funded through the CRP (this part of the review was carried out by GCDT staff and is reported elsewhere);
- Recommend modifications in the work program for inclusion in the current 5-year work plan.

The panel and ILRI staff had identified the following specific areas for more focused attention:

- The implementation of the QMS;
- Planned activities to align the operations and clarify the respective roles of the forage collections held at ILRI and other major forage collections held at CIAT and ICARDA;
- The interactions and impacts of relevant CRPs on genebank operation and vice versa;
- Cost-efficiencies in long-term conservation and regeneration.

Overview of the ILRI genebank

- Conserves almost 19,000 accessions of forages representing 383 genera and over 1700 species.
- Genera with over 1000 accessions include *Trifolium*, *Vigna* and *Stylosanthes*.
- 253 genera are represented by 10 or less accessions.
- 57% of the accessions are forage legumes, 24% are forage grasses and 19% are fodder trees.
- Over 5388 accessions were collected between 1983 and 1993 by ILCA scientists in Ethiopia and surrounding countries and are the most distinct, well documented accessions in the collection. This early germplasm set the tone of the collection, which today houses the world's major collection of African grasses and tropical highland forages and specializes in species adapted to high altitude tropics and the dry and semi-arid tropics.
- An estimated 8639 accessions are considered unlikely to be well represented elsewhere.
- The majority of the collection is from sub-Saharan Africa with 17% collected from Ethiopia.
- The remainder of the collection has been acquired from other gene banks. In 2000, 5500 accessions were obtained from CSIRO with the closure of the ATFGRC.
- Among the CG forage genebanks, ILRI has 3000 accessions in common with CIAT and 600 with ICARDA.
- Unlike most CG genebanks, there are no forage breeding programs at the ILRI Addis campus. The genebank has filled this void by evaluating germplasm and identifying 48 "best-bet" species of legumes, grasses and fodder trees that are made available locally for sale by its Herbage Seed Unit (HSU) on a cost-recovery basis. Thus the ILRI genebank not only supplies small quantities of seed from its germplasm collection to support research and breeding, but sells larger quantities of "best-bet" species to farmers, NGOs, government offices, educational institutes and seed producers.

In addition to managing genebank activities and the HSU, the ILRI genebank is also responsible for managing the Forage Nutrition Lab on the ILRI campus.

Review of Gene Bank Operations

Merging the three CG forage collections

The 2005 Center-Commissioned External Review of ILRI proposed to consolidate the tropical forage collections and discussions have been ongoing in this regard. However, each genebank focuses on germplasm adapted to specific conditions: ILRI houses germplasm adapted to high and mid altitude tropic and subtropic forages, especially species native to Africa, CIAT houses tropical herbaceous forage legumes and grasses adapted to low fertility acid soils with high aluminum and ICARDA houses subtropical and Mediterranean forage legumes adapted to dry areas. There are considerable advantages to this separation not only with respect to ecological aspects of regeneration but also in supplying a local user base and reducing potential phytosanitary problems. The three CG genebanks need to maintain close

linkages and maximize joint and mutual activities. Considering its close linkages within ILRI, with its exclusive focus on livestock and forages, we feel that the genebank at ILRI has a pivotal role to play in global forage germplasm conservation and use.

Recommendation

We recommend that the three CG forage collections remain separate and that they maintain close linkages and maximize joint and mutual activities.

Facilities

The ILRI genebank maintains both active and base collections at its site on the ILRI campus in Addis Ababa. Other activities conducted by the genebank include germination testing to monitor seed viability and plant disease screening to ensure disease-free germplasm. The Unit is housed in a prefabricated building built in 1986. During our visit we saw ceiling tiles with water damage (Fig. 1). Apparently the roof has broken down around the roof ventilation ducts, allowing water to pool and leak into the building. A temporary fix to this problem has apparently been made. The ILRI Safety and Risk Committee (Efie Khaemba and Josephet Oluoch were met during the review) has recognized the need to stabilize the building, but considering it is over 25 years old, solutions need to be explored for complete replacement of

Figure 1 Ceiling tiles damaged by water adjacent to seed drying room

Figure 2 Combustible materials stored adjacent to the cold storage unit

the prefabricated part of the building. An annex was constructed within the past few years, on the west side of the prefabricated building to house the germination, germplasm health and molecular laboratories. During our visit we observed major cracks along the floor and up the wall in the new annex, which suggested that its structural integrity needs to be assessed with some urgency.

An additional concern was the storage of potentially combustible items in an area diagonally above the cold storage area. This concern mirrors one apparently already raised by the ILRI Safety and Risk Committee. Empty solvent bottles were removed soon after our visit. However, we would recommend an urgent tidy up of this space which should only be used for storage of equipment with low risk of combustion.

Overall, on the Addis campus, the genebank has well equipped, well-lit laboratories with adequate space for packaging seed, conducting germination and plant health tests, molecular work, and storing herbarium specimens. The space is organized to accommodate efficient

work flow. The ILRI genebank also has several greenhouses and screen houses, a transplant production area and several small field areas on the Addis campus (Shola fields). The main regeneration fields are located at Zwai, Debre Zeit, and Soddo which provide a range of altitude and soil types. Harvested material is taken to Debre Zeit for threshing and cleaning. Facilities at Debre Zeit appeared adequate and suitable for the tasks with a good array of seed cleaning equipment and cool temporary storage. However, field irrigation was one issue identified as a concern. Considering that many legumes (especially *Trifolium*) require abundant water to ensure good seed production, we support all efforts to establish reliable sprinkler irrigation. A further issue was uncertainty over the tenancy arrangement with the Ethiopian Government; already part of one of the fields has been built over to provide an accommodation camp for railway workers.

Recommendations: The storage area diagonally 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. Newly purchased cold storage units should have the capacity to store seed at -20º C. Generally field facilities were good; however, we support all efforts to establish reliable sprinkler irrigation at the Debra Zeit site. Tenancy arrangements with the Ethiopian Government at the Debre Zeit field site need to be monitored.

Human Resources and Succession Planning

Table 1 summarizes the Genebank activities and associated staffing structure. With the exception of laboratory management, the staffing structure appeared adequate with sufficiently well qualified staff in supervisory roles. Although the Nutritional Lab came under the management of the genebank to prevent its closure; it is an ILRI-wide resource. Currently, Alexandra Jorge is responsible for managing the Genebank, the HSU and the Nutritional Lab.

Table 1. Genebank activities and associated staff structure (Alexandra Jorge, supporting documents).

Genebank Area	**Seed storage/ distribution**	**Plant health**	**Viability**	**Characterization**	**Field- Addis**	**Field- Debre Zeit**	**Field- Zwai**	**Field- Soddo**
Activities and tasks	Seed drying Seed moisture Seed packing Seed requests Safety duplication	Disease diagnosis Quality control Testing/Adopting new methods	Germination tests Pre germination for all sites Germination methods Longevity studies	Collection of morphological characters Collection of herbarium samples Lab tests of molecular characters	Field Regeneration field prep, planting, species ID verification, weeding supervision, pest/disease checks, seed harvesting Screenhouse Regeneration potting, species ID verification, pest/disease checks, seed harvesting, watering	Regeneration field prep, planting, species ID verification, weeding supervision, watering, pest/ disease checks, seed harvesting Field genebank as above except no seed harvest *Note: this site cleans and processes seed, and collects characterization & herbarium samples for all sites.*	Regeneration field prep, planting, species ID verification, weeding supervision, watering, pest/disease checks, seed harvesting Field genebank (as above except no seed harvest)	Regeneration field prep, planting, species ID verification, weeding supervision, pest/disease checks, seed harvesting
Supervision	Alexandra Jorge				Alexandra Jorge/Asebe Abdena			
Research technician/ Research officer (RO)	Yeshi W/Mariam (2%)	Temeselew Mamo (100%) Yohannes Derese (70%)	Yeshi W/Mariam (73%)	Yohannes Derese (30%)	Asebe Abdena (10%) RO Yeshi W/Mariam (25%)	Asebe Abdena (30%) RO	Asebe Abdena (20%)	Asebe Abdena (20%) RO
Technical assistant	Mulu Abebe (5%) Juneidi Abas (40%) Solomon Fikre (15%)	Gebre H/Giorgis (20%) Solomon Fikre (30%)	Mulu Abebe (95%) Solomon Fikre (30%)	Gebre H/Giorgis (20%) Juneidi Abas (20%) Solomon Fikre (10%)	Gebre Hiwot Giorgis (60%) Juneidi Abas (30%) Solomon Fikre (15%)	Tesfaye Tadesse (70%) Yirsaw Wubete (100%) Fetene Arega (60%)	Tsige W/Tensai Amanuel Hailu	Bezuayehu Angasu Michael Gashaw
Security guards							Bonso Bude Deksiso Gemeda Zeyede Tsige	Anjasa Tugo Dubale Dulo
Cleaner						Aberash Tadesse		Asnakech Awano
Admin. assistant	Aster Mehret							

Within the Genebank, there are labs that focus on germination testing, plant germplasm health and molecular biology. These require daily oversight from Alexandra to ensure production of high quality data, especially the molecular marker lab. Similarly, relatively junior staff carry out much of the banking work with relatively little supervision (spot checks are carried out); errors at this stage can take considerable effort to rectify and in some cases may never be detected. Given the scope of Alexandra's responsibilities, we recommend a staff member be hired and supported jointly by ILRI, to manage the quality assurance in laboratory and banking work, including the Nutritional Lab.

Succession planning was more of a concern. Dr. Jean Hansen, who has managed the genebank from its inception, retired in 2010. Currently she is retained as a consultant. Efforts have been ongoing to develop and refine Standard Operating Procedures (SOP). ILRI have played an instrumental role in developing the SOPs published on the *Crop Genebank Knowledge* Base website and use these as a basis for their work. However, the on-line SOPs need to be adapted to reflect local facilities and procedures. We highly recommend that these SOP be completed within one year and that they focus on detailing the local procedures used. This is particularly important for the local database, which was developed by Dr. Hansen. The SOPs need to be detailed enough that, in the absence of Jean Hansen and Alexandra Jorge, current staff and new hires could manage the day to day operations. A second recommendation is to ensure that succession planning is in place for Asebe Abdena. He has been a long time employee with extensive knowledge and experience at the genebank and holds key responsibilities for regeneration and seed production.

Not surprisingly, the problem was expressed to us of staff that have been trained leaving for better jobs. There is not an easy solution to this though anything that improves the career structure will help.

Currently, the Genebank can call on an electrician who is well experienced with the management and maintenance of the refrigeration equipment on site in Addis and Debre Zeit. It was suggested that ILRI may out-source electrical work. There are considerable concerns should this happen as the quality of service could decline particularly if personnel not experienced with the particular equipment are used e.g., for out-of-hours call out.

One aspect of the genebank's work that must not be overlooked is the large amount of capacity building that it provides drawing interns and students from a wide range of countries in both the Developed and Developing World. Within the CG network, interviews with both Daniel Debouck (CIAT) and Ahmed Amri (ICARDA) highlighted the potential value of three month exchange visits of staff between the three CG centres working with forage genetic resources.

Recommendations

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 genebanking 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.

Risk Assessment of Collection

Discussion with members of the ILRI Safety and Risk Committee revealed that the last project-level risk assessment had been four years ago. 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. Similarly, a regular testing regime for safety devices should be in place. Although the risk assessment available on the Crop Genebank Knowledge Base would be a helpful guide, it was felt that it was overly complicated and contained far too many items concerned more with quality assurance rather than catastrophic collection loss. To this end, all potential risks of fire should be considered (see note above about storage of combustibles above bank) including dust, poor electrics etc. Leaving aside safety duplication (see below), accidental loss of this (or indeed any similar world-class collection) could have far-reaching effects beyond the immediate effect; there could be a severe international loss in confidence in genebanking. Although there is a fire detection system in the building housing the genebank it only alarms in / on the building. Consequently, at night, detection requires one of the security guards to be in earshot. This appears to be too hit and miss and given the extremely valuable nature of the germplasm, we would urge that a hard-wired alarm link be made to the security office. We understand that the fire protection provider has two trucks and foam / carbon dioxide extinguishing systems are used. We also understand that a single lightning conductor adequately covers the entire campus. Flooding would not appear to be a major risk as the genebank building has not been inundated since its inception and additionally there are drainage culverts around it.

Power supply seems to be adequate with a back-up generator in place. Because the stored collections are packaged, short periods of power failure although undesirable will not be disastrous. However, collection drying and experimentation could be severely affected.

The potential damage at the ICARDA site during the civil emergency in Syria has thrown into sharp relief the potential risks at other CG centres. With civil unrest having occurred in Addis during the last decade, consideration should be given to whether and if so, how, the most important collections could be moved to safety. We would recommend that this be considered as part of the risk assessment. As a precaution, the most important collections should be labeled in order to allow rapid extraction from storage.

Data is backed up regularly on site but there was uncertainty about whether it is regularly transferred to ILRI in Nairobi. This needs to be checked.

Recommendations

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 labeled in order to allow rapid extraction from storage. Regular data back-up transfers to Nairobi need to be confirmed.

Seed Storage

Cleaned seed is brought to the ILRI Gene bank and stored in a walk-in drying unit kept at 20ºC and 20% relative humidity for 4 weeks (the room is filled twice each year following harvesting). Seed moisture content is then tested and seed repackaged when it's at 5±2% moisture content.We understand that a Rotronic RH monitor is on order; this should allow non-destructive monitoring of the dryness of the collections. The drying is by means of a Munters dehumidifier located in an outside covered cage. However, if the intake and extract of the reactivation cycle for this unit could be moved further apart greater efficiency might be achieved (see figure); similarly, it would be worth checking the damper setting to ensure >90% recirculation within the dryer.

Medium term seed storage (MTS) is accommodated in 2 cold storage units that are kept at 8ºC. One unit was purchased in 1986 and the second in 1995; compressors were replaced in the 1990's (and are located in an external covered cage). The newer room has an internally-mounted dehumidifier. 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. Similarly, consideration of the future availability of certain refrigerants needs to be considered. In the EU, R12 and R22 refrigerants are no longer available after 2015 and this may be reflected internationally.

Seeds of all accessions in the MTS units are stored in laminated aluminum foil packets. Seed is organized by harvest date and the database is used to locate accessions. A variety of foil bags are currently used, the best quality being those used to send samples to Svalbard. It is strongly recommended that high quality bags are used for all samples (LTS and MTS). Although more expensive, the added cost is a minor addition to the overall costs of running the bank bearing in mind the value of the material.

The following data on the status of the collection was established as part of the review (though ILRI needs to confirm the final figures). The fact that this took time to establish indicates the annual performance indicator questionnaire (Table AS1) completed for the

GCDT needs to be adapted in order that the fields to be completed yield mutually exclusive information.

Table 2. Status of the accessions showing their best storage conditions

Storage type	**Viability test**	**No. accessions**	**Comment**
Long-term	Passed	3302	Jean Hanson data / Table AS1
Long-term	Not tested	1211	Jean Hanson data. Unregenerated accns
Long-term	Not passed	1012	Jean Hanson data
Medium-term	Passed	5096	Deduced from table AS1. Of these, 1202 need to be regenerated due to low seed number. Priority for LTS
Medium-term	None	6744	Incl. 5248 CSIRO
Living collection	-	1353	Jean Hanson data / Table AS1
Total		**18,718**	

The above table categorizes accessions based on the best storage conditions under which they are kept. There are actually 17,285 accessions in MTS so most of those in LTS can also be found in MTS[1]. If we accept that the collection stored only in MTS should be secured where possible in LTS and leaving aside the CSIRO collection (see below) and the living collection, 6592 accessions should be prioritized for backing-up under improved storage conditions. If possible, all collections (including living collections with 'short-lived' seed storage) should be under LTS conditions though it is accepted that work should be prioritized. Although a first step is to merely subsample the MTS collections and place them under LTS, this may have limited benefit as Walters *et al.* (2004) showed that the benefit of low temperature storage (at -18 or -135ºC) on seed longevity was progressively lost if seeds were first stored at 5ºC. This could also have implications to collections already duplicated in Svalbard (see below).

Of the 5525 accessions in LTS (comprising original, wild-harvested accessions collected by ILRI up to 1993 and the 'most-original' samples of accessions only held as regenerations), 1211 have not had viability tests due to insufficient seed quantity, and 1012 have unacceptable viability, thus 2223 accessions in LTS should not yet be considered as secure.

[1] If Table 2 is correct and 1211 accessions in LTS have never been regenerated and if the living collections are not represented elsewhere in the collection, then there would appear to be only 18,718 – 1211 – 1353 = 16,154 accessions in MTS indicating a data mismatch. ILRI need to clarify the situation.

Most accessions have multiple seed lots, reflecting different regenerations and multiple harvests during the lifetime (sometimes several years) of a given regeneration. Although the gene bank has nearly 19,000 accessions, 65,000 seed lots are physically stored and monitored for viability. We would strongly recommend a reduction in the number of multiple samples of each accession in MTS. The argument for maintaining multiple samples is, rightly, that there could be significant ageing between the first and last samples taken from a regeneration carried out on a perennial accession over several years. However, if the rate of ageing was slowed then this argument doesn't hold so strongly. Consequently, we would recommend that consideration be given to lowering the temperature to -5ºC in the two cold rooms currently running at 8ºC. We understand that the newer room is capable of operating at -7ºC; there is a question mark over the older room. By lowering the temperature by 13ºC, for example, there will be a theoretical increase in longevity of three times for *Eragrostis tef* (using the seed viability equation constants of Zewdie & Ellis, 1991). Under these circumstances, we believe that it is reasonable to combine future harvest samples from a given regeneration provided that the population size has not changed dramatically between the start and finish of regeneration. This would considerably reduce the amount of viability testing and would allow the genebank to offer the user a genetic mix representing all harvest dates (currently the oldest available sample is offered). A few distribution samples could be pre-packed separately from the main bulk. The downside to this overall approach is that the bank needs to consider the practicalities of combining samples through time using a foil bag system. The above relates to regenerations from now on and so leaves the problem of what to do with the existing samples. The same approach could also be adopted, accepting the inherent weaknesses with respect to seed viability (see comments above). Another suggestion would be to viability test only the oldest and newest samples from a regeneration and to distribute from the newest sample (thereby providing the user with the highest quality seed with greatest chance of field establishment) until a proven interest in the material was established. Consideration should also be given to reducing the quantity of seed sent to users.

Long term seed storage (LTS) is accommodated by upright freezers. Although only 13 out of 20 are currently in use, there is insufficient upright freezer space to house the entire collection. Although the establishment of base and active collections was recommended by the SGRP review in 1996, and the CCER report in 2005, little progress has been made in increasing the number of accessions in the base collection. Considering the efforts needed to establish two separate collections, this is understandable. However, considering the gains in efficiency that result from increasing seed longevity, we recommend that the ILRI genebank move towards storing the majority of their accessions under LTS conditions as mentioned above. If new storage facilities are built, consideration should be given to storing all samples (for conservation and distribution) under LTS. We accept that there may be concerns amongst staff of working at 8ºC let alone at -5ºC or -20ºC. It is our belief that some of this might be due not to the temperature but due to the current design of the cold room which lack windows and natural light. This could be rectified in any new build. This said, staff would need to be trained not to go directly from outside to -20ºC without acclimatization as the temperature shock is potentially dangerous. Another option is to store a small quantity of distribution seed at 8 º C, for those accessions with a marked distribution history.

Recommendations

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 8ºC, to -5ºC. 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 (ref table 2). Finally, it is strongly recommended that high quality bags are used for all samples.

Regeneration

Approximately 45 % of the ILRI seed accession collection has low seed numbers (2011 Baseline Performance Indicator Report). 8073 active seed accessions have only a single seed lot (i.e. they have never been regenerated, personal communication, J. Hanson). This includes 5248 CSIRO accessions; however these accessions are low priority for regeneration, safety backup and germination testing. Based on these priorities, the 2012 regeneration backlog estimate is 2825 accessions[2]. In the 2005 CCER report, the regeneration backlog was estimated at 3500 accessions, and at a regeneration rate of 700 accessions per year, the backlog was predicted to be eliminated in 2010. In light of these numbers, there appears to be a bottleneck in the regeneration process. Considering that most of the accessions managed by ILRI are wild species, and that they have many different wild species, and that wild species are typically difficult to grow and poor seed producers, and that many are cross-pollinated, regeneration is a considerable challenge. An additional challenge is accessions with low seed numbers. It's not surprising a bottleneck has been encountered as ILRI addresses regenerating the most challenging accessions. In light of this, we recommend that funding for non-recurrent costs be continued contingent upon ILRI developing a detailed regeneration plan that provides a realistic timeframe for regenerating the backlog. We also encourage ILRI to explore new approaches that will help them to meet the challenges presented by their "problem children". One approach is to increase their capacity for cross pollinated species. The regeneration fields at ILRI are arranged as isolation blocks separated by a large intervening field used to produce seed for the HSU. ILRI maintains a physical isolation distance of 100 m between accessions of the same out crossing species. For insect-pollinated forages this is the acceptable standard, but not the most preferred standard (which is pollination cages) proposed by the ECP/GR Forage Working Group (Boller et al. 2010). For wind pollinated grasses, evidence suggested that 50 m is adequate (Johnson et al. 1996). If perennial grasses were used as isolation barriers, the distance could be reduced to 30 m (Marum et al 2007). We recommend that isolation distances be reduced for wind pollinated grasses, if that would help free up ground to increase more accessions per year. Certainly experiments could be conducted to investigate the feasibility of this option. Another option would be to investigate the use of pollination cages. If a commercial source for bumble bees or leaf cutter bees can be located, these pollinators are easier to work with than honey bees.

[2] This figure needs to be reconciled by ILRI with the data in Table 2 which in turn need to be confirmed

We also suggest following up with Amri Ahmed's (ICARDA) suggestion that ILRI could house some of ICARDA field collections, in exchange for ICARDA conducting cage increases on ILRI germplasm (of course, dependant on ICARDA situation). Another suggestion is to increase the number of plants per plot for accessions that are low seed producers so adequate seed can be produced in the shortest amount of time. Use of cages and short regeneration periods has the added benefit of reducing genetic change by minimizing pollen contamination and selection. We encourage the genebank to increase accessions with low seed numbers, especially if seed age is greater than 20 years. We recognize this is difficult to do when seed quantity and quality are poor, since the risk of losing accessions is high. However, the risk should be taken bearing in mind that losing accessions due to regeneration is an acceptable part of the process. What is not acceptable is loss due to seed death in storage when regeneration (or recollection) is not attempted.

Recommendation

We recommend that funding for non-recurrent costs be continued 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 also encourage ILRI to explore new approaches that will help them to meet their regeneration challenge.

Database/Documentation

Dr. Jean Hansen is to be commended for the comprehensive program in FoxPro 2.6 DBMS that she has developed to manage information on all activities in the gene bank. The quality and quantity of passport information in the database is also to be commended. Because Fox Pro is no longer supported by MicroSoft, 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. Recognizing the expertise required to develop and maintain a DBMS, and the desirability to harmonize with the other CG Forage genebanks, we recommend that Grin Global (GG) be used. GG has been developed as standard off-the-shelf genebank software that not only supports daily activities, but provides a web-based interface where users can browse, select and order accessions. GG will need to be customized to meet ILRI's specific needs and resources should be made available to facilitate the migration. The benefit of using GG is that it helps avoid the problem of genebank staff being dependent on a single "guru" to operate and maintain a custom DBMS system. This appeared to be the current situation, although SOP's are being developed and Alexandra is receiving on-the-job training from Jean Hanson. In determining a new platform, the ILRI genebank needs to keep in mind that GG is already being adopted by major CG genebanks and national gene banks, so an active user community and outside technical support are available to support the current migration and ease transitions in the face of further staff turnover. We also recommend that ILRI explore opportunities to harmonize their database and web user interface with the other CG forage genebanks. Whether this occurs through Genesys or Grin Global, forage users will find it easier to access germplasm, and appreciate the opportunity for one-stop shopping using a single portal.

Recommendation

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.

Seed Viability and Germplasm Health

ILRI activities in these areas were generally well managed. The Genebank is to be commended for their efforts to test and clean germplasm with respect to diseases, especially Napier grass.

Germination testing involved using the best conditions noted in the literature. There is considerable scope for exchanging germination data and experience between ILRI, CIAT and ICARDA and also other international banks (such as the Millennium Seed Bank).

ISTA techniques have mainly been adopted. Seed tests are based on four replicates of either 25 or 50 seeds and the results analyzed using tolerance tables. When experimenting to find dormancy-breaking treatments, a single replicate of 10 seeds might save time and seeds. A germination medium of 1% water agar was used. There is an aim to retest grass collections every five years and legume collections every 10 years. There was a major round of retesting nine years ago and there is a plan to carry out a large retest in 2013. There is an intention of using these retest results to provide the third point on a set of decline curves for collections and through aggregation for species. This will allow re-estimation of retesting intervals and may help cut down on testing by lengthening the intervals for a number of species. We support this plan but would advise ILRI contact Robin Probert from the MSB who has considerable experience in this area (now contacted).

Recommendation

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 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.

Germplasm Characterization

The ILRI genebank captures a large quantity of characterization data during the regeneration process. We suggest that ILRI consider photographing accessions as they are regenerated. Images should be taken using a standard format, with scale and color standards. Images of overall plant habit and close-ups of flowers, pods and seed (using a flat bed scanner) are useful to plant breeders and taxonomists. A challenge that ILRI faces is getting characterization data into the hands of users. An ideal situation would be to allow users to query the characterization data to select accessions with specific attributes. At the very least this data should be available online when users browse the collections. As the ILRI genebank

determines the best platform to migrate to, it should keep in mind that the Grin Global public website will soon have the capacity to deliver characterization data in both formats.

Recommendation

We recommend that ILRI consider photographing accessions as they are regenerated. ILRI also 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.

Safety Duplication

While safety duplication is essential, few genebanks would find it easy to reconstitute their collection from this source in the event of a disaster – therefore the risk assessment (see above) is also essential. The safety duplication of ILRI's collections was laid out in Table B.01 of the 2011 Baseline Performance Indicator Report and appears to be at 65%. All germplasm collected by ILRI from 1983-1993 (i.e. ILRI's most distinct germplasm) was duplicated through black box arrangement either at the Royal Botanic Gardens Kew Seed Bank, UK (now the MSB – duplicates were some *Neonotonia* collections) and the ICRISAT Sahelian Centre (ISC), Niger between 1987 and 1991. However, the collection from ISC was returned to ILRI in 2001 and efforts have been underway to regenerate the germplasm. The ILRI genebank considers overlapping duplication with other collections as "safety duplication". We recommend that formal agreements be made with all institutes with duplicate accessions (for example CSIRO and CIAT) to recognize these accessions as safety backups for ILRI. We also recommend that these institutes notify ILRI if the status of these accessions change. These agreements should be noted in subsequent performance indicator reports. We recommend that within 5 years, 90% of the collection be safety duplicated, including field collections which should be established at a second site, or cryo-preserved. We recognize the efficiency of regenerating accessions prior to safety duplication, however, for valuable ILRI-distinct germplasm that may not be queued up for regeneration in the near term, we suggest safety duplication be carried out, even if it means splitting very small seed lots.

ILRI has already duplicated some collections in Svalbard. We note that one of the requirements of duplication in Svalbard is that material must also be duplicated elsewhere e.g., CIAT. This 'triplication' seems surprising and we would suggest that the GCDT reviews the return on this extra effort and use of resources.

Recommendation

We recommend that formal agreements be made with all institutes with duplicate accessions (for example CSIRO and CIAT) to recognize these accessions as safety backups for ILRI. We also recommend that these institutes notify ILRI if the status of these accessions change. We recommend that within 5 years, 90% of the collection be safety duplicated, including field collections which should be established at a second site, or cryo-preserved. We recognize the efficiency of regenerating accessions prior to safety duplication, however, for valuable ILRI-distinct germplasm that may not be queued up for regeneration in the near

term, we suggest safety duplication be carried out, even if it means splitting very small seed lots.

Collection Assessment for Gaps/Redundancy and Acquisition Priorities

Since the collection was originated, there has been general recognition that original collecting efforts did not adequately sample forage species diversity in Africa (i.e. Hanson and Maass 1999). However, no germplasm acquisition has taken place since the in-trust agreement was signed with FAO in 1994, except a major donation in 2000, of almost 5500 accessions received from ATFGRC (CSIRO) when it closed its operations. It's understandable that acquisition has been placed on hold due to the complex legal situation introduced by the CBD in 1993. However, many countries have since developed permitting and benefit-sharing mechanisms which allow joint collecting efforts to move forward. For example, in recent years, the MSB has formed effective partnerships with many African countries to collect wild species. Given the rich diversity of grasses and legumes in Africa and a quickly changing landscape, it is imperative that ILRI focus efforts on securing valuable gemplasm before it is lost. However before embarking on collecting missions, the ILRI genebank needs to carefully identify gaps and redundancies and develop an acquisition strategy. A logical starting point would be to create a prioritized list of forage species that are used or have potential for use and that are native to Africa. Examples of new African species of interest include *Trifolium michelianum* and *T. resupinatum* (Nichols et al. 2008), *T. spumosum* (Loi et al. 2012), and *Bituminaria bituminosa* (Pang 2011). Species of interest, but with insufficient germplasm available include *Biserrula pelecinus* (personal communication, Amanuel Asrat 2012), *Listia bainesii* (syn. *Lotonois bainesii*) (Hughes et al. 2008), and *Vigna parkeri* (Kretschmer and Pitman 2001). Crop wild relatives that are native to Africa also need to be identified; not only of forage crops but cultivated crops. For example, important CWR of pearl millet are *Pennisetum stenostachyum, P. purpureum* (Napier grass), and *P. squamulatum*. The progenitor species of *Eragrostis tef* is thought to be *E. pilosa* (Ingram and Doyle 2003). Species that are vulnerable or endangered also need to be identified and targeted for conservation. For example, *Trifolium ukingense* and *T. wentzelianum* var. *wentzelianum*, are both endemic vulnerable species in Tanzania; *T. somalense* and *T. spananthum* are endangered and rare species in Ethiopia (1997 IUCN Red List of Threatened Plants). Once a list of potential candidates is identified, species distribution maps can be compared with the locations of accessions already collected to identify geographic gaps. Only after target taxa and geographic areas have been identified, should efforts focus on identifying collecting partners and funding. ILRI does have a newly funded collecting project with the Volcani Institute, to collect in Israel. However, Israel has an arid Mediterranean climate, and the species targeted (especially annual medics) are species managed and distributed by ICARDA. In acquiring new germplasm, care needs to be taken to limit overlap between the three CG forage genebanks. ILRI's focus should be on strengthening its representation of high and mid altitude tropic and subtropic forages, especially grasses and legumes native to Africa.

A comprehensive examination of the ILRI collection would also be beneficial for identifying overlap with other forage collections. Operational efficiencies could be gained by limiting redundant holdings, especially for those accessions not requested. For example, can the 3000

accession overlap with CIAT be minimized? How much overlap is there between ILRI's fodder tree collection and ICRAF? Why are there 613 accessions of crop species such as oats, beans and pea? Even if there is interest in developing feed-fodder crops for Africa, these accessions are best held and distributed from the mandated CG genebank. There are 1128 species which are represented by 3 or less accessions. If these accessions are maintained by other genebanks, and if they have never been distributed, can ILRI take them out of their collection? Finally, what's to become of the large CSIRO donation? In 2000, CSIRO originally identified these accessions as less important and placed them in a base collection. ILRI agreed to distribute the seed but considers regeneration, viability monitoring and safety backup a low priority. Circumstances in Australia may be changing with the recent implementation of a national PGR program. The ATCFC at Biloela, Central Queensland should be contacted for an update to see if they are now actively managing the entire original CSIRO ATCFC collection. At some point ILRI needs to carefully examined this collection and decide if it's worth incorporating into the main collection, or if they are simply going to distribute seed until seed is exhausted or dead. A key factor for effectively developing a germplasm collection that serves a dual purpose (i.e. meeting the needs of a broad range of users, and conserving germplasm for the future) yet remains manageable in size, is having a curator that understands the gene pools of the crops in question, who is actively engaged with users and other PGR institutes conserving the same or similar material. For example, it would be beneficial for ILRI to network with the Australian PGR community, but also EMBRAPA / CENARGEN in Brazil.

Recommendations

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.

Distribution

A total of 20% of the ILRI collections are in the ITPGRFA multilateral system and 80% outside. However, all samples are distributed under the sMTA. A *Rhizobium* collection is also available from ILRI and samples are occasionally supplied with seed. Overall the distribution levels appeared low; less than 1000 samples have been distributed annually since 2008. We conducted a survey of collection users and potential users, which is summarized in Table 3. The general consensus of the three users we communicated with was that they received sufficient amounts of seed, and that the seed had good germination and was clean. One mentioned about the difficulty of getting the form (sMTA) that needed to be filled in. Associated data was sufficient. Accessing the collection and selecting material was best done by directly interacting with the genebank manager who provided good customer support.

Table 3. Collection users and potential users contacted during the review.

COLLECTION USERS	Germplasm requested	Use of Germplasm	Comments
Jean Francois Arrighi, Laboratoires de Symbioses of Tropicales et Mediterranean, France.	*Aeschynomene* species	Looking at NOD factors present in South American and African species of *Aeschynomene*	Suggested more collection was needed for African species due to their unique nodulation at root and stem level.
Amanuel Asrat, Center of *Rhizobium* studies, Murdock University Australia	Forage legume species	Examining rhizobium diversity in native forage legumes of Ethiopia	Suggested more collections of *Biserrula pelecinus* were needed.
Tony Hooper, Rothamstad Research, UK	Various species	Examining semiochemistry of the plants to see how they may interact with soil microorganisms, insects and weeds	ILRI seeds were desirable due to high quality
POTENTIAL USERS	Comments		
Chris Tsopito, Ruminant Nutritionist in the Department of Animal Science and Production at BCA, Botswana	Was not aware of the ILRI genebank but expressed interest in knowing more when he was contacted.		
Melanie Harrison-Dunn, USDA Tropical Grass Curator, Griffin, GA	Was aware of ILRI genebank but has not had any interaction with the genebank		
Russell Jessup Texas A&M Univ, TX	Was aware of the ILRI genebank but has never requested seed from it nor interacted with staff, mainly due to different program interests		
William Anderson USDA/ARS Research Geneticist, Tifton Georgia	Has not ever requested germplasm from ILRI because he does not know much about them. Requested a list of taxa and web site link when contacted.		

Recommendation

We recommend that the ILRI genebank focus on activities that will enhance the use of the collection. Specific suggestions:

- As relevant CRP's are implemented we recommend that mechanisms be put in place to ensure the ILRI genebank manager be a part of initial planning efforts so that genetic resources are integral to the programs and not bolted on later. The importance of genetic resources within the CG value chains was discussed with CRP 3.7 leader, Tom Randolph, and nutritionalist, Michael Blumel. They stressed that the call for genetic resources was demand-driven. However, it does seem to us that if users are not necessarily aware of what is available they will not demand it. Special mention was made of dual purpose crops which might tend to suggest the kinds of forage species held by the ILRI genebank are unlikely to be in demand within CRP 3.7 at least, especially as there was particular concentration on dairy systems in Tanzania and India. This said, the traits (e.g., salinity or drought tolerance) held by the forage collection may be of interest and this was re-iterated in interviews with Ian Wright and Shirley Tarawali who stressed the potential value of the material to biotechnology especially given the access to the latter on the ILRI campus. There are a number of other CRPs with which ILRI is linked and dialogue needs to be started with them soon.
- Increase linkages and partnerships with users outside of the CG system, for example IBC (keep pursuing the possibility of collecting in Ethiopia), EMBRAPA, ATCFC, USDA and others. We have been encouraged by the extent of current partnerships. In the *short- term* there needs to be enhanced visibility of genebank database on ILRI website and in the *medium-term*, improved collection visibility and ordering through internet site such as GRIN global web.
- Enhance availability of accessions by addressing regeneration backlog. Expand scope of what is available through seed collection and especially in response to a dialogue with the potential African user community on what they'd like to have available.
- Capitalize on collection site georeference data and available GIS resources (such as those offered by GeneSys) that provide environmental datasets (i.e. rainfall, soils) to help users identify germplasm adapted to specific target environments. This can help package collections for the user.
- Keep in mind that the user community is focusing on topics other than traditional forage crop improvement (i.e., there is a user community outside the CRPs). Users are conducting *Rhizobium* studies, phylogenetic analysis and will be mining useful alleles from CWR using genomic tools. Discussions with small number of users revealed some exciting studies e.g. on *Rhizobium* phylogeny.
- Follow up of use was highlighted as particularly important. One suggestion was to request the user's Skype address such that follow up at intervals could be made without the need for the user to fill out a questionnaire. It is felt that success stories with respect to use are an essential way of highlighting the value of the collection to funders. It is instructive that the outcome stories in the 2011 Performance Indicators Report centre on Napier Grass when a few Skype interviews revealed interesting research using an array of other ILRI material.

Conclusion

Overall the ILRI Genebank is a well run facility with highly motivated staff. It is the only CG facility devoted solely to forage germplasm and within the ILRI environment it has all the appropriate research and expertise on hand to ensure that it plays a central role in global forage germplasm utilization. Its significance is heightened at present by the disruption to the involvement of ICARDA in this area. There is the concern that the CRPs (such as 3.7) may have a fairly restricted interest in forage germplasm. It is the job of the ILRI genebank leadership to find ways of demonstrating the potential role for the germplasm within the CG value chains. This said, it is essential to remember that the collections have a wider international role in underpinning crop improvement and scientific discovery.

The ILRI genebank has a number of challenges over the coming few years. The very first task of a genebank is to secure the germplasm that it has been entrusted with. Consequently, it must ensure that the collections (or at least samples of all of them) are stored under the best conditions to make sure that they are available for future generations. One of the greatest benefits of genebanks is that a large amount of diversity is located in one convenient place. This is also their biggest potential downfall. Consequently, it is essential that the material is adequately duplicated (triplication is not necessary) and that risk assessments are comprehensive. The material must also be monitored for viability and the documentation must be objective and as complete as possible. With this in place, it is essential that the germplasm is made to work and in order for this to happen there needs to be good connection to the potential user community. All the changes that need to be made are ones of degree only. Most of the above happen but a further push will make a significant difference.

The ILRI genebank rightly has a strongly positive international reputation for the conservation of forage germplasm. Under Jean Hanson's (and subsequently Alexandra Jorge's) guidance it has helped to develop swathes of crop genetic resource protocols used by the international community and has trained a significant number of scientists. The bank appears to stand at a cross-road. A successful future depends on it being used to its maximum potential within the CRPs and, preferably, its continued tenure at the Addis site. The continued support through the GCDT of the Genebank CRP is essential if this globally important facility is to thrive.

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Appendices

Appendix 1- Review panel

Stephanie Greene (Chair)

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Appendix 2- Agenda

Day		Item	Issues to be addressed
Day 1 (Tuesday 27 Nov)	8:30 – 9:30	Logistics	Setting up computers to network and to printers, Bank issues, etc
	9:30 – 10:15	Brief presentation by the Review Panel Chair and Q&A to all relevant staff including senior management	Introduction to the review panel and to the objectives of the review
	10:15 – 10:30	Coffee break	
	10:30 – 11:30	PLE director presentation	ILRI vision and work and how the genebank connects into the various teams.
	11:30 – 12:30	Genebank presentation	Overview of genebank objectives, activities and major links with other units. Introduction to all genebank operations and review of the basic operations and main activities of the past 5 years
	12:30 – 13:30	Lunch	
	13:30 – 15:30	Tour of the genebank facilities in the fields, screenhouses and laboratories (Shola site)	Getting to know the genebank infrastructure and the people who work there.
	15:30 – 17:00	Data Management Unit	Data management issues, data archives, distribution and acquisition
	17:00 – 18:00	Skype conference with key forage genebanks	ICARDA and CIAT
Day 2 (Wednesday 28 Nov)	8:30 – 9:00	Queries and clarifications	
	9:00 – 10:00	Web links and knowledge sharing	Forage registries, Crop Genebank Knowledge Base, Tropical Forages, Napier grass google site, GRIN global
	10:00 – 10:15	Coffee break	
	10:15 – 11:15	Seed viability	Seed germination data and procedures
	11:15– 12:30	Seed Health Unit	Seed health data and procedures (including laboratory work)
	12:30 – 13:30	Lunch	
	13:30 – 17:00	Visit to IBC	Visit to the National genebank facilities
	18:30 (bus departure at 18:00)	Traditional dinner and dances	Yod Abissinia or Habesha 2000
Day 3 (Thursday 29 Nov)	8:30 – 9:00	Queries and clarifications	
	9:00 – 17:00	Field visit to Debre Zeit	Overview of field genebank (grasses) and regeneration plots (annuals, perennials and fodder trees). Overview of seed harvesting, cleaning, processing facilities. Overview of

Day		Item	Issues to be addressed
			characterization facilities and laboratories. Seed unit activities and links to CRP 3.7
Day 4 (Friday 30 Nov) Addis campus	8:30 – 9:00	Queries and clarifications	
	9:00 – 10:00	Relevant CRP 3.7 Theme leaders and other forage related/users projects	Linkages with CRP 3.7 (Tom Randolph, Michael Blumel)
	10:00 – 10:30	Meeting with Senior Management – Addis/Nairobi (skype)	Iain Wright, Shirley Tarawali, Steve Staal
	10:30 – 10:45	Coffee break	
	10:45 – 12:30	Interactions with partners and users (NARs, Universities, etc)	Skype or telephone calls with a select group of users and key partners
	12:30 – 13:30	Lunch	
	13:30 – 14:30	Risk Management & Quality Management System	Implementation and impact of the QMS
	14:30 – 15:30	Review of any outstanding issues with genebank staff	
	15:30 – 16:30	Review Panel	Presentation of preliminary recommendations and Wrap-up (skype with Iain Wright)
Day 5 (Saturday 1 Dec) Addis campus	9:00 - 9:30	Queries and clarifications	
	9:30 – 10:30	Meeting the ILRI health and safety committee	
	10:30 – 10:45	Coffee break	
	10:45 – 11:45	Questions for the Review Panel	Issues concerning the management of the grant and the Trust
	11:45 – 12:30	Report writing / final discussions	
	Afternoon	Free	
	Evening	Departure of Simon and Stephanie	
Day 6 (Sunday 2 Dec)		Free	
Day 7 (Monday 3 Dec) Addis campus	8:30 – 9:00	Queries and clarifications	
	9:00 – 12:30	MYB and links with ILRI budget procedures	
	12:30 – 13:30	Lunch	
	13:30 – 15:00	Discuss targets for the genebank CRP	
	15:00 – 17:00	Pending final issues	
	evening	Departure to Nairobi (Charlotte)	
Day 8 (Tuesday 4 Dec) Nairobi campus (Charlotte and Anne)	9:00 – 12:30	Finance Dept in Nairobi (Robert, Sharald)	Financial reporting, illustration of FCR in action, budget issues
	12:30 – 14:00	Lunch	
	14:00 – 17:00	Cont. from morning/report writing	
	17:00 – 18:00	Meeting with Senior Management – Nairobi (set up by Terry)	DG, DDG, Iain, Shirley, Tom

Appendix 3- List of people and institutes consulted

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Appendix 4- List of documents provided by ILRI

- CGIAR Costing Study
- CGIAR Research Program 3.7 proposal
- Signed LTG Agreement
- Genebank CRP Proposal
- PMIs table
- Annual Technical reports (2007, 2008, 2009, 2010, 2011)
- Table f09- Internal Distributions
- Table f10-external distributions
- Staffing Chart
- Distribution breakdown
- Country table for dispatch
- EARO_paper_29Aug 11
- Species prioritization report
- CIAT Forage Strategy Africa
- CIAT Forage Strategy review
- Anti-fraud and anti-corruption policy and risk management policy