

# NACGRAB

## Genebank Review Report 2020



## National Centre for Genetic Resources and Biotechnology (NACGRAB) Genebank Review 2020

<b>Genebank reviewed</b>	National Centre for Genetic Resources and Biotechnology (NACGRAB)
<b>Site visit dates</b>	October 9 - 14, 2019
<b>Review report date</b>	20 April 2020
<b>Institution and Crop Trust responses</b>	
<b>Place</b>	Ibadan, Nigeria
<b>Genebank manager</b>	Sunday Aladele
<b>Review panel</b>	Paula Bramel Simon Linington Bonny Ntare Milko Škofič
<b>Crop Trust staff</b>	Nora Castañeda

Nr.	Reviewers recommendation	Timeframe	Responses
1	Given the concerns raised on financial management and control systems, we recommend that a qualified accountant is recruited or allocated to the S4R project at NACGRAB to oversee the financial management and reporting as well as the implementation of a fixed asset register. In addition, the Crop Trust should conduct on site annual audits of the project financial and technical aspects .	2020 - 2024	<p>NACGRAB: The recommendation is accepted, however we have competent accountants who could be trained to take up the assignment otherwise a new staff may be appointed by the Trust to take up the job.</p> <p>Crop Trust: We understand that NACGRAB has its own accountants with the capacity to manage and control project funds. It is important that an annual financial audit is conducted, as a means to support NACGRAB in meeting the accounting standards required by the project.</p>
2	We recommend that a long-term plan for the sustainable operation of the genebank be developed for NACGRAB and when the upgrade is completed, a costing study of routine operations be done to help secure adequate annual funds for the conservation and use of the collections.	Q1 2023	<p>NACGRAB: Agree. This is necessary to ensure the security of accessions kept in the genebank. It will also enhance sustainability of the genebank for a very long time.</p> <p>Crop Trust: The Crop Trust agrees with this recommendation and NACGRAB's response. To reach a steady state of operation it will be important to have well-established processes and to clear all backlogs.</p>

3	<p>We recommend that NACGRAB invest in enhancing staff capacity for the long term through:</p> <ul style="list-style-type: none"> <li>• On-site capacity building by experts to train staff and upgrade the key processes</li> <li>• Exchange visits with ICRISAT, IITA, ILRI, etc. to build capacity for specific processes</li> <li>• Staff succession planning to address the potential loss of key long-term staff with key knowledge of the collection or seedbank management</li> </ul>	2020 - 2023	<p>NACGRAB: The recommendation is in order, though NACGRAB is already enjoying some support in terms of capacity building from IITA, this will be further strengthened. Staff succession plan is in order, though NACGRAB staff turnover has been very low and most of the staff are at the middle stage of their career.</p> <p>Crop Trust: The Crop Trust supports this recommendation. Training on technical aspects of germplasm collection management is needed to upgrade the operations of NACGRAB. High-level support from NACGRAB management will be required to encourage staff participation and to enable potential changes in processes and institutional culture. Working in a QMS framework will provide support to NACGRAB on staff succession planning.</p>
4	<p>We recommend that a study be done to formally determine redundancy between the collection held by NACGRAB with other collections held by national and international institutions that were either involved in joint collecting with NACGRAB or served as host sites for duplicates. This in-depth analysis of the uniqueness of the accessions should lead to opportunities for rationalization. It would also give NACGRAB an opportunity to recover accessions that have been lost and are no longer found in their original collecting sites. The results of the study would allow for NACGRAB to prioritize crops and accessions for long term conservation.</p>	Q2 2020	<p>NACGRAB: Agree: It is necessary because some of the collections were assembled before adequate technologies for documentation of geo-references and other unique characteristics were available. It will also provide information on long term conservation and safety duplication as well as reduce space.</p> <p>Crop Trust: The Crop Trust supports this recommendation. Under the context of a global rational system of PGRFA, it is critical to understand what unique accessions in national collections may be priorities for regeneration and safety-backup. Based on this study, we encourage NACGRAB to select unique accessions of specific crops, which will be used to assess genebank management performance under the Seeds for Resilience project.</p>
5	<p>As a priority, we recommend that NACGRAB fully clarify the legal status of all accessions that they conserve by determining and making public the access and benefit sharing terms under which accession can be shared. NACGRAB should update the inventory to accurately reflect the current composition of the collection; the active or historical status of each accession; and all available passport and characterization data. This updated accession level information should be shared with users using Genesys</p>	2020 - 2021	<p>NACGRAB: Agree. Nigeria has an access and benefit sharing law of 2008 which domesticates the Nagoya Protocol. However, the ITPGRFA has not yet been ratified, therefore effort is in top gear to rectify this. We have involved the Minister of Science and Technology to prevail on the Minister of Agriculture to expedite action on ratification.</p> <p>Crop Trust: The Crop Trust agrees with this recommendation. It is of critical importance that a material transfer agreement (preferably as close as possible to the SMTA) is drafted and in use in the meantime while Nigeria seeks to ratify the International Treaty for</p>

			Plant Genetic Resources for Food and Agriculture. We encourage NACGRAB to maintain an accurate inventory of its collection as a basis for effective management, collaboration and making accessions available. The inventory should thereafter be kept up to date, as well as relevant information published on Genesys. The Crop Trust encourages NACGRAB to prepare a notification letter of material available in the MLS and submit it to the ITPGRFA Secretariat.
6	To address the lack of secure safety back-up, we recommend that NACGRAB prioritize by crop all unique accessions that are not already safety duplicated for safety duplication with institutions outside of Nigeria to serve as a primary black box and at the Svalbard Global Seed Vault as the secondary site.	2020 - 2023	<p>NACGRAB: Agree. NACGRAB have already done some work in this regard e.g. 108 sorghum, 124 cowpea and 167 pearl millet accessions have been duplicated at Svalbard Global Seed Vault. We have also duplicated the cowpea at IITA genebank as well as millet and 315 sorghum accessions at ICRISAT Regional Genebank in Niamey.</p> <p>Crop Trust: The Crop Trust supports this recommendation. We encourage NACGRAB to prepare a plan for all unique accessions to be safely duplicated in Svalbard.</p>
7	We recommend that NACGRAB adopt a quality management system (QMS), including the development and regular updating of standard operating procedures (SOPs) for routine operations, as well as any new processes.	2020 - 2023	<p>NACGRAB: Agree. NACGRAB will seriously need further capacity building in this regard in order to utilize the QMS and SOPs, with suggestion and support from the Trust.</p> <p>Crop Trust: The Crop Trust agrees with this recommendation. The Crop Trust will continue to provide technical support to NACGRAB on this, working towards the adoption of a minimal QMS by the end of 2023. It is important that the adoption of a minimal QMS is supported and encouraged by NACGRAB management.</p>
8	We recommend that the items in Table 5 be procured with careful consideration of each item by NACGRAB staff and with the guidance in the subsection "Seedbank operations for long-term conservation and active use of the collections" in the full review report.	2020 - 2023	<p>NACGRAB: Agree. NACGRAB procurement unit, with the guidance of the relevant subsection (Seedbank), will follow suitable methods and processes to achieve efficiency and value for money based on international standards.</p> <p>Crop Trust: The Crop Trust supports this recommendation. Particular attention needs to be given to re-organizing the current layout of the genebank, in order to have an area dedicated to germination testing.</p>

9	As a priority, we recommend NACGRAB's accession numbers be used as the primary identifier to label all containers and aluminum packs of seed. The collection number or other alternative ID can be included in the label only if needed. A plan to update labels is required, giving priority to newly collected and regenerated material. Once GRIN-Global and the labelling equipment (printers and readers) are setup and working, all handwritten labels should be replaced with a barcoded label.	2020 – 2023	<p>NACGRAB: Agree. NACGRAB will comply accordingly to reorganize all the accessions as recommended. However, staff will need further capacity building on GRIN-Global and use of labelling equipment.</p> <p>Crop Trust: The Crop Trust agrees with this recommendation and NACGRAB's response. We encourage NACGRAB to adopt GRIN-Global as its genebank management system.</p>
10	We recommend the establishment of a process for documenting and monitoring the quantity of seed conserved for distribution and for conservation against acceptable thresholds, using 100/1000 seed weight for each accession to determine the number of seeds per accession for the purposes of monitoring.	2020 - 2023	<p>NACGRAB: Agree. NACGRAB will comply with the recommendation of using 100/1000 seed weight for each accession wherever applicable.</p> <p>Crop Trust: The Crop Trust supports this recommendation and NACGRAB's response. It is important that the room where these measurements are to be taken is properly set up, as indicated in the review report. We encourage NACGRAB to record information on seed numbers directly in the genebank database and use it, together with viability test results, to decide when regeneration is needed.</p>
11	<p>To address the inadequacy in feedback on the use of accessions, we recommend that NACGRAB utilize a routine formal process for soliciting and using feedback from recipients to improve the use of the collection and seedbank operations with actions such as to:</p> <ul style="list-style-type: none"> <li>● Conduct routine user surveys on the use of the collections, delivery timelines, quality of seed received and other useful information.</li> <li>● Fully implement DOIs to better link to information generated on the accessions.</li> <li>● Develop a procedure for ensuring that information on the evaluation and use of the distributed germplasm is shared with the seedbank to enrich the accession level databases.</li> </ul>	2020 - 2023	<p>NACGRAB: Agree. This is a welcome development and we are pleased with the recommendation. NACGRAB has an Extension and Linkages department which will be saddled with some of these responsibilities.</p> <p>Crop Trust: The Crop Trust supports this recommendation. We encourage NACGRAB to continue digitizing information about its accessions (passport information, characterization and evaluation data), and to request DOIs for its plant material. It is important that NACGRAB develops a procedure to recover evaluation and characterization information of distributed germplasm, particularly from partners such as NIHORT and national research institutes.</p>
12	We recommend that NACGRAB develop and implement a realistic five-year plan to securely regenerate at least 800 accessions per year. There will be a need to initiate conversations with the itinerant farmers and community leaders	2020 - 2023	NACGRAB: Agree. NACGRAB will ensure that all necessary guidelines are adhered to as well as ensure the field site in Ibadan and other three out-stations are secured for the germplasm during regeneration. NACGRAB will also establish a formal arrangement

	<p>in the adjacent areas on how to effectively reduce illegal harvesting and to fence the field sites in Ibadan. NACGRAB also need to establish formal arrangements for regeneration or multiplication by partners. This would include sharing standard guidelines, agreeing field sites and design, and NACGRAB staff overseeing monitoring and harvesting to ensure that accession identity is maintained and seed quality is acceptable.</p>		<p>for regeneration and multiplication by stakeholders. The guidelines for multiplication will also be strictly adhered to.</p> <p>Crop Trust: The Crop Trust agrees with the recommendation. It is important that the regeneration plan gives precedence to unique, threatened accessions of selected crops that fall below seed quantity and viability thresholds. Further details about the regeneration plan should be described in the project workplan. It is important that a plan is in place to avoid illegal harvesting of planted material. We support NACGRAB in collaborating with other institutions in regenerating seed material.</p>
13	<p>We recommend that a long-term plan needs to be made to securely conserve vegetative propagated and tree crops. This would include: an assessment of the risks for the Ibadan site and actions to be taken to mitigate these; an assessment of the level of diversity maintained in the field collections; actions to be taken for safety duplication; and approaches to enhance the use of the accessions. Support should be solicited from IITA to provide technical guidance for planning and implementation to secure these accessions for the long term.</p>	2020 - 2023	<p>NACGRAB: Agree. NACGRAB will liaise with IITA to obtain technical guidance for planning and implementation of conservation of vegetative propagated crops to avoid losses experienced in the past. Field collections will also be replicated in one of our out-stations.</p> <p>Crop Trust: We encourage NACGRAB to identify unique accessions of vegetative crops in coordination with IITA or other CGIAR Centres. It is important that a plan for cleaning and safety duplicating such accessions is discussed with partners as well.</p>
14	<p>We recommend that all efforts be made by NACGRAB to enhance internet connectivity at the seedbank to the server to allow for the full implementation of seedbank information systems such as GRIN-Global.</p>	2020 - 2021	<p>NACGRAB: NACGRAB management endorses the recommendation of enhancing internet connectivity for accessibility of the seedbank to all interested stakeholders.</p> <p>Crop Trust: The Crop Trust agrees with this recommendation and welcomes NACGRAB's response. The Crop Trust will provide technical support to NACGRAB to adopt GRIN-Global.</p>
15	<p>We recommend that NACGRAB utilize the planned National Summit on Genetic Resources to initiate joint actions to better secure conservation of key crop diversity in Nigeria through better coordination, greater sharing of accession level information, annual updates on the conservation status of accessions in the various collections, and increased safety duplication.</p>	2020 - 2024	<p>NACGRAB: Agree. The forthcoming National Summit will be used to address the gaps between and among the researchers/scientists who are users of genetic resources in the research institutions in order to secure conservation of crop diversity in Nigeria.</p> <p>Crop Trust: The Crop Trust supports this recommendation. As the national genebank of Nigeria, it is important that NACGRAB coordinates activities related to germplasm use and conservation with other stakeholders in the country, particularly those</p>

			conserving PGRFA in public institutions. A user group with representatives from other seed collections (e.g. NIHORT) will provide NACGRAB the opportunity to meet and coordinate with national stakeholders.
16	We recommend that NACGRAB organize facilitated meetings at agro-ecological zone level (2-3) with representatives of farmers' organizations, NGOs, local government agencies, research institutions/universities based in the zones, and local seed producers (max. 40 participants per zone). We also recommend that NACGRAB constitute a technical working group of breeders/researchers from other national research centers, universities, and the private sector for characterization, evaluation and use of collections in crop improvement. In order to elevate the profile of the national seedbank and enhance awareness on the importance of supporting it, we strongly recommend that NACGRAB and FMST hold at least two facilitated high-level meetings with key policy makers during the implementation of the S4R project.	2020 - 2024	<p>NACGRAB: Agree. NACGRAB management will ensure that the recommendations are strictly followed through and will constitute a technical working group of breeders/researchers for adequate implementation. The high level policy-makers' meeting will be organized with Crop Trust participating during the S4R project.</p> <p>Crop Trust: It is important that a structured communications plan is first developed, as this can guide NACGRAB's efforts to enhance its communications with all users and other stakeholders, including genebank users. The Crop Trust will support NACGRAB in designing and implementing a communications plan aiming to enhance the genebank's visibility.</p>
17	<p>To address the limited use of national collections and to enhance crop diversity to mitigate the effects of climate change, we recommend that NACGRAB facilitate technical support in the evaluation, characterization, and multiplication of accessions of underutilized and climate-smart crops for direct use in the cropping system by the following actions:</p> <ul style="list-style-type: none"> <li>● Together with the Technical Working Group of researchers/scientists, identify a core collection of underutilized and climate-smart crops (e.g. Bambara, sorghum, pearl millet, yams, popular vegetables landraces and some crop wild relatives) for use in crop improvement</li> <li>● Multiply/bulk seed of selected accessions for distribution</li> <li>● Together with breeders/researchers, conduct phenotypic/genotypic characterization for climate smart traits</li> <li>● With user groups, provide technical support in the evaluation of characterized accessions for climate-smart traits with researchers, farmers' organizations, State</li> </ul>	2020 - 2024	<p>NACGRAB: Agree. The management of NACGRAB endorses the recommendation. We are working with some universities with colleges of agriculture for pre-breeding activities while our extension units are also exposing some of our germplasm to farmer based organizations for direct utilization.</p> <p>Crop Trust: Given restricted resources we would prioritize:</p> <ul style="list-style-type: none"> <li>● The identification of promising landrace material through participatory field evaluation trials.</li> <li>● Multiplication and distribution of promising landraces displaying climate-smart traits.</li> <li>● Registration and multiplication of selected accessions.</li> <li>● Preparation of core collections based on passport and characterization data.</li> </ul> <p>It is important that NACGRAB selects the most promising crop(s) for climate-change affected regions of Nigeria, for which NACGRAB conserves a substantial diversity of accessions. Collaboration with relevant researchers and breeders is key and</p>

	<p>Agricultural Development Programs (ADPs) and NGOs that can then facilitate access to seed and knowledge to farmers.</p> <ul style="list-style-type: none"> <li>• With breeders, undertake introgression and genetic enhancement with selected accessions to develop diversified populations</li> <li>• Conduct participatory selection with farmers to identify preferred resilient varieties (medium term)</li> <li>• Seek registration and seed multiplication of selected varieties</li> <li>• With support from farmers' organizations, ADPs and NGOs, facilitate access to seed and knowledge to farmers (long term).</li> </ul>		<p>Crop Trust would support outsourcing some of these activities with specialized NGOs or other institutions based in Nigeria.</p>
18	<p>We recommend that a detailed risk management matrix (such as Table 7) is agreed upon and used as the basis for monitoring risk for the seedbank on an annual basis with updates provided as needed by NACGRAB to the Crop Trust.</p>	2020 - 2024	<p>NACGRAB: Agree. The concerned stakeholders will be duly informed and adequately carried along.</p> <p>Crop Trust: The Crop Trust supports this recommendation. Work on QMS will provide support to NACGRAB to strengthen its risk management.</p>

**National Centre for Genetic Resources and Biotechnology – Ibadan, Nigeria**

External Review Report

April 27, 2020

**Review Team:**

- **Paula Bramel**
- **Simon Linington**
- **Bonny Ntare**
- **Milko Škofič**

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## Executive summary

The “National Seeds Collections for Climate-Resilient Agriculture in Africa – Seeds4Resilience” project aims to safeguard selected national seedbanks in Africa and empower them as entry points for developing new climate-resilient crop varieties. As the first step in the implementation of this project, an external review was commissioned to review the current institutional and technical capacity, adequacy of facilities, and operational procedures to meet the challenges of long-term conservation and use of key global collections held by national seedbanks. The external reviewers utilized a baseline survey of, intensive site visits to, and consultative discussion with each seedbank to assess the short-term and long-term upgrade needs for the National Centre for Genetic Resources and Biotechnology (NACGRAB) to meet international seedbank standards in order to better secure conservation and improve use for the future.

NACGRAB was established in 1987. Previously, it was the Genetic Resources Unit within the Federal Ministry of Science and Technology (FMST). The Centre, through Decree 33 of 1987 (now Act of Parliament, 2016), has a role in the regulation of the seed, livestock, and fisheries industries through the Varietal Release Committee Secretariat. NACGRAB is under the FMST rather than the Ministry of Agriculture because of its initial focus on biotechnology. The current facilities in Ibadan were established in 1986. The various crop research institutes in the Ministry of Agriculture also have a mandate for conservation of diversity, and they have genetic resources units to this end. When NACGRAB was established, a request was made to these institutes to share their crop genetic resources for duplication and these were the initial accessions in the seedbank. In 2004, NACGRAB became a semi-autonomous institute within FMST, with an Executive Director. It also expanded its focus to work in out-stations within six geopolitical zones of Nigeria. NACGRAB has two general objectives: i) to conserve, document, and enhance use of plant and animal genetic resources; and ii) to act as the coordinator for the activities of the National Committee on Naming, Registration and Release of Crop Varieties, Livestock Breeds and Fisheries.

In the baseline questionnaire, NACGRAB responded that the total number of accessions in the collection currently was 10,611 but, in the question, relating to the composition of the collection, they listed 13,839 accessions from 125 genera. The difference between the total number of accessions in the inventory list and that given in the baseline seems to be due mainly to the loss of accessions in the field seedbank. NACGRAB classified 92% of the accessions as landraces collected by its own institute. The collections also have 206 crop wild relatives collected by their institute and 354 obtained from other institutions. A small number of accessions of breeding material and released varieties are conserved, mainly due to NACGRAB’s role in variety release.

The Crop Trust utilizes a set of indicators to monitor various aspects of a seedbank’s performance. The baseline performance of NACGRAB for this set of indicators was reviewed. There were significant gaps identified for seed viability monitoring; seed health testing; regeneration; safety backup at sites outside Nigeria; documentation and sharing of accession level information; and the use of a quality management system with written, accurate standard operating procedures for the key routine operations. Key recommendations were made to address these gaps. Many of these gaps were due to shortfalls in the current operational procedures, equipment, and facilities.

Each of the steps in the flow of seed through the seedbank operations was reviewed as well as the adequacy of the workspaces, laboratories, drying unit, seed storage freezers, and field sites to meet the needs for secure, cost-effective, sustained conservation for the long term. The various risks associated with their current processes were identified and upgrade recommendations made to mitigate these risks and to improve the flow of the operations to address the significant gaps.

The reviewers also considered the degree and effectiveness of the current use of the collection. They assessed the interaction with users through distribution of accessions

nationally and internationally. The engagement with users was reviewed in relation to the effectiveness of feedback from users to improve seedbank operations as well as to enhance accession-level information for future users. The level of engagement of NACGRAB with stakeholders and users to enhance the use of accessions in the collection, especially to mitigate the impact of climate change, was assessed. Finally, the level of the current engagement of NACGRAB within the global conservation system was reviewed. A key set of recommendations were made for action to be taken to enhance the use of the accessions and the engagement with stakeholders for the longer term.

A comprehensive risk assessment was done by the reviewers with the identification of key actions required to mitigate these risks. Generally, the reviewers found that NACGRAB is an important national collection in the global system that conserves unique accessions of key crops. It has all the essential facilities, equipment, expertise, and operational processes required for long-term conservation, but these are not operating at optimal levels. Thus, the reviewers have made a set of key recommendations to upgrade the seedbank operations to meet the future challenges for sustained, secure, cost-effective conservation and enhanced use.

### **List of Recommendations**

**Recommendation 1:** Given the concerns raised on financial management and control systems, the reviewers recommend that a qualified accountant is recruited or allocated to the S4R project at NACGRAB to oversee the financial management and reporting as well as the implementation of a fixed asset register. In addition, the Crop Trust should conduct on site annual audits of the project financial and technical aspects.

**Recommendation 2:** The reviewers recommend that a long-term plan for the sustainable operation of the genebank be developed for NACGRAB and when the upgrade is completed, a costing study of routine operations be done to help secure adequate annual funds for the conservation and use of the collections.

**Recommendation 3:** The reviewers recommend that NACGRAB invest in enhancing staff capacity for the long term through:

- On-site capacity building by experts to train staff and upgrade the key processes
- Exchange visits with ICRISAT, IITA, ILRI, etc. to build capacity for specific processes
- Staff succession planning to address the potential loss of key long-term staff with key knowledge of the collection or seedbank management

**Recommendation 4:** The reviewers recommended that a study be done to formally determine redundancy between the collection held by NACGRAB with other national and international collections held by national and international institutions that were either involved in joint collecting with NACGRAB or served as host sites for duplicates. This in-depth analysis of the uniqueness of the accessions should lead to opportunities for rationalization. It would also give NACGRAB an opportunity to recover accessions that have been lost and are no longer found in their original collecting sites. The results of the study would allow for NACGRAB to prioritize crops and accessions for long term conservation.

**Recommendation 5:** As a priority, the reviewers recommend that NACGRAB fully clarify the legal status of all accessions that they conserve by determining and making public the access and benefit sharing terms under which accession can be shared. NACGRAB should update the inventory to accurately reflect the current composition of the collection; the active or historical status of each accession; and all available passport and characterization data. This updated accession level information should be shared with users using Genesys.

**Recommendation 6:** To address the lack of secure safety back-up, the reviewers recommend that NACGRAB prioritize by crop all unique accessions that are not already safety duplicated for safety duplication with institutions outside of Nigeria to serve as a primary black box and at the Svalbard Global Seed Vault as the secondary site.

**Recommendation 7:** The reviewers recommend that NACGRAB adopt a quality management system (QMS), including the development and regular updating of improved standard operating procedures (SOPs) for current processes for their routine operations, as well as any new processes.

**Recommendation 8:** The reviewers recommend that the items in Table 5 be procured in the upgrade with careful consideration of each item by NACGRAB staff and with the guidance of the discussion in the relevant subsection “Seedbank operations for long-term conservation and active use of the collections” of this report.

**Recommendation 9:** As a priority, the reviewers recommend NACGRAB’s accession numbers be used as the primary identifier to label all containers and aluminum packs of seed. The collection number or other alternative ID can be included in the label only if needed. A plan to update labels is required, giving priority to newly collected and regenerated material. Once GRIN-Global and the labelling equipment (printers and readers) are setup and working, all handwritten labels should be replaced with a barcoded label.

**Recommendation 10:** The reviewers recommend the establishment of a process for documenting and monitoring the quantity of seed conserved for distribution and for conservation against acceptable thresholds, using 100/1000 seed weight for each accession to determine the number of seeds per accession for the purposes of monitoring.

**Recommendation 11:** To address the inadequacy in feedback on the use of accessions, the reviewers recommend that NACGRAB utilize a routine formal process for soliciting and using feedback from recipients to improve the use of the collection and seedbank operations with actions such as to:

- Conduct routine user surveys on the use of the collections, delivery timelines, quality of seed received and other useful information.
- Fully implement DOIs to better link to information generated on the accessions.
- Develop a procedure for ensuring that information on the evaluation and use of the distributed germplasm is shared with the seedbank to enrich the accession level databases.

**Recommendation 12:** The reviewers recommend that NACGRAB develop and implement a realistic five-year plan to securely regenerate at least 800 accessions per year. There will be a need to initiate conversations with the itinerant farmers and community leaders in the adjacent areas on how to effectively reduce illegal harvesting and to fence the field sites in Ibadan. NACGRAB also need to establish formal arrangements for regeneration or multiplication by partners. This would include sharing standard regeneration/multiplication guidelines, agreeing on field sites and design, and NACGRAB staff overseeing monitoring and harvesting to ensure that the accession identity is maintained and the seed quality is acceptable.

**Recommendation 13:** The reviewers recommend that a long-term plan needs to be made to securely conserve vegetatively propagated and tree crops. This would include an assessment of the risks for the Ibadan site and actions to be taken to mitigate these; an assessment of the level of diversity maintained in the field collections; actions to be taken for safety duplication; and approaches to enhance the use of the accessions. Support should be solicited from IITA to provide technical guidance for the planning and the implementation to secure these accessions for the long-term.

**Recommendation 14:** The reviewers recommend that all efforts be made by NACGRAB to enhance internet connectivity at the seedbank to the server to allow for the full implementation of seedbank information systems such as GRIN-Global.

**Recommendation 15:** The reviewers recommend that NACGRAB utilize the planned National Summit on Genetic Resources to initiate joint actions to better secure conservation of key crop diversity in Nigeria through better coordination, greater sharing of accession level information, annual updates on the conservation status of accessions in the various collections, and increased safety duplication.

**Recommendation 16.** The reviewers recommend that NACGRAB organize facilitated meetings at agro-ecological zone level (2-3) with representatives of farmers' organizations, NGOs, local government agencies, research institutions/universities based in the zones, and local seed producers (max. 40 participants per zone). The reviewers also recommend that NACGRAB constitute a technical working group of breeders/researchers from other national research centers, universities, and the private sector for characterization, evaluation and use of collections in crop improvement. In order to elevate the profile of the national seedbank and enhance awareness on the importance of supporting it, the reviewers strongly recommend that NACGRAB and FMST hold at least two facilitated high-level meetings with key policy makers during the implementation of the S4R project.

**Recommendation 17:** To address the limited use of national collections and to enhance crop diversity to mitigate the effects of climate change, the reviewers recommend that NACGRAB facilitate technical support in the evaluation, characterization, and multiplication of accessions of underutilized and climate-smart crops for direct use in the cropping system by the following actions:

- Together with the Technical Working Group of researchers/scientists, identify a core collection of underutilized and climate-smart crops (e.g. Bambara, sorghum, pearl millet, yams, popular vegetables landraces and some crop wild relatives) for use in crop improvement
- Multiply//bulk seed of selected accessions for distribution
- Together with breeders/researchers conduct phenotypic/genotypic characterization for climate smart traits
- With user groups provide technical support in the evaluation of characterized accessions for climate-smart traits with researchers, farmers' organizations, State Agricultural Development Programs (ADPs) and NGOs that can then facilitate access to seed and knowledge to farmers.
- With breeders to undertake introgression and genetic enhancement with selected accessions to develop diversified populations
- Conduct participatory selection with farmers to identify preferred resilient varieties (medium term)
- Seek registration and seed multiplication of selected varieties
- With support from farmers' organizations, ADPs and NGOs facilitate access to seed and knowledge to farmers (long term).

**Recommendation 18.** The reviewers recommend that a detailed risk management matrix (such as Table 7) is agreed upon and used as the basis for monitoring risk for the seedbank on an annual basis with updates provided as needed by NACGRAB to the Crop Trust.

### **Introduction to the external review**

The Crop Trust has organized and facilitated a number of reviews to assess and monitor performance and identify improvements required to allow seedbanks to operate to internationally agreed management standards. This national seedbank review is an activity of the "National Seeds Collection for Climate-Resilient Agriculture in Africa- Seeds4Resilience" project that is funded by the Federal Republic of Germany.

A review team was engaged to conduct a review of each of the five seedbanks with the key expertise needed to cover the various aspects of the review. The review team were:

- Paula Bramel: Chair of the review panel with experience in conducting seedbank reviews with expertise in institutional analysis, diversity assessment, and seedbank management.

- Bonny Ruhemurana Ntare: Operations and use expert, to support the chair in the areas of general seedbank management and links with users.
- Simon Linington: Equipment and facilities expert, who assessed in detail equipment status and needs.
- Milko Škofič: Information systems expert, who assessed seedbank management data flows and software and hardware needs.

The review took into consideration various aspects that affect the overall functioning of the seedbank, including technical, financial, organizational, regulatory, social, and environmental aspects. The exact terms of reference for the review are given in Annex 1.

For the Seeds4Resilience Project, the Crop Trust staff and the reviewers prepared a baseline questionnaire on institutional, financial and technical topics and circulated it to all the five pre-selected national seedbanks. The review team did a background review that included this baseline survey. Paula Bramel, Bonny Ntare, and the project manager visited the NACGRAB seedbank from 11-14 October 2019. Simon Linington and Milko Škofič were not able to travel but extensive teleconferences were arranged for them during the visit. The agendas of each visit are available in Annex II.

The reviewers have prepared this report with their recommendations for upgrades at NACGRAB and submitted it to the Crop Trust. The Crop Trust will prepare a recommendations matrix where the reviewed seedbank comments on their agreement or an alternative to each of the specific recommendations of the review, which is then further discussed with the seedbank and eventually agreed by the Crop Trust. Based on this matrix, a recommendation action plan will be developed which will be used to design project agreements between the Crop Trust and the seedbank. The Crop Trust have used this approach with all international seedbanks, and it has proven to be an effective tool in the preparation of multi-year upgrading projects.

### **History and Mandate**

The National Centre for Genetic Resources and Biotechnology (NACGRAB) in Nigeria was established in 1987. Previously, it was the Genetic Resources Unit within the Federal Ministry of Science and Technology (FMST). The Centre, through Decree 33 of 1987, has a role in the regulation of the seed, livestock, and fisheries industries through the Varietal Release Committee Secretariat. NACGRAB is under the FMST rather than the Ministry of Agriculture because of its initial focus on biotechnology. The current facilities in Ibadan were established in 1986. The various crop research institutes in the Ministry of Agriculture also have a mandate for conservation of diversity, and they have genetic resources units to this end. When NACGRAB was established, a request was made to these institutes to share their crop genetic resources for duplication and these were the initial accessions in the seedbank.

In 2004, NACGRAB became a semi-autonomous institute within FMST, with an Executive Director. It also expanded its focus to work in out-stations within six geopolitical zones of Nigeria. NACGRAB has two general objectives: i) to conserve, document, and enhance use of plant and animal genetic resources; and ii) to act as the coordinator for the activities of the National Committee on Naming, Registration and Release of Crop Varieties, Livestock Breeds and Fisheries. NACGRAB's programs are as follows:

- Conservation, preservation and maintenance of valuable plant and animal genetic resources, for immediate utilization and posterity.
- Development of animal genetic resources (poultry, snailery, fisheries).
- Application of tissue culture for plant conservation and overall agricultural development.
- Servicing of the activities of the National Committee on Naming, Registration and Release of Crops Varieties, Livestock Breeds and Fisheries.
- Networking and coordinating activities in the development of capacities in plant and animal genetic resources.

## **Institutional Capacity**

NACGRAB is headed by the Director, who is also the Chief Executive. The Director is accountable to the Permanent Secretary of FMST. Within FMST, the National Biotechnology Development Agency (NABDA) oversees NACGRAB. The CEO of NACGRAB is the Chairman of the NACGRAB Management Board, with all the 10 heads of technical, administrative, and financial departments as members. The Management Board is responsible for annual budget development and allocation, setting priorities for the center, and Human Resources (HR) issues such as disciplinary actions, recruitments, and promotions. NACGRAB has a committee for procurement planning, a Tender Board with the CEO as Chair, and budget sub-committee.

The technical departments are Research & Development; Plant Genetic Resources; Animal Genetic Resources; Biotechnology; and Extension & Linkages. The units within the Plant Genetic Resources Department are the Seedbank, the Field Genebank, and Seed Health. The units within the Biotechnology Department are Tissues Culture and Molecular Biology.

NACGRAB has experience with international projects, as leader as well as a partner. They shared some technical and financial reports that indicate that they were able to complete projects in a timely fashion, although some of these are relatively small projects. The review of the Crop Trust CWR Project done in 2018 concluded that NACGRAB had limited opportunities for projects given their location in the FMST and most relevant partners being located in, or otherwise connected to, the Ministry of Agriculture. This limited opportunities to build strong links between the seedbank and potential users.

### *Finances and accounting*

Please note, most of the information provided as part of the institutional analysis has been contributed by NACGRAB, unless specified otherwise, and has not yet been independently verified. Funds for FMST come from the Ministry of Finance, which manages Government budget allocations. The Auditor General is responsible for compliance and audits. Thus, the Internal Audit department has autonomy from NACGRAB. Procurement also requires ministerial approval above NGN 50 million. The Auditor General appoints an External Auditor once per year. NACGRAB receives a copy of the auditor's report in which issues are identified to respond to and resolve. The Auditor General reviews the audit with responses and does any follow-up. Within Parliament, there are two oversight committees for FMST. They also do site visits to monitor what is being done. There is one Standout Body that has a monitoring and evaluation team to evaluate progress. This team includes the Federal Budget Office.

NACGRAB outlined that the Budget Office of the Federal Government in collaboration with board members visit the seedbank at the end of each annual budget cycle to monitor the implementation of the approved budget. There is a template from FMST and the National Assembly to monitor budget performance every year. There is financial control with the Administration of Treasury Single Account in operation to monitor both inflows and outflows. NACGRAB stated that there are due diligence procedures in place to address issues related to financial irregularities, terrorism, money laundering, corruption and similar issues. These procedures are strictly followed and adhered to. Also, there are government agencies responsible for prosecuting any financial crimes. These agencies are the Economic and Financial Crime Commission and the Independent Corrupt Practices and Other Related Crime Commission.

NACGRAB does not have the option to have a separate bank account for a project. Since the institute is a government agency, all its accounts are operated under the Treasury Single Account (TSA). NACGRAB shared two years' budget classification explaining the breakdown of the government budget in terms of activity centers. It seems that financial transactions on the seedbank are captured under Research and Development. The projects are given separate code (ERGP) numbers and accounted for separately. The current budgeting system being operated by NACGRAB allows for monthly expenditure reports segregated under different relevant expenditure classifications.

NACGRAB shared two years of audits done by a chartered accountant and a two-year financial statement and audit statement done for the same two years. While the overall audit statement had no reservations, there were many significant issues in the reports by the chartered accountant, as follows:

- No supporting documentation for diesel purchased.
- Storekeeping is very poor as the store items are not properly arranged and labelled.
- Insufficiently funded in 2017 by Government – shortfall of USD 416K on overheads and USD 204K on capital projects.
- Electricity and diesel budgets inadequate to meet actual costs: electricity budget USD 1.8K versus actual USD 5.5K; diesel USD 999 versus actual USD 6K.
- Financial records are not properly recorded and completed; negligence in recording transactions; no identified finance officer.
- Poorly maintained fixed asset register and buildings and library books left out of fixed assets balance thus undervaluing assets of the center.
- Opening balances not matching previous year closing balances in ledger.
- General ledger not updated on a timely basis.

The above raise some serious concerns about the competence of financial management and control systems. As a response to this concern, we have been told that a chartered accountant and an assistant with an MSc in accounting has been posted at NACGRAB to be in charge. It is still not clear that this has improved the financial management and control system. In addition, it was noted that the financial statements for the year ending 31 December 2016 show negative reserves with less than USD 200 cash on hand and a significant reduction in fixed asset values in 2016. We were provided with incomplete draft financial statements for 2017 and subsequently received ones for 2018 which show a continued reduction in fixed asset value but a positive reserve and cash on hand of less than USD 3,500.

**Recommendation 1: Given the concerns raised on financial management and control systems, the reviewers recommend that a qualified accountant is recruited or allocated to the S4R project at NACGRAB to oversee the financial management and reporting as well as the implementation of a fixed asset register. In addition, the Crop Trust should conduct on site annual audits of the project financial and technical aspects.**

The working currency is the Nigerian Naira (NGN), but external projects are usually funded in USD, EURO and GBP. The funds are converted at prevailing government exchange rate before spending. There is no overhead policy or rate. NACGRAB also has some income generating activities, such as bench fees, training programs, sales of planting material, sales of vegetable seedlings and produce to the local community as well as in the market.

*Annual routine operational funds*

The seedbank’s financial allocation, budget and financial report approval are the responsibility of the Director/CEO. Budgets are developed by the NACGRAB Budget Committee. The annual allocated budget has been increasing in recent years, but it seems that the Government has failed several times to actually disburse the allocated support in a timely fashion.

Table 1. NACGRAB annual budget in Naira. Based on survey responses.

2015	2016	2017	2018	2019
225,018,874	213,271,501	330,172,629	350,805,066	354,103,415

The FMST budget is made up of three components. For 2019, the recurrent costs including the salary component was NGN 359,430,299 and included all costs for permanent staff. There was an overhead on the salary of NGN 20,516,000 and this is used to cover operational needs for the seedbank. There is a capital budget allocation of NGN 51,797,000 for non-tangible assets which is a service contract to an outside contractor that is awarded

through the procurement process each year. The bid covers all the routine operations since it seems that the Federal Government cannot cover operational costs directly for the national centers. However, selected bidders contract back NACGRAB because they cannot get access to the seed material and thus cannot perform the work. The selected bidder gets a 35% overhead but has to pay 10% back to the government for VAT. Thus, the routine operations are actually not budgeted to NACGRAB but to an independent contractor who can have no links to NACGRAB.

The average annual budget allocation for the last five years has been about USD 831,000. The annual estimate for routine operational costs is about USD 200,000. It would seem that the annual budget is adequate, but this allocation is not always made available in a timely manner, especially for the operational funds. The annual allocation is mainly made up of staff salary. With the upgrade, it will be necessary to assess the cost of routine operations to better secure the collections. There needs to be awareness-raising within the Nigerian Government on the urgent needs to secure consistent annual operational funds for routine operations for conservation.

The current funding model used by the Nigerian Government is not very clear nor is it a secure source for the long-term future. Funds from the government can be disbursed late and they have to involve a contract to an independent service provider. More strategic approaches must be made to ensure adequate resources to the seedbank for long-term conservation and enhanced use. There is a need to secure adequate annual funds for direct use for routine operations, so the project funds can add value to conservation through greater use. This will require a better understanding of the cost of routine operations and more long-term planning for resources. There is a need to invest in a long-term strategic plan and a business plan to secure annual funds for routine operations. Insecure annual funds results in inadequate operations and the reappearance of gaps to be filled. This risks loss of accessions and their genetic integrity.

**Recommendation 2: The reviewers recommend that a long-term plan for the sustainable operation of the genebank be developed for NACGRAB and when the upgrade is completed, a costing study of routine operations be done to help secure adequate annual funds for the conservation and use of the collections.**

*Staff capacity for both long-term conservation and active use*

The seedbank is supported by a total of 111 long-term staff with qualifications ranging from Agric Diploma to PhD level. There are nine staff with a PhD and 21 staff with MSc degrees. They have qualifications in various fields of plant genetic resource management and enhancement. In the baseline survey, they indicated 0.6% staff turnover rates in the last five year but not the years of service for the existing staff. Thus, the staff turnover rate would indicate that they did not have any issues with retention of long-term staff but any issues related to staff succession planning is less clear.

They also did not indicate if the long-term staff had received any additional training for their current position. During the visit, there was a discussion of all the various capacity building programs at IITA and MSB that NACGRAB had been involved with. Thus, it is assumed that in the past, the staff have had opportunities for capacity building through workshops, training programs, and hands-on experience.

Industrial training students and Nigeria Youth Service Corps (NYSC) trainees are engaged in seedbank operations but not remunerated. On average, 100 trainees are received by the seedbank annually. In the future, there may be a need to reallocate long term staff or employ medium-term and short-term staff to address the significant backlog in some operations. This will require efforts to be made to ensure the capacity of all these students, trainees, and medium- /short-term staff. Currently there is no documentation of the key processes that could be used to ensure the capacity of any short-term staff and new long-term staff. This gap needs to be addressed.

**Recommendation 3: The reviewers recommend that NACGRAB invest in enhancing staff capacity for the long term through:**

- **On-site capacity building by experts to train staff and upgrade the key processes**
- **Exchange visits with ICRISAT, IITA, ILRI, etc. to build capacity for specific processes**
- **Staff succession planning to address the potential loss of key long-term staff with key knowledge of the collection or seedbank management.**

**Composition of the collection in relation to the uniqueness of the accessions**

In the baseline questionnaire, NACGRAB responded to the question on the total number of accessions in their collection today as 10,611, but in the table that requested a specific inventory for the accessions they conserved in total, they listed 13,839 accessions from 125 genera. A summary of the composition of the collection is given in Table 2. The difference between the total number of accessions in the inventory list and the total number given in the baseline currently seems to be due solely to the loss of accessions in the field collection. NACGRAB classified 92% of the accessions as landraces collected by their own institute. The collections also have 206 crop wild relatives collected by their own institute and 354 obtained from other institutions. A small number of accessions of breeding material and released varieties are conserved, mainly due to NACGRAB's role in variety release.

Table 2. Inventory of NACGRAB

<b>Crop</b>	<b>Genus</b>	<b>Total</b>	<b>Seed storage</b>	<b>In vitro culture</b>	<b>Field seedbank</b>
Sorghum	<i>Sorghum</i>	1,808	1,808		
Pearl millet	<i>Pennisetum</i>	1,467	1,467		
Maize	<i>Zea</i>	1,375	1,375		
Yam	<i>Dioscorea</i>	1,138		4	34
Wild Vigna	<i>Vigna</i>	1,062	1,062		
Cowpea	<i>Vigna</i>	822	822		
Okra	<i>Abelmoscus</i>	506	506		
Rice	<i>Oryza</i>	492	492		
Melon	<i>Cucumis</i>	444	444		
Soybean	<i>Glycine</i>	424	424		
Pineapple	<i>Ananas</i>	400		3	14
Groundnut	<i>Arachis</i>	368	368		
Amaranths	<i>Amaranthus</i>	252	252		
Celosia	<i>Celosia</i>	248	248		
Pepper	<i>Capsicum</i>	214	214		
Wheat	<i>Triticum</i>	212	212		
Bitter leaf	<i>Vernonia</i>	190		1	6
Cassava	<i>Manihot</i>	147		8	62
Tomato	<i>Lycopersicon</i>	144	144		
Phaseolus	<i>Phaseolus</i>	144	144		
Corchorus	<i>Corchorus</i>	118	118		
Plantain/banana	<i>Musa</i>	118		1	91
Citrus	<i>Citrus</i>	115			115
Garden egg	<i>Solanum</i>	114	114		
Acha	<i>Digilaria</i>	110	110		
African yam bean	<i>Sphenostylis</i>	100	100		
Pigeon pea	<i>Cajanus</i>	50	50		
Mustard seeds	<i>Brassica</i>	46		1	
Bambara nut	<i>Vigna</i>	42	42		
Sweet potato	<i>Ipomoea</i>	19		1	3
Cocoyam	<i>Colocasia</i>	10		1	2
Bread fruit	<i>Artocarpus</i>	8			8
Cabbage	<i>Brassica</i>	3	3		

Crop	Genus	Total	Seed storage	<i>In vitro</i> culture	Field seedbank
Others		1129	108	6	875
<b>Total</b>		<b>13,744</b>	<b>10,527</b>	<b>26</b>	<b>1,215</b>

Nigeria was not included in the initial assessment of countries or seedbanks for the Seeds4Resilience project. The initial criteria for consideration in the Engels and Thormann study was that the country had to be a party to the ITPGRFA. Nigeria has not ratified the ITPGRFA so is one of the few non-party countries. Thus, there was no diversity score assessed nor any consideration given to their status as a globally important seedbank. An assessment by the reviewers, using the same criteria, concluded that they have 14 priority crops with 6 in a region of diversity; yams, cassava, *Musa*, rice, pearl millet, sorghum, cowpeas, and maize. When their score is compared with Ghana (the other national seedbank pre-selected from West Africa), they will rank higher given the greater number of priority crops and the much higher number of accessions held for pigeonpea, yams, *Musa*, rice, pearl millet, sorghum, cowpeas, and maize.

Kiambi (2011)<sup>1</sup> pointed out that there has been a long history of cross-border movement of crop germplasm in this region, both for farmers' varieties as well as for improved varieties. Thus, much of the crop diversity is more unique to the region rather than to individual countries. Therefore, the germplasm held by NACGRAB in the global system could be similar to the diversity held by the Plant Genetic Resources Research Institute (Ghana) seedbank. It is difficult to assess the uniqueness of these two seedbanks separately. For the long-term, there is a need to determine the degree of diversity within locally collected germplasm of yams, cassava, *Musa*, and sweet potato from Nigeria, Ghana and regionally, to identify redundancies and significant gaps in all collections. This will likely need to be done with genotypic estimates of diversity but given the long-term cost of conservation for these crops, it will likely result in cost savings from rationalization across all collections in the region.

As with the Plant Genetic Resources Research Institute (Ghana), they have had a significant loss of accessions in the case of vegetatively propagated crops. In the baseline, they only have about 13% of the accessions noted in the inventory actually conserved in the field collection and thus these are assumed lost from the collection. The majority of these are yams that were jointly collected with IITA and duplicated there. This does indicate that there is a need to formally determine redundancy with other international collections that were involved in joint collections or that served as duplicate sites for conservation. This in-depth analysis of the uniqueness of the accessions would lead to opportunities for rationalization by all collection holders. It also better secures the collections through these known duplications. Unnecessary redundancy in the global system and at NACGRAB will reduce the conservation resources available to focus on addressing other unique accession or crops of global relevance that need urgent conservation *ex situ*.

**Recommendation 4: The reviewers recommended that a study be done to formally determine redundancy between the collection held by NACGRAB with other national and international collections held by national and international institutions that were either involved in joint collecting with NACGRAB or served as host sites for duplicates. This in-depth analysis of the uniqueness of the accessions should lead to opportunities for rationalization. It would also give NACGRAB an opportunity to recover accessions that have been lost and are no longer found in their original collecting sites. The results of the study would allow for NACGRAB to prioritize crops and accessions for long term conservation.**

#### **Baseline Performance Targets**

<sup>1</sup> Kiambi, Dan. 2011. Economic study on the contribution of local germplasm of yams, pearl millet, sorghum, and cowpeas to the agriculture of Ghana, Mali and Nigeria.

The Crop Trust utilizes a set of indicators to monitor various aspects of seedbank performance. Table 3 gives the current status of NACGRAB performance for these indicators. NACGRAB conserved 13,839 accessions as seed in the seedbank, in the field, and as *in vitro* cultures. Three quarters of the accessions are conserved as seed.

Table 3. Baseline information on performance indicators

<b>Baseline criteria</b>	<b>Number of accessions</b>	<b>% of total accessions</b>
<b>Composition of collections</b>		
Number of accessions in total	13,839	
Number of seed accessions	10,627	76.8%
Number of accessions conserved <i>in vitro</i>	26	0.2%
Number of Field bank accessions	1,210	8.7%
<b>Availability</b>		
Viability tested	10,627	100.0%
Viability above 85%	5,448	51.3%
Health tested	0	0.0%
Adequate seed number	not reported	
Included in MLS	not reported	
Regenerated or multiplied in last five years	0	0.0%
<b>Security</b>		
Number of MTS	10,516	99.0%
Safety duplicated outside country	521	3.8%
Safety duplicated at Svalbard or other site outside country	399	2.9%
Field collection maintained in two sites at least	0	0.0%
<b>Distribution</b>		
Total distributed nationally in last five years	4,697	
Total distributed internationally in last five years	0	
Number of countries distributed	0	
<b>Accession level information</b>		
Minimum passport data (online)	1,445	10.4%
Minimum characterization data (online)	423	3.1%
Passport completeness index	not reported	
<b>QMS</b>		
Elements of QMS in place	0	
SOP written reviewed and approved	0	
Overall satisfaction of seedbank users	not reported	

NACGRAB indicated that 90% of the accessions are fully owned by the institute and have responsibility for management decisions; these are available to all requesters. Germplasm exchange is subject to institutional regulations for in-country research users. They have used the Standard Material Transfer Agreement (SMTA) for international distribution to ICRISAT and the MSB for Crop Trust projects. However, Nigeria has not yet ratified the ITPGRFA and does not formally participate in the Multi-lateral System (MLS). Thus, none of the accessions conserved by NACGRAB has a clear, transparent legal status in terms of access by users. Formally, accessions are not distributed under the MLS of the ITPGRFA or under any formal access and benefit sharing agreement so there is a high risk that any significant case of biopiracy for germplasm from Nigeria could result in the implementation of a restrictive policy by the Ministry or Government. Efforts need to be made on the ratification of the ITPGRFA and clarification on the legal access and benefit sharing terms of the accessions held.

**Recommendation 5: As a priority, the reviewers recommend that NACGRAB fully clarify the legal status of all accessions that they conserve by determining and making public the access and benefit sharing terms under which accession can be shared. NACGRAB should update the inventory to accurately reflect the current composition of the collection; the active or historical status of each accession; and all available passport and characterization data. This updated accession level information should be shared with users using Genesys.**

In the baseline, they indicated that 315 accessions of sorghum were safety duplicated at the ICRISAT Sahelian Centre in Sadore, Niger and 206 accessions of crop wild relatives are conserved at the Millennium Seed Bank of Kew in the UK. They also indicated that 52 accession of cowpeas were being safety duplicated at IITA in Ibadan, but the latter does not meet the international standards for safety duplication given the close proximity to the NACGRAB site. Also, 399 accession of sorghum, cowpeas, and pearl millet have been sent as black box storage in the Svalbard Global Seed Vault.

The does not completely match the NACGRAB description of the status of safety duplication in their website (<https://nacgrab.gov.ng/index.php/2016-07-25-08-55-11/seed>) as “Similarly, as part of the requirement of the collaborative project between NACGRAB and Global Crop Diversity Trust, safety duplicate of the materials collected by the participating National Agricultural Research Institutes (i.e IAR, Zaria and Lake Chad Research Institute) were sent to Svalbard Global Seed Vault and ICRISAT Sahelian Centre, Niamey for safe keeping in the year 2013. NACGRAB successfully sent 423,176 and 34 accessions of sorghum, cowpea, and sesame seed respectively to Svalbard Global Seed Vault in Norway. Also, 423 and 167 accessions of sorghum and pearl millet respectively were sent to ICRISAT Sahelian Centre in Niamey. It is not clear why there is a discrepancy, but this needs to be clarified in the future. Thus, based upon the baseline, as much as 6.7% of their collection is safety duplicated in at least one location outside Nigeria according to international standards. This low level of safety back-up risks loss of genetic variation for unique accessions of important global and national crops and wild species.

**Recommendation 6: To address the lack of secure safety back-up, the reviewers recommend that NACGRAB prioritize by crop all unique accessions that are not already safety duplicated for safety duplication with institutions outside of Nigeria to serve as a primary black box and at the Svalbard Global Seed Vault as the secondary site.**

NACGRAB indicated in the baseline survey that the seedbank staff follow established protocols for all operations except clonal propagation but none of these are written or available on request. Insecure and inefficient management of collections risk the loss of genetic diversity among and within accessions as well as its availability to users.

**Recommendation 7: The reviewers recommend that NACGRAB adopt a quality management system (QMS), including the development and regular updating of improved standard operating procedures (SOPs) for current processes for their routine operations, as well as any new processes.**

### **Seedbank operations for long-term and active use of the collections**

During the site visit, the reviewers focused on understanding the current flow of routine operations from receiving seed or plant material into the seedbank through to storage of seed or establishment of accessions in the field. Similarly, sending material to the field for regeneration/multiplication and characterization through to its receipt in the seedbank again for processing. The various facilities in the building or fields were assessed for their adequacy for the current operation as well as for the increase in workflow expected from the upgrade. The essential equipment was reviewed based on baseline information requested prior to the visit and on the visit to the seedbank. Table 4 lists the flow of seed or plant material through the various steps at locations in the seedbank as given in Figure 1.

This nationally important seedbank facility is in urgent need of investment not least to allow it to meet internationally accepted standards of storage. Currently, there is a great dependence on uncontrolled sun drying. The cold rooms operate at temperatures that are too high. Given the importance of germination in monitoring performance and providing essential data for management and users, the creation of a proper germination facility is essential. All of these improvements are totally dependent upon a reliable electricity supply which in turn relies on being able to afford fuel for the generator. In general, the reviewers found that the NACGRAB seedbank has many of the essential elements for ensuring the secure

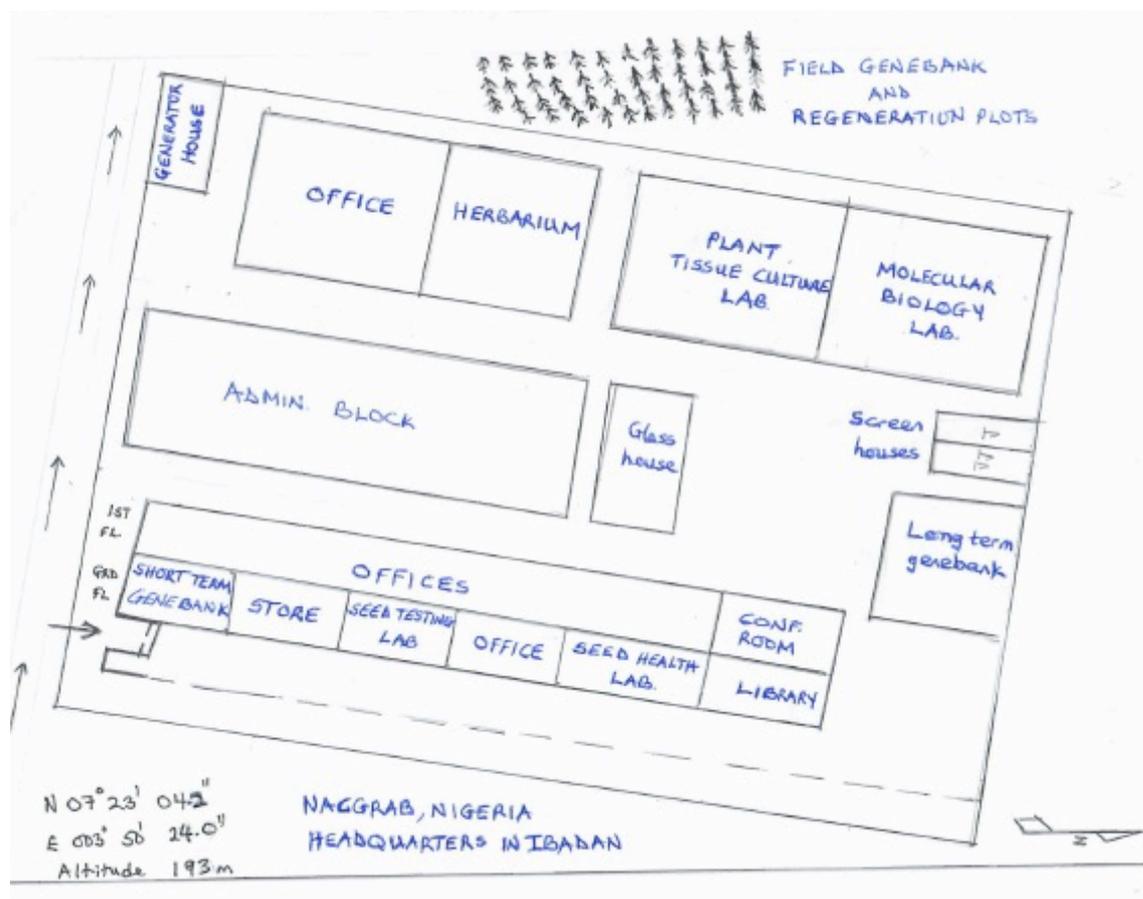
conservation and use of the accessions but has the need for the key elements of investment in facilities, equipment and expert services.

**Recommendation 8: The reviewers recommend that the items in Table 5 be procured in the upgrade with careful consideration of each item by NACGRAB staff and with the guidance of the discussion in the relevant subsection “Seedbank operations for long-term conservation and active use of the collections” of this report.**

Table 4 NACGRAB flow of routine operations

Step	Description of activity
1	Seed or plant material is harvested from regeneration/multiplication fields or during collection
2	Seed is put into store next to seed testing laboratory
3	If needed, plant material or seed is laid out to dry in the sun or the shade of the veranda outside the seed testing laboratory
4	When dry enough, seeds are threshed or extracted from fruits outside the seed testing laboratory
5	Seed is cleaned by winnowing, sieving or hand picking outside the seed testing laboratory
6	Seed is fumigated or treated if needed in the store next to the seed testing laboratory
7	Seed is dried further in the sun or shade of the veranda, small drier, or desiccators
8	Moisture content is monitored every 3-4 days until it reaches close to 5-7% in the seed testing laboratory
9	If new accession, then it is registered in logbook with collection number or alternative name and given accession number that will be put on a new label for accession
10	Sample is taken for initial germination testing
11	Germination test is carried out and the results recorded in logbook
12	If mold or disease on germination test, the sample is sent to seed health laboratory for diagnosis and a recommended treatment carried out on the seed lot
13	Total seed lot weighed and packaged (80g for large seed crops and 20g for small seeded crops) in aluminum pack and sealed to put in long-term cold store unit as base collection
14	The rest of seed lot is put into plastic containers in the short-term seedbank and used for distribution
15	The germination of accessions in short-term seedbank is monitored with retest in the seed testing laboratory
16	Accession with low seed quantity in short-term seedbank or low viability are identified for regeneration/multiplication with partners if funds are available
17	Characterization is done when funds are available or if there is a collaboration providing a student study
18	Accessions that require regeneration/multiplication are packaged, the field plans done with partners, seed sent to partners and planted with supervision of NACGRAB staff
19	Seed or plant material is harvested by partners/NACGRAB staff and received as for step 1

**Figure 1. Current layout of seedbank buildings (as provided by NACGRAB)**



### Short-term storage

See under Seed cleaning & quantity determination.

### Seed cleaning

There is a total lack of space for cleaning, temporary storage, and fumigation or treatment of seed with insect infestations. When plant material and seed are brought to NACGRAB, the plant material, seeds, or fruits are kept in the multipurpose store as needed; similarly, for material undergoing sun drying for storage at night. This room is also used for storing equipment and consumables. When needed it is used for fumigation of seed samples during the weekend. It lacks air-conditioning and proper ventilation for any of these uses with live plant material. This is also a risk to human health. A lack of a suitable containment area for short-term storage, cleaning and fumigation is a concern as is the potential contamination of 'clean processes' as there is no dedicated area to winnow and clean seed. *There is no seed aspirator / blower at present, therefore a purchase is recommended (see Table 5 – item 18). It is not clear if they have sufficient good quality sieves available so as a precaution one set is included in the Table 5 (item 19). Dust protection provided to staff (e.g. face masks of known specification) is uncertain. Therefore, a provision has been included in the Table 5 (see item 25).* Inhalation of dust can lead to lung irritation or infection and is a serious risk.

As a priority, the reviewers recommend construction of an appropriate crop work area with provision for temporary storage, threshing, winnowing, cleaning seed, and doing fumigation is recommended (Table 5- item 14). The reviewers suggest that the abandoned old glass house should be partially demolished and renovated to be used as a covered work area with a proper fumigation room.

### Drying & moisture content determination

Seed moisture content is a key determinant of seed longevity and thus central to any seedbank operation. Within limits, a logarithmic decrease in moisture content leads to a logarithmic increase in seed longevity (straight-line relationship). For any given species, moisture content is determined by relative humidity and temperature. Having control of these two parameters is essential in the seed drying process.

Currently, seeds are harvested at the driest time of the year, so they are sun dried. The small chamber in the multipurpose seed testing laboratory that is being used for drying is not appropriate to accommodate bulk samples and it has issues with the temperature control and with monitoring relative humidity and temperature. In both cases, the seeds are being exposed to high temperatures and final moisture content appears to be >7%. Because adequate and controlled drying is central to satisfactory seedbank operations, a drying room is required at NACGRAB (especially given the humid environmental conditions). Dependent upon the report from the structural survey on the state of the building currently containing the long-term / medium-term store (this is discussed later in the section on Buildings), the proposal is to get specialized refrigeration and air-conditioning advice (see Table 5 – *item 2*) on the design, procurement and installation of an insulated drying room (with Munters dryers plus chilling plant) and as part of a larger scale refurbishment of the cold storage.

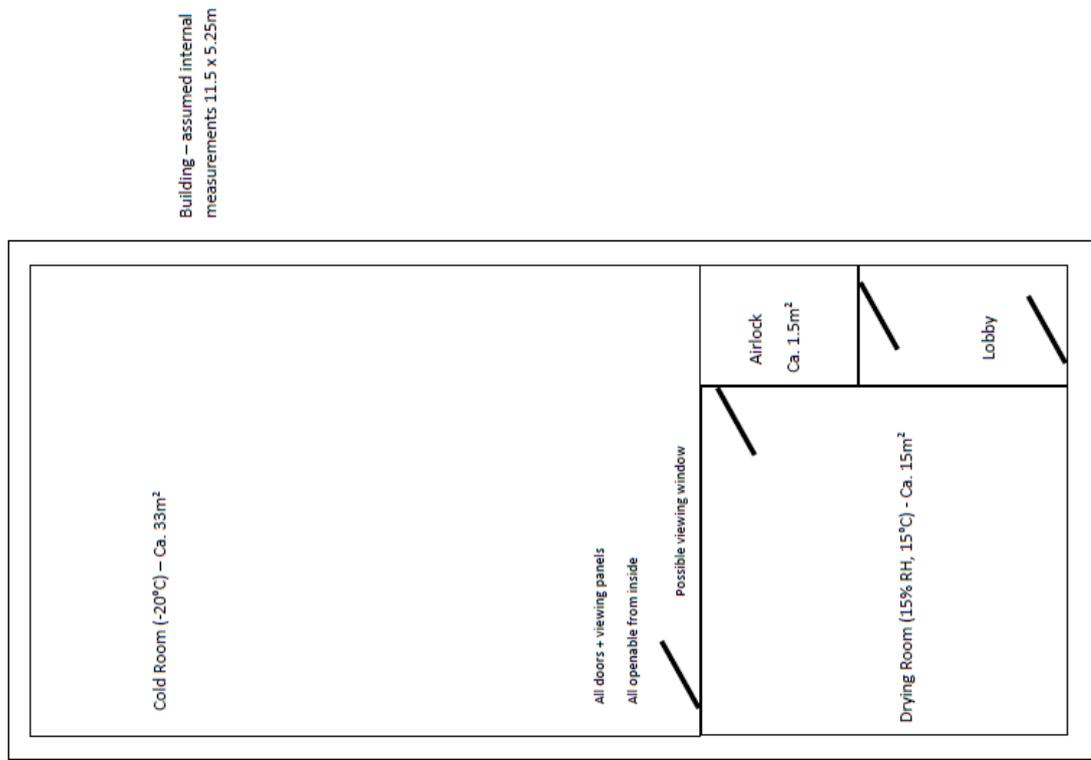
The reviewers recommend a refrigeration and air-conditioning consultancy to address the need for technical advice across a range of equipment and facilities that need to be upgraded (*Table 5- item 2*). Thus, the basis for the terms of reference for the consultancy is to provide written specialist advice on:

- An estimate for the installation of a drying room (approximately internally 15m<sup>22</sup>) to include: walls and ceiling constructed of interlocking high quality insulated panels and incorporating an air lock; an insulated floor; insulated doors with vision panels; paired Munters dryers feeding into the room via ductwork and a chilling system; an external control panel linking to 'outside of condition alarms and sounders; fluorescent lighting and electrical sockets. The drying room should provide direct access to the cold room.
- An estimate for a cold room to include: walls and ceiling constructed of interlocking high quality insulated panels; an insulated non-slip floor; insulated doors with vision panels; paired refrigeration systems for each room; de-icing drains; pressure-equalization valves; an external control panel linking to outside of condition alarms and sounders; and low temperature lighting. Additionally, the existing facility needs to be removed.
- Provision of air-conditioning for the room selected to act as the germination room.
- Advice on air-conditioning and dehumidifying the short-term store (STS).
- Advice on the required servicing of the new facilities and the stock of spare parts that should be held.

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<sup>2</sup> Ideally significantly more (rather uncertain of cold storage floor area at present – data seems contradictory). Subject to space requirements, throughput (drying room) and required storage capacity (cold room).

**Figure 2. Possible design for new drying and cold storage facility in building holding existing LTS**



Ideally, the cold rooms should be accessed directly from the drying room (this is beneficial when moving seeds between drying and storage and vice versa; it also means that the evaporators in the cold storage suffer reduced icing thereby improving efficiency). It should be sized according to peak loads (if appropriate the size could account for uncleaned material thereby creating a suitable containment area and allowing cleaning to proceed at rate of available manpower without loss of viability). *A possible design (which would need to be modified on the basis of NACGRAB and consultant advice and the actual space available in its eventual location; ideally, it should be as large as practicable) is shown in Figure 2. Notional costs for the construction of such a drying and cold storage facility have been included in the Table 5 (items 4 – 8). Obviously, the outcome of the structural survey and the location / size of the facility will have an impact on how much of this budget is required.*

*Any new drying room should be provided with plastic crates and trolleys (see Table 5 – items 10 & 11). In addition to the monitoring of conditions that would be part of any building package, a downloadable hygrometer should be purchased to check the calibration of the controls (see Table 5 – item 22).*

Moisture testing is currently non-destructive for large-seeded crops but destructive for small-seeded crops. A drying oven (2009) is in “good” condition as are two balances, therefore the necessary equipment for destructive gravimetric testing is in place. *A non-destructive moisture meter for small-seeded species is also part of Table 5 (item 21); such a meter (and indeed many of the items of seedbank equipment) need to be the subject of regular calibration.*

#### *Seed viability monitoring*

It is reported in the baseline that 100% of the accessions have been tested for viability and 51% had germination of > 85% (Table 3). Seed viability testing is a routine operation for the seedbank for conservation as well as distribution. They indicated that they retest every two

years for medium-term storage and every 5-7 years for long-term storage. It was not clear that these retests are being done yet. In the next section we will discuss some of the issues with the current protocol but there is no significant backlog in viability testing, although all the data is still recorded in a logbook, so it needs to be fully digitized. The high number of accessions with low viability is a high risk to the integrity of the accessions and can lead to their loss. These low viability accessions need to be regenerated urgently.

Seed viability monitoring is the key measure of the seedbank's efficacy in conserving the material and knowing the conditions necessary to germinate a given accession are central to unlocking its potential for the user. Currently, one room, the seed testing laboratory, is used for all processes including cleaning, drying, packaging and germination tests; which is absolutely inadequate to handle all these processes. There is a need for a separate room used solely for seed viability testing and provided with the necessary equipment.

The current storeroom next to the seed testing laboratory could be used to create a germination room similar to the one at IITA; it can also be used to place any germination incubators. This would require air-conditioning, some form of temperature control, the installation of suitable lighting (fluorescent or LED) on a timer, and the installation of some benches (see Table 5 – *items 1, 2 and 9*). This should provide sufficient control to ensure a reasonable level of repeatability of the tests; without this, germination monitoring will become difficult and users cannot be provided with details of how to germinate the seeds. Using one germination room rather than several incubators means that the bank will have to batch-load its germination, changing the conditions appropriate to the material between batches. The specificity in germination conditions offered by incubators (e.g., alternating temperature regimes) will not be available with a room. Tests should be scored on a bench next to the window because staff would benefit from having natural daylight to examine the tests.

In order to get repeatable results, germination tests need to be carried out using reasonably pure water. *Consequently, a water purification system is required (see Table 5 – item 15).*

*One stereomicroscope (2011) is shared with the Plant Pathology Laboratory and so purchase of another is recommended (see Purchase Plan – item 16).*

#### *Seed Packaging*

Once the seeds have been dried, it is essential that they remain that way during packaging and once sealed in the container. Dried seeds will readily imbibe moisture along a water potential gradient if the seal is ineffective and the storage environment is more humid.

Seedlots of unknown weight and quantity are packed in plastic containers for the short-term seedbank and in aluminum foil packets envelopes for the long-term cold room. The labels on the outside and inside of the containers and envelopes are manually written with a permanent marker. One issue is the use of collection number and other alternative identifiers on many of the packages instead of the NACGRAB accession number given after registration. Although the staff indicated that the registration accession number is used after assignment, there were many cases in the labels on containers and packet where the original identifier is still being used with no reference to accession number.

**Recommendation 9: As a priority, the reviewers recommend NACGRAB's accession numbers be used as the primary identifier to label all containers and aluminum packs of seed. The collection number or other alternative ID can be included in the label only if needed. A plan to update labels is required, giving priority to newly collected and regenerated material. Once GRIN-Global and the labelling equipment (printers and readers) are setup and working, all handwritten labels should be replaced with a barcoded label.**

Two bag sealers are available but of uncertain effectiveness, so *the purchase of a rugged and effective machine is also recommended (see Purchase Plan – item 23)*. Bag quality was thought to be high though there is some uncertainty over the specification. *As a precaution, the purchase of 20,000 high quality medium-sized foil bags is recommended (see Purchase Plan – item 24)*. NACGRAB will need to decide sizes. No tests are currently carried out to

test the efficacy of the bag seals. These need to be carried out by filling a bag with air, sealing it and checking where the break occurs when pressure (such as stamping on it) is applied; if the break is along the seal then insufficient heat has been applied.

#### Seed number determination

According to the baseline, none of their accessions have an estimate of the quantity of seeds available. There is no seed counter so they only count seed by hand for distribution. They do not routinely take 100/1000 seed weight, but they do weigh the packets for short- and medium-term storage. They need to determine seed weight per 100/1000 seeds before sealing packets and digitize both 100/1000 seed weight and total packet weights to facilitate monitoring of seed quantity for distribution and multiplication. The lack of monitoring of seed quantities risks the loss of an accession when the sample size falls below the number required to securely regenerate an accession.

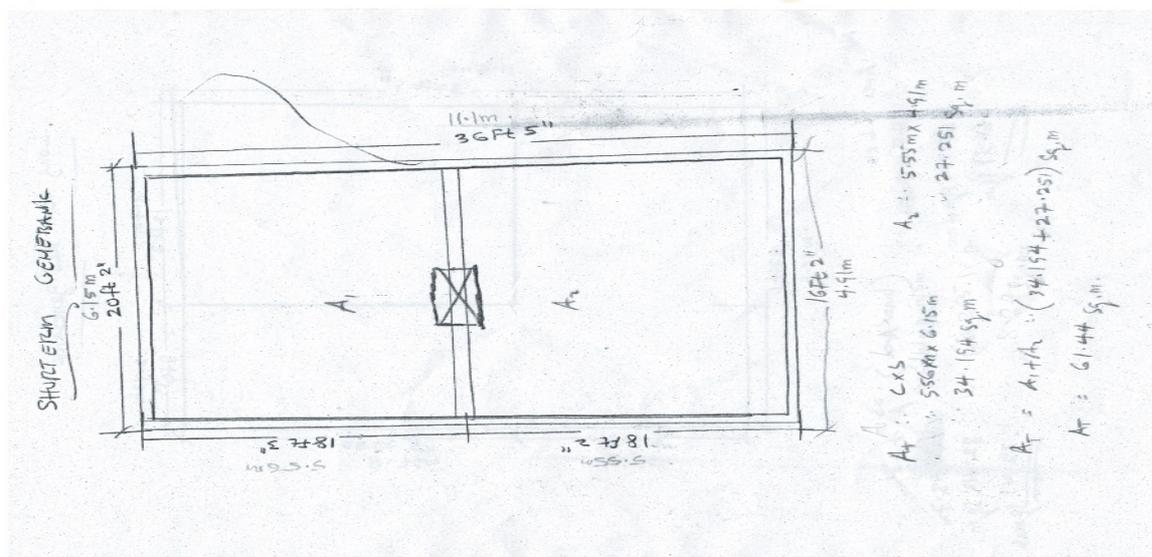
**Recommendation 10: The reviewers recommend the establishment of a process for documenting and monitoring the quantity of seed conserved for distribution and for conservation against acceptable thresholds, using 100/1000 seed weight for each accession to determine the number of seeds per accession for the purposes of monitoring.**

There are no seed counting machines available creating a backlog in the 100/1000 seed weight determination. *The purchase of one is recommended (see Table 5 – item 20). This counter will need to be calibrated regularly.* No monitoring of the seeds available is a risk to the genetic integrity of the accession if distribution reduces the supply significantly thereby creating a genetic bottleneck during multiplication.

#### Seed storage

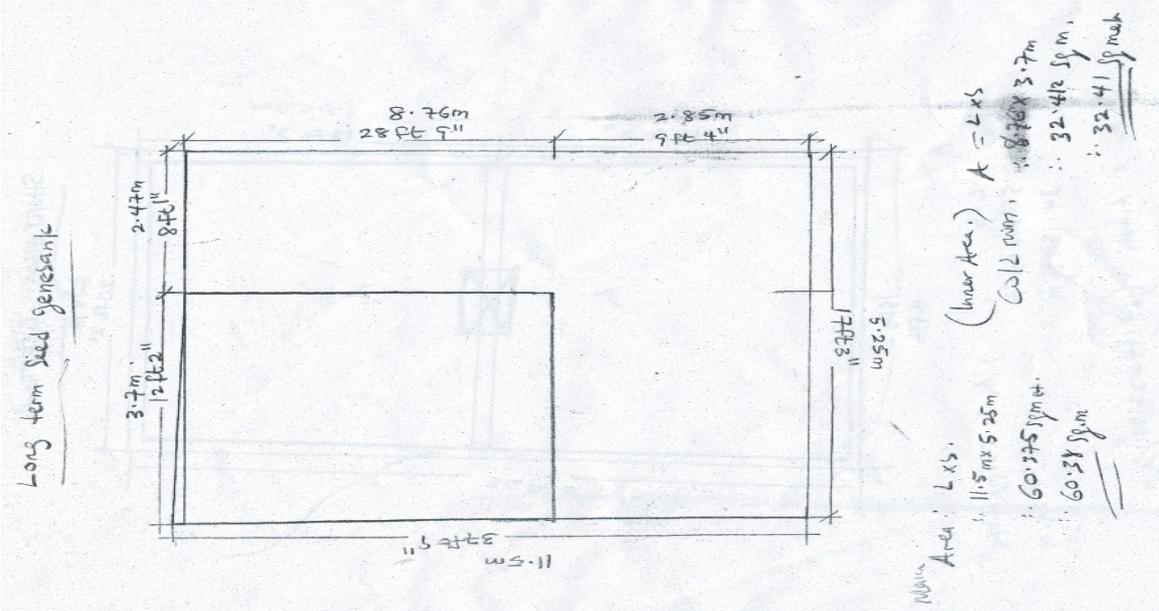
Seed is stored in in both short- and long-term storage rooms. The short-term storage room (Figure 3) uses domestic dehumidifiers and air conditioning. Consideration should be given to improving the short-term storage with improved air-conditioning and possibly a higher quality dehumidifier.

**Figure 3. Short-term storage room (as provided by NACGRAB)**



At the time of the visit, the long-term storage room (Figure 4) was at +8°C instead of -20°C. The temperature is monitored during the day and the data kept in a logbook. This shows that the temperature in the cold room is not kept at a constant temperature and rarely gets to -4°C. The cold room is serviced every 6 months and the service/repairs record is kept in a logbook. Clearly the current cold room is not a functional long-term storage facility as these need to be maintained at a temperature of -20 °C to meet international standards.

**Figure 4. Long-term (medium-term) seedbank (as provided by NACGRAB)**



There is a need for new cold storage with consideration paid to energy efficiency. It is recommended that the refrigeration and air-conditioning consultant (see above) advises on the design, procurement and installation of one (or two) new insulated cold rooms (capable of operating at  $-20^{\circ}\text{C}$ ) and preferably accessed from the proposed new drying room (see also under Drying, above, for suggested basis for consultancy ToR). The room would need to be sized according to realistic future needs. A possible design (which would need to be modified on the basis of NACGRAB and consultant advice and the space available in its eventual location; ideally, it would be as large as practicable) is shown in Figure 2. A notional cost has been included in the Table 5 for cold room construction (see items 4, 5, 7 and 8). It would need simple metal shelving / plastic crates to hold the foil bags. Ideally, the shelving should be mobile which although being more expensive than static would reduce storage volume and hence running costs. Additionally, cold room clothing would need to be purchased (there is a particular risk of staff moving quickly across a large temperature gradient between hot outside and subzero conditions) – see Table 5 (item 13).

**Seed health testing**

There are no accessions with known health status documented (Table 3). The seed pathology laboratory identifies pathogens on a seed sample where the viability test has indicated that there is a significant bacterial or fungal growth. The identification is limited by lack of equipment and facilities which will be discussed in the next section. There is monitoring of plant health in the field during regeneration/multiplication and characterization. This allows for control methods to be used if needed. They also monitor field collections. The lack of standard seed health testing can result in a reduction in viability, accelerated seed aging, loss of plants during regeneration, and the spreading of harmful pathogens through distributed seed and planting materials.

The reviewers recommend that a Seed Health Specialist consultancy be done to provide technical support on seed and plant health (Table 5- item 40) with the term of reference that includes: to establish seed health testing protocols: develop a handbook for the identification of key pathogens and pests of the crops in the collections: and provide capacity building with follow-up technical support on-site to institutionalize these processes.

Lack of seed health monitoring and functioning equipment risks the non-detection of seed-borne pathogens or misidentification leading to the spread of seed-borne pathogens in areas where they do not exist and thus affecting crop productivity and food security. The seed health laboratory has capacity to detect seed pathogens but lacks a permanent stereomicroscope or a culture room. They have no capacity for virus indexing. NACGRAB

needs to establish a list of the minimum equipment needed to verify seed health status in the laboratory. *In the short-term, it is recommended that at least the compound microscopes are replaced for better identification of the pathogens (see Table 5 – item 17).* Additionally, NACGRAB needs to establish the monitoring of disease incidences at regeneration and multiplication sites and in the field collection sites.

The reviewers also recommend that they establish a step in the seed handling process to utilize a hermetically sealed storage system (<http://www.knowledgebank.irri.org/training/fact-sheets/postharvest-management/storage-fact-sheet-category/hermetically-sealed-systems-fact-sheet>) to eliminate stored insect pests after initial seed cleaning rather than use fumigation. There are various options available such as these from <https://www.vestergaard.com/zerofly/> or <https://grainpro.com/solution-storing/>.

### Distribution

On average, 337 accessions were distributed within NACGRAB annually over the last five years, but yearly distributions declined from 1,090 accessions in 2014 to 19 in 2018 (Table 6). Distribution within the country was an average of 1,174 accessions per year from 2015. It was reported that the high number of accessions distributed outside the institute was due to increased awareness about the collections. However, it was not clear to the reviewers how the awareness was being created. The accessions were only distributed to breeders/scientists since it is the policy of NACGRAB to not distribute accession directly to farmers. This policy limited the direct use of accessions by smallholder farmers, and thus the capacity of the seedbank to meet its objectives in terms of contribution to resilient seed and cropping systems that are essential for food and nutrition security. By user type, the bulk of accessions distributed were to scientists (5,193) and 206 cowpea crop wild relatives IITA. Generally, seedbank staff have no experience with international users. International distributions will be a challenge due to the need for additional packaging, phytosanitary permits, and shipping costs. No distribution internationally means that NACGRAB makes only a limited contribution to the global system of conservation and use. The reviewers recommend that NACGRAB establishes and shares clear, transparent protocols to meet distribution requests by both national and international users.

Table 6. Number of accessions distributed to users 2014-2019

Recipients	2014	2015	2016	2017	2018
Within NACGRAB	0	221	155	201	19
Within Nigeria (excluding NACGRAB)	1090	1335	1175	1028	1159
Outside Nigeria	0	0	0	0	0

The low level of distribution is not surprising given the low knowledge users have of the composition of the collection, the limited access users have to accession level information, and the lack of access to characterization or evaluation data. It was reported that informal feedback is solicited on accession intended use, type of traits or characteristics found in the material, and any publications arising from the research; but recipients never respond to the requests. This hamper effective seedbank operations creating risks of distributing poor-quality seed and limits knowledge about the growth or use of the collections.

**Recommendation 11: To address the inadequacy in feedback on the use of accessions, the reviewers recommend that NACGRAB utilize a routine formal process for soliciting and using feedback from recipients to improve the use of the collection and seedbank operations with actions such as to:**

- **Conduct routine user surveys on the use of the collections, delivery timelines, quality of seed received and other useful information.**
- **Fully implement DOIs to better link to information generated on the accessions.**
- **Develop a procedure for ensuring that information on the evaluation and use of the distributed germplasm is shared with the seedbank to enrich the accession level databases.**

There were no priority needs for equipment for distribution. There is a need to establish a protocol for international distributions that will take into account the provision of an SMTA or other agreement, as well as phytosanitary certificates and appropriate packaging.

#### *Regeneration, multiplication, and characterization*

The baseline information indicates they have not done any regeneration in the past five years (Table 3) but about 50% of accessions require regeneration based upon the viability tests. For just Annex 1 crops, this is nearly 4,000 accessions, and to address this backlog during the upgrade, they will have to increase the rate of regeneration to 800-1000 accessions per year. This will be a significant challenge to their current approach to regeneration and multiplication that the reviewers will discuss in the next section.

The seedbank has four regeneration sites from the humid to sub-humid agro-ecological zones. The reviewers were only able to visit the site at the NACGRAB Headquarters. The soils at this Ibadan location are heavily eroded and cannot be expected to support a good crop. Even the few accessions of vegetable crops that were being multiplied at the time of the visit looked poor and unlikely to produce seed optimally. It was clear that the Ibadan site is not suitable for multiplication of many of the crops thus limiting availability of good quality seed for distribution to users.

The Ibadan land is surrounded by a growing urban settlement and not fenced to keep off intruders who sometimes steal crops from the field seedbank. In order to avoid this in the case of yams, they harvest the tubers early. There is a significant risk to genetic integrity from illegal harvesting from regeneration plots by the local communities.

Screenhouses are available but in need of rescreening and repair. *There is a need to rescreen the two old screen houses to be used for the urgent regeneration and for shifting the vegetative crops to tissue cultures (see Table 5 – item 26).*

The farm equipment in Ibadan is in very poor condition. Consequently, they currently have to hire or borrow from other institutions. The tractor is not working, and they have a very old plow and ridger. There is a need to procure a new tractor with key accessories (e.g. plow and or ridger) to facilitate the management of the field operations. Prior to this investment, there needs to be clarity on how they will reduce illegal harvesting.

The other three sites are hosted by the National Cereals Research Institute, the National Horticultural Research Institute, and the Rubber Research Institute. The geographical distances between the four regeneration sites are not conducive to an efficient regeneration and multiplication program. They also do multiplication and regeneration with partners. The reviewers visited the accessions being multiplied by the National Institute of Horticultural in Ibadan. It was not clear how NACGRAB staff managed or monitored these joint plots. They need to resource and train staff from partner stations in key regeneration sites where the majority of the crops can be securely regenerated to produce adequate quantities of seed for distribution and storage. The long distances to the regeneration sites pose enormous logistical challenges and the institute does not have sufficient human and financial resources at these sites to manage the risk to accession identity and genetic integrity.

**Recommendation 12: The reviewers recommend that NACGRAB develop and implement a realistic five-year plan to securely regenerate at least 800 accessions per year. There will be a need to initiate conversations with the itinerant farmers and community leaders in the adjacent areas on how to effectively reduce illegal harvesting and to fence the field sites in Ibadan. NACGRAB also need to establish formal arrangements for regeneration or multiplication by partners. This would include sharing standard regeneration/multiplication guidelines, agreeing on field sites and design, and NACGRAB staff overseeing monitoring and harvesting to ensure that the accession identity is maintained and the seed quality is acceptable.**

*Handling species that are best conserved in the field or in vitro*

The field collections are not securely conserved, either at Ibadan or *in vitro*. Only 192 accessions of cocoyam, yam, sweet potato, cassava, and *Musa* are maintained in the field but there are 1,432 accessions in the inventory for these crops. This likely includes a collection of more than 1,100 accessions of yams that are also conserved by IITA. The seedbank suffers from many constraints, including diseases, pests, rodents, and illegal harvesting. Efforts have been made to reduce the impact of this harvesting in yams, but the impact is still significant on the long-term viability of the accessions conserved. There is a need to develop a long-term plan for the conservation of the vegetatively propagated and other recalcitrant-seeded crops. The needs for the field collections are also discussed further in the next section. In the future, once the field collections are secured, there will need to be an effort made to recollect the accessions that have been lost.

The institute has set up a tissue culture laboratory, but the priority is given to developing protocols for *in vitro* growth of vegetatively propagated materials and mass propagation for sale. It does not consider long-term back-up of field collections as a priority. The facility is run on solar power, but it is not sufficient to power a slow growth culture room thus conservation is not done routinely for any crop. Currently there are only 16 accessions from the field seedbank backed-up *in vitro*.

The lack of safety duplication for the field seedbanks is a very high risk that has already resulted in a significant loss of accessions as already discussed above and as given in Recommendation 11. The low priority and limited capacity to back-up all the field accessions in the *in vitro* facility is a high risk to the continued loss of genetic diversity for these crops. Lack of capacity for virus indexing means the quality of the conserved material cannot be assessed or cleaned up. Vegetatively propagated crops suffer from significant virus and other fungal disease issues that are difficult to manage for the long-term and risk the loss of the accessions.

**Recommendation 13: The reviewers recommend that a long-term plan needs to be made to securely conserve vegetatively propagated and tree crops. This would include an assessment of the risks for the Ibadan site and actions to be taken to mitigate these; an assessment of the level of diversity maintained in the field collections; actions to be taken for safety duplication; and approaches to enhance the use of the accessions. Support should be solicited from IITA to provide technical guidance for the planning and the implementation to secure these accessions for the long-term.**

#### *Documentation*

In the baseline survey, NACGRAB indicated that 1,445 accessions of a few crops including tomato, sorghum, sesame, celosia, okra and *Solanum* are entered into Multi-Crop Passport Descriptor (MCPD) data in an electronic, searchable database that is to be published on Genesys (Table 3). Only 423 have been characterized with key morphological descriptors but, of these, only 80 accessions have that data in a database. A total of 410 accessions have been genotyped with SSR markers but results have yet to be published. MCPD descriptors are used at collection time. Characterization uses IPGRI/Bioversity descriptors. There are conflicting numbers of accessions posted on Genesys. In the baseline, 2,140 accessions are on a searchable database while those with passport data number were only 1,445. Passport data is to be fully published on Genesys and released varieties are listed in a catalogue available through their website. Currently, the users have limited knowledge available to enhance utilization of accessions that risks future productivity and supply for key crops.

Germplasm is collected according to that which is locally utilized, to store and conserve it for future use and to make varieties available to farmers in geographical regions where these crops are not found. When germplasm is collected, they record MCPD descriptors and geographical coordinates in decimal format on paper. The germplasm then enters the institute and a logbook is filled with all the information collected in the field. After that, the logbooks go to the inventory where the information is stored in Excel sheets.

Material is subdivided based on category or class: storage cabinets are assigned on that basis. Categories are based on use: medicinal, legumes, underutilized crops, etc. The Excel sheets that contain the digitized data are also categorized in that way. They have one Excel sheet for the characterization, which uses IPGRI/Bioversity descriptors, a folder containing Excel sheets of morphological characterization, and the passport data is organized by crop, like in Genesys. Folders are organized by kind of data: characterization, regeneration, etc. One folder was created for Genesys where the information is stored by crop following the MCPD standard. When material has to be located in the cold room, they also use this classification.

There are four people who have access to the Excel files, but a local area network is not available, so the computers are not networked. The Excel sheets are basically on one computer and they move them around. Since Excel sheets are single user, meaning that only one user at the time can edit the file, they tried using Google Applications to allow several users to edit the same file. Unfortunately, they have a pay-as-you-go based internet contract, which means that internet access is very limited and not a permanent option, so the above solution cannot be implemented. For this reason, they use their personal laptops to move files around. While the reviewers can fully appreciate the issue in relation to abuse of the internet by staff for personal use, the pay-as-you-go option is not a feasible option for the longer term. There are other options that have been used successfully by organizations.

**Recommendation 14: The reviewers recommend that all efforts be made by NACGRAB to enhance internet connectivity at the seedbank to the server to allow for the full implementation of seedbank information systems such as GRIN-Global.**

Hard copy data sheets and logbooks are not securely stored or duplicated. Besides the issue of storing information on paper, digital information is stored in electronic sheets that cannot be shared and used efficiently. For this reason, NACGRAB has been investigating the option of implementing a dedicated system to manage the seedbank. GRIN-Global was evaluated in IITA and AfricaRice.

The first thing that needs to be implemented is a local area network. This will allow accession level information to be shared with other units of the seedbank. All Excel files should be stored in a common area of the server, accessible to the other computers in the network. This will prevent the need to use staff owned laptops and make the sharing of files easy. This is also required for implementing GRIN-Global. The reviewers recommend that all computers operating in the seedbank should be connected to the same network, as well as the server that should act as the shared data repository.

In order to migrate documentation under GRIN-Global it is important to start with a good existing documentation workflow, regardless of which tools are currently used. An expert, with skills in seedbank operations and with a good knowledge of GRIN-Global, should visit the seedbank and revise, in collaboration with the staff, all existing documentation practices, optimizing processes and adding all missing information elements. This should be done using the current logbooks and Excel sheets, so that the staff are not distracted by new technologies and can grasp the rationale behind the choices.

As processes are revised and rationalized, the relative workflows will be migrated into GRIN-Global, having a short period in which the latter works as a proof of concept and the existing system takes care of daily tasks. This will make the transition to the new dedicated information system faster and safer. This will also be led by the expert who should be able to assess the correct order in which documentation modules will have to be migrated and implemented.

The reviewers recommend that an expert in seedbank operations and GRIN-Global visit the seedbank and analyse with the staff the current workflow and documentation practices to migrate the current activities under GRIN-Global. The role of the expert would be essentially to guide current staff in rationalizing the activities, to correct or add eventual missing steps and to translate this into a workflow that integrates with the features of GRIN-Global. The expert's experience in implementing that system should be tapped, so that the correct

modules are covered in the right order, while the staff are trained on the tool using the actual data in the actual environment. Thus, the reviewers recommend a GRIN-Global Specialist consultancy with an expert who is also familiar both with seedbank operations and GRIN-Global to work directly with NACGRAB (Table 5- item 41) with the following term of reference to:

- Rationalize the responsibilities of the various units to create a working environment that matches the features and organisation of GRIN-Global
- Facilitate the full implementation of GRIN-Global.

The reviewers recommend that while GRIN-Global is being installed and its modules progressively implemented, staff should start using the Google suite of applications in order to allow more than one user to concurrently modify one electronic sheet. This will allow entering much more information in less time, make documentation practices more flexible and allow additional staff to clear the documentation backlog. The reviewers also recommend that current long-term staff be reallocated or additional temporary staff be hired to digitize as much information as possible, to reduce the amount of information stored on paper and ease the migration to GRIN-Global. The local area network is also required for this.

The seedbank presently has a desktop computer, a server, a label printer and a barcode reader. *The computers could be augmented with two extra workstations (Table 5- item 29) that can be used to increase data input.* While a label printer and a barcode reader are available, the staff still lack enough training to actually use barcoding. Labels, on the outside and inside of the germplasm containers and envelopes, are manually written with a permanent marker, GRIN-Global integrates well with barcoding systems, so this could be the opportunity to establish barcoding in the institute. As indicated in Recommendation 9, replacement of the current handwritten labels with collection number or other alternative identifier with a barcoded label that utilizes the NACGRAB accession number should be conducted once GRIN Global and the labelling equipment (printers and readers) are setup and working.

*There is need for an additional four barcode readers, a portable bar code printer, and a new printer/scanner (Table 5 – items 36, 37, and 38). It is also recommended that a camera be purchased to allow images to be captured in the databases as well (Table 5 – item 39).*

Currently, paper is used to capture documentation at the source, especially when collecting and characterizing in the field. The use of electronic tablets could free these activities from the reliance on paper, making data input much faster and reliable, it would allow the expanded use of descriptors lists when collecting and evaluating germplasm, validating data and increasing quality. GRIN-Global also integrates well with these kinds of devices, *so three electronic tablets could be purchased (Table 5 – items 34 and 35) and integrated into the documentation workflow.*

NACGRAB has developed a close collaborative relationship with IITA, in which the latter plays a mentorship role to the seedbank staff by offering training in seedbank management and conducting joint collection missions for mandate crops: this collaboration is vital, since IITA has experience in the use of GRIN-Global. The reviewers recommend that NACGRAB continue to strengthen the evolving collaborative framework with IITA in all documentation areas: GRIN-Global, barcoding and the use of electronic tablets are areas that will benefit from that collaboration.

Currently, data is on the server of the documentation manager and backed-up on an external drive kept in her office. Data is also backed-up on a couple of personal computers including the director's computer. *A couple of portable rugged hard drives (Table 5 – item 33) could be used to make complete backups of the server so that the whole system could be restored in case of failure. All current backups are on-site based, it would be important to add off-site backups, such as Dropbox, Google Drive or other cloud solutions.* This could be possible only if the internet contract is changed to a flat rate.

### *Buildings including safety, security and services*

The seedbank has three main areas for operations. The main building has a series of rooms on the ground floor which are used for short-term storage followed by a large storage room, a multi-purpose room (Seed Testing Lab – Figure 1) with lab benches and equipment that is used for seed processing and packaging, a large office space for the seed conservation staff, a large room for students and staff offices, and then a series of rooms for the plant health laboratory. Upstairs there are two rooms assigned for the documentation team. In a separate building, there are the long-term/medium-term cold storage units that only utilize part of the room, plus two chest freezers. At the back of the building is a series of smaller spaces that are used for storage and offices. This building has a number of cracks that need to be checked by a structural engineer. Finally, the tissue culture facility is in a separate building that is shared with the Biotechnology Group.

All seed processing is done in the single multi-purpose room which has benches. This is not an efficient use of space and mixes up many processes in a limited space. The adjacent room is a large office with a small number of desks and a couple of filing cabinets to hold the logbooks and data records. There is a need to rationalize the use of the multipurpose store adjacent to the Seed Testing Room and the large office. It could be repurposed as a germination room, similar to that used in IITA. The Seed Testing Room could then be used only for seed number determination, packaging, and distribution. As discussed earlier, the abandoned old glasshouse could be partially demolished and renovated to establish a crop work area, short term storage facility, and fumigation room to separate the dirty and clean seed processing operations. Finally, the large office could be split to create a secure storage space for consumables.

As discussed earlier, there is a need to have a space for controlled drying. A drying room adjacent to one or more new cold rooms (as discussed in seed drying and moisture determination section) is proposed though there are concerns over the reliability of the electricity supply. There will be a need to continue to utilize the building that currently holds the long-term storage (Figure 1) to create adequate space for a new modern cold room(s). There may be a need to utilize some of the office space in the back of that building so that packaging is done adjacent to the new drying room (if there is insufficient space to do it in that room).

The long-term seed storage building has a number of cracks that need to be checked by a structural engineer (possibly from IITA – see Table 5 – item 3) before any significant investment is made into the new drying room and new cold rooms.

The three generators are 10, 8, and 6 years old and all are regularly maintained every three months. It is switched on manually. The main problem is the unaffordability of fuel for the generator given the very long period of power outage. This creates a significant risk to the entire operation and NACGRAB need to make representations to government to obtain sufficient funding to remove this serious constraint to a nationally important facility.

Smoke detectors were noted by the reviewers. NACGRAB needs to confirm the frequency of testing and who attends in the event of an alarm being sounded. Fire extinguishers were also noted. There needs to be confirmation as to how frequently they are replaced and whether they are suitable for all types of fires that might be encountered in the facility including electrical fires.

The site is considered secure with a police station nearby and many other government facilities.

The facility has limited power obtained from alternative sources, such as solar panels. With a costly and intermittent electricity supply in Nigeria into the foreseeable future as well as the high cost of fuel for the generator, a longer-term aim should be to mitigate this risk for long-term conservation with increased energy efficiency and meeting a significant portion of their energy needs from electricity provided from solar or other alternate sources.

In the short term, the reviewers recommend that energy efficiency is considered in all equipment purchases. To facilitate this shift to energy efficiency and alternative energy sources, the reviewers suggest that a solar energy consultancy be done (Table 5- item 42) with the task of conducting an energy audit, recommend investment into energy efficiency and an alternative energy option with the full cost as well as providers.

Table 5. List of recommended infrastructure, equipment, supplies, and services to procure in upgrade. (Table excludes most consumables.)

	Item	Proposed purchase	Potential supplier	Est. item cost <sup>3</sup> (Euro)	No. items	Est. shipping & import cost (Euro)	Total cost (Euro)	Comment
1	Germination Room	Room conversion	(a) Local	2,000	-	Local	2,000	Includes provision of benches and LEDs
2	Refrigeration and air-conditioning consultancy		(a) Club Refrigeration, RSA (b) Various potential RSA Refrigeration companies online	9,300	-	-	9,300	Assume return scheduled SAA flight RSA to Nigeria = GB£ 1,373 = Euro 1,524; travel in-country = Euro 100; per diems x 4 nights = Euro 150 x 4 = 600; consultancy charges = Euro 1,000 per day x 7 days = 7,000. Total = Euro 9,224 say 9,300. If one company does the consultancy and purchase then this cost may be reduced. Also could visit other banks as well – one contract (more cost-effective)
3	Building structural survey consultancy	Survey of safety of building proposed for new Drying Room / Cold Room facility	(a) IITA	-	-	-	-	Assume IITA is able to provide advice.
4	Installation costs of following five items		(a) Club Refrigeration (b) Various potential RSA Refrigeration companies online	100,000	-	-	100,000	Notional sum including shipment of items
5	Insulated Drying Room and Cold	-	(a) Club Refrigeration, RSA	250,000	-	-	250,000	Depends on advice received. Notional

<sup>3</sup> Exchange rate assumptions: Euro 1 = US\$ 1.11; Euro 1 = GB£ 0.86; Euro 1 = CDN\$ 1.45

	Room structure		(b) Various potential RSA Refrigeration companies online					sum
6	Munters units	E.g., MCS300	(a) Club Refrigeration, RSA (b) Munters RSA	10,000	2	-	20,000	Depends on advice received. Notional sum
7	Refrigeration for both Drying Room and Cold Room structure	-	(a) Club Refrigeration, RSA (b) Various potential RSA Refrigeration companies online	10,000	3	-	30,000	Depends on advice received. Notional sum
8	Control panel and alarms	Model TBC	(a) Club Refrigeration, RSA (b) Munters RSA	5,000	1	-	5,000	Depends on advice received. Notional sum
9	Air-conditioning	Model TBC	(a) Club Refrigeration, RSA (b) Local	1,500	3	-/Local	4,500	Depends on advice received. Local purchase
10	Stackable crates (Drying Room)	E.g., 600x400x154 ventilated HDPE	(a) Schoeller Allibert, NL (b) Local	15	100	300	1,800	Freight may be prohibitively expensive and >>Euro 300 given quantity. Depends on above
11	Trolleys for crates (Drying Room)	600x400	(a) Schoeller Allibert, NL (b) Local	45	10	200	650	Similar comments to above
12	Cold Room shelving		(a) Local	1,000	-	Local	1,000	Notional. Depends on above
13	Cold Room clothing		(a) TBC (b) TBC	500	-	100	600	Notional
14	Building conversion to create suitable cleaning area		(a) Local	1,000	-	Local	1,000	Notional
15	Water purification unit	E.g., SLS Lab Pro 20T3 PurA-Q3 Reverse Osmosis + 35l storage	(a) SLS, UK (b) Try VWR / Avantor (but for different model)	4,000	1	1,000	5,000	Requires given water flow and pipe fittings. Also electricity supply.
16	Stereomicroscope	Nikon SMZ445	(a) Nikon Instruments Europe BV, NL (b) Try VWR / Avantor	1,000	1	250	1,250	May require light source within stand

17	Compound microscope (seed health)		(c)	1,000	2	500	2,500	Uncertain of requirements. Notional sum included
18	Aspirator	Agriculex CB1	(a) Agriculex, Canada	3,500	1	1,000	4,500	Export to Africa?
		Oregon Seed Blower	(a) Hoffman, USA					Do they require the CB-3 for larger seeds?
								Hoffman machine is cheaper at US\$1,950
19	Sieves	Endecott	(a) SLS, UK	100	10	1,000	2,000	Sieve dimensions / pore size to be advised
			(b) Endecotts, UK (RSA distributor)					
20	Seed counter	Contador	(a) Pfeuffer, Germany	8,000	1	250	8,250	16 kg
			(b) Hoffman, USA					Check seed sizes required
21	Moisture meter	E.g., Burrows DMC-750 or Gemini Tiny Tag View 2 TV-4500 plus probe	(a) Seedburo	250	1	50	250	Notional. Can't find Burrows machine on Seedburo website. Used by CIAT. Perhaps instead purchase modified Gemini data logger (extra to that below), probe and Wheaton Vial
			(b) Gemini Data Loggers, UK					
22	RH / Temperature logger	Gemini Tiny Tag View 2 TV-4500	(a) Gemini Data Loggers, UK (RSA distributor)	200	1	50	250	
			(b) tbc					
23	Foil bag sealer	HM305CTD	(a) Hulme Martin, UK	1,250	1	250	1,500	Do they export? 10.7kg DHL cost (up to 12kg) £139
			(c) ?					
24	Foil bags	Type 321/04 (Moore & Buckle)	(a) Moore & Buckle, UK	12,000	-	1,500	13,500	Notional
			(b) tbc					
25	Face masks	TBC	(a) 3M, UK	30	20	200	800	Preferably re-usable half masks with replaceable filters
			(b) Local					

26	Repairs to screen house	-	(a) Local	1,000	-	Local	1,000	Notional
27	Equipment for Plant Health Laboratory	Unspecified	(a) Various	?	-	?	?	To be specified
28	Field equipment e.g., tractor & plough		(a) Various	?	-	?	?	Probably subsequent to this project
29	Workstation	Dell Vostro Desktop 3471; Intel® Core™ i7-9700 [Intel Prozessor der 9. Generation mit 8 Cores/8 Threads, 12 MB Cache, 4,7 GHz], 8 GB DDR4, 1 x 8 GB, 2.666 MHz, 3,5 Zoll, 1 TB, 7200 U/min, SATA-Festplatte		620	2		1240	Workstations for data entry and hosting applications (Excel, Access and others), potential server. Should have the following configuration: I7 Processor, 8GB RAM, and 1TB HD.
30	Uninterrupted power supply	Eaton Ellipse ECO 800 USB UPS AC 9230 V (500W)		150	2		300	To power workstations during electricity outages. Should handle at least 500W.
31	Monitor	Dell 24 Monitor: SE2416H		100	2		200	Monitors for workstations.
32	Router	Nighthawk X4S AC2600 WiFi VDSL/ADSL Modem Router		330	1		330	Wi-Fi router. What is important is that the router has a long range so that it can cover as much as possible. A cable-based LAN is another option, but, depending on the required amount of work, it might end up being more expensive.

33	Backup HD	Silicon Power Armor A60 IPX4 Shockproof/Waterproof 2.5 USB 3.0 Military Grade Portable Hard Drive – 2 TB		120	2		240	What is important is that the model is rugged, it should be water and shock proof. At least 2TB of storage to be on the safe side.
34	Electronic tablet	Zebra TC750		1500	1		3000	For use as mobile data input devices. These devices could be used when the seedbank management system is operational, thus the model depends on the compatibility with the management software.
35	Electronic tablet	Zebra ET50		3500	1		3500	For use as mobile data input devices with more complex input forms.
36	Barcode reader	Zebra Symbol LS2208		100	4		400	To be used to read barcoded labels.
37	Barcode portable printer	Zebra Series ZQ500		600	2		1200	Use direct thermal printing for short-term usage indoors.
38	Printer/Scanner	Brother DCP-L5500DN DCP A4 Mono; Multifunction monochrome laser printer/scanner		300	1		300	To print forms that will be filled, then transcribed on the computer, for scanning and archiving documents, for general printing necessities.
39	Camera	Nikon Coolpix W300; Digital Camera (16 MP, 5x Optical Zoom/7.6 cm (3 Inch) LCD Display, 4K UHD Video, Image Stabilization, GPS)		350	1		350	To use when collecting and characterizing, to add images to germplasm information.

40	Seed Health Specialist Consultancy				1		16500	
41	GRIN-Global specialist Consultancy				1		16500	
42	Solar energy consultant				1		3000	
	Total Estimated Cost						513,710	

## Communication, Use of accessions and Linkages with users

The seedbank has effective opportunities to reach smallholder farmers through the State and Local Government Agricultural Development Programs (ADPs) and NGOs working in these states on specific livelihood programs promoting underutilized indigenous crop species for resilient seed and cropping systems, food and nutrition security. The ADPs have communication units that can facilitate information flow at this level. The national research institutes also have annual work plan meetings which can be used as a platform to develop joint activities on evaluation and characterization of accessions. The limited promotion of the use of accessions with key traits poses a risk to the disappearance of underutilized and indigenous species that are otherwise essential for crop diversity needed to mitigate the effects of climate change.

For all users, the reviewers recommend that accession level information be published online and updated regularly in a searchable database on the NACGRAB website and Genesys as discussed in the section on the baseline indicators. In addition, the reviewers recommend greater efforts be made to increase national awareness of the seedbank and the accessions conserved through key actions such as:

- With support from the Crop Trust, prepare a standard presentation on all aspects of the national collection conservation and use to be presented at various fora.
- Develop awareness materials and communication pathways tailored to different user groups including farmers/NGOs and seed producers at agroecological level; breeders and scientists; and policymakers.
- Share information on accessions in both print and electronic media that is tailored more to the users' needs.
- Compile a list of key journalists to be contacted to write stories about the seedbank services and diversity available, for publication in local media.
- Prepare a calendar of agriculture-related events where the national seedbank can be presented and its services and diversity showcased.
- Develop a mobile phone app that recommends seed material to users (e.g. farmers, NGOs, breeders) according to local agroecological conditions and availability.
- Ensure an online presence via social media, such as Facebook, Twitter and Instagram.

### *Effective collaboration with other conservers nationally and internationally*

NACGRAB used to be a member of Genetic Resources Network of West and Central Africa (GRENEWCA), coordinated by Bioversity International from its regional office at the IITA office, Cotonou, Benin. But this has been inactive since 2007, due to lack of funding. Nigeria has not ratified the ITPGRFA, but NACGRAB would be the focal point if the country is to become a contracting party. Currently, policies and procedures to access genetic resources are very unclear and spread among a number of different ministries.

There are at least 12 other organizations or institutes in Nigeria that are involved in conservation and use of plant genetic resources, but many of these are located in the Ministry of Agriculture. NACGRAB is planning to hold a stakeholder meeting in Abuja in 2020 to develop a national strategy for crop genetic resources conservation and use. They describe this as a National Summit on Genetic Resources that will be held in February of 2020 with multinational companies and other key stakeholders. The reviewers commend NACGRAB on taking leadership in developing a national strategy for genetic resources conservation and use. The National Summit is an excellent opportunity to not only raise the visibility of the opportunities and challenges for genetic resources in Nigeria, but it will also give NACGRAB an opportunity to facilitate greater collaboration amongst the many conservers nationally.

NACGRAB has developed close collaborative relationships with IITA in which the latter plays a mentorship role to the seedbank staff by offering training in seedbank management and conducting joint collection missions for mandate crops such as CWR of cowpea (in 2011) and regional landraces of yam. IITA provides technical backstopping in the development of *in vitro* conservation especially in creating protocols and resolving contamination challenges. A collaborative framework has been developed. A

duplicate sample of cowpea accessions is also kept at IITA. Collaborative arrangements also exist with ICRISAT and a joint collection mission for sorghum is planned.

There is collaboration with IITA and ICRISAT in areas of capacity building in seedbank and data management, tissue culture especially in the development of protocols, provision of packaging materials, joint collections of mandate crops, and safety duplication of some accessions. The current collaborative arrangements seem to be informal depending on the responsible persons in the collaborating organizations. There are no mechanisms in place to enhance information flow and knowledge sharing. Lack of effective engagement with other conservers to share knowledge about genetic resources management and conservation results in limited support for sustainable conservation and use of the collections.

**Recommendation 15: The reviewers recommend that NACGRAB utilize the planned National Summit on Genetic Resources to initiate joint actions to better secure conservation of key crop diversity in Nigeria through better coordination, greater sharing of accession level information, annual updates on the conservation status of accessions in the various collections, and increased safety duplication.**

*Engagement with stakeholders at local, national, and international levels in an effective manner*

One significant challenge for NACGRAB is to link to all the varied stakeholders involved in crop improvement and conservation activities in Nigeria. There are at least 12 other organizations or institutes in Nigeria that are involved in conservation and use of plant genetic resources, but many of these are located in the Ministry of Agriculture. It seems this has led to poor links to other agricultural research organizations as well as to farmers, seed companies, and farmer organizations.

Most of the national users are researchers, in the different national research institutes and universities, for evaluation and in some cases characterization of specific traits; but data from such activities is rarely shared with the seedbank for incorporation into the database. With the growing use of a limited number of improved varieties from a small number of crop species, limited knowledge about the present and future use of conserved accessions is a big risk in eroding crop diversity and hence increased vulnerability of cropping systems to climate change.

NACGRAB has no experience with participatory evaluation of accessions by smallholder farmers although they have had at least one project that involved seed multiplication for distribution in farmer trials. They do have a unit that deals with farmer training in areas such as seed saving practices and improved agricultural production practices. They also undertake specialized training courses which are requested and paid for by other institutions, such as the crop research institutes. These are not done very frequently. They also have some joint regeneration and characterization activities being done with the National Horticultural Research Institute and others research centers.

At the local level, the seedbank engages smallholder farmers through field days; demonstrations; printed instructions on ways to access germplasm held in the collection and text messages. A research-extension linkage unit is responsible for outreach programs of the Institute. The head of the unit described collaborative arrangements developed with farmers' organizations, State Agricultural Development Programs (ADP) and NGOs in participatory evaluation of germplasm with farmers as well as seed multiplication and distribution. There were also collaborations with universities and national research institutes for germplasm characterization, evaluation and participatory breeding.

Users want to know more about the accessions held in the seedbank and to be able to access information more readily. The staff recognize a need to promote the seedbank to farmers and researchers but not necessarily to provide information on individual accessions. They have an interest to meet the objective to have greater use of the seedbank, but there is no clear communication strategy with users or other stakeholders.

To enhance the engagement of the seedbank with stakeholders at the national, international, and local levels, the reviewers recommend the development of a participatory and cost-effective communication strategy to facilitate dissemination of appropriate information suited to each users group. Key activities are:

- Enhance collaboration and engagement with national and international stakeholders, including the private sector and CGIAR centers that are located in Ibadan

- Participate in regional events/shows related to plant genetic resources and climate change.
- Active engagement with regional and international plant genetic resources platforms/networks.

From the above assessment, the reviewers identified three distinct user-groups that can contribute to increasing the use and visibility of NACGRAB, and ultimately contribute to a more climate-change resilient agriculture. These include: 1) direct users group representing all stakeholders operating in different agro-ecological zones; 2) breeders/researchers' group which includes breeding companies and researchers from national agricultural research institutes and universities interested in using seed diversity to develop new varieties; and 3) the policy-makers -user group comprising of decision-makers such as director generals of key institutions, representatives from the government and donors, where possible, relevant to increasing general awareness of the value of national seedbanks. Implementation of a tailored communications strategy will facilitate effective linkages with the various user/stakeholder-groups.

**Recommendation 16. The reviewers recommend that NACGRAB organize facilitated meetings at agro-ecological zone level (2-3) with representatives of farmers' organizations, NGOs, local government agencies, research institutions/universities based in the zones, and local seed producers (max. 40 participants per zone). The reviewers also recommend that NACGRAB constitute a technical working group of breeders/researchers from other national research centers, universities, and the private sector for characterization, evaluation and use of collections in crop improvement. In order to elevate the profile of the national seedbank and enhance awareness on the importance of supporting it, the reviewers strongly recommend that NACGRAB and FMST hold at least two facilitated high-level meetings with key policy makers during the implementation of the S4R project.**

The objective of the first meeting in the agro-ecological zones could be to:

- increase awareness about national seedbank and activities (e.g. the seed material adapted to the agro-ecological zone and available for distribution; process to request and obtain seed samples)
- identify farmers' "repatriation" needs
- identify crops and varieties of interest for multiplication
- identify opportunities for collaboration among the stakeholders
- identify mechanisms for registering farmers varieties
- identify collecting gaps (e.g. unique seed material available in farmers' fields but not yet conserved in the seedbank)
- articulate the information needs and feedback mechanisms for each agro-ecological zone
- agree on the *modus operandi* of each agro-ecological zone user group for information sharing and feedback.

Other key activities that should be considered include:

- Multiply/bulk seed of accessions of identified crop portfolios for distribution
- Conduct participatory multi-location (2-3 sites in each zone) trials to identify farmer-preferred and climate smart accessions for direct use in the cropping system.
- With support from farmers' organizations, State Agricultural Development Programs (ADP) and NGOs, organize field days to expose a larger number of farmers to diverse accessions
- Provide technical support in the registration of selected accessions for large scale use
- Provide technical support to development projects to enhance use of accessions and conservation services by smallholder farmers.
- Provide technical support to programs engaging farmers in participatory evaluation and multiplication of local landraces for direct use.
- Participate in any annual biodiversity fairs in each agro-ecological zone.
- Engage researchers at research institutes, universities, or private companies in adjacent areas to review germplasm being regenerated at the stations.

As noted earlier, NACGRAB needs to establish formal processes to obtain feedback on the use of the germplasm in the breeding programs and to increase collaboration with national agricultural research institutions and private seed companies in the country. It is also essential to institute a formal agreement with researchers to share results and data for inclusion in the database.

The reviewers also recommend that NACGRAB constitutes a Technical Working Group of breeders/scientists from national agricultural research institutes and universities for characterization, evaluation and use of collections in crop improvement. We propose at least one annual meeting to convene around 10-15 key researchers and scientists from national agricultural research institutes, universities and any other institution conducting plant breeding in the country. The objectives of this user-group should be to:

- obtain direct feedback on minimum traits that breeding users need to make decisions on seed material requests;
- identify data needs;
- identify candidate seed material of interest to breeders;
- identify opportunities to create core collections;
- collaboratively introgress new genes in crop improvement;
- coordinate participation in multi-location diversity and participatory plots;
- identify opportunities for joint germplasm evaluations;
- publish results from joint activities.

#### *Contribution to climate change adaptation and resilient seed systems*

In the past four years (2015-2019) NACGRAB has participated in Crop Trust-funded projects on collecting CWR and pre-breeding cowpea for improved adaptation to drought and heat. In these projects, 100 cowpea accessions were involved. There has been limited use of the conserved crop diversity directly by farmers, especially for underutilized and indigenous crops. These hampers enhanced resilience and productivity of the cropping system with the challenges of climate change. Limited testing and use of accession for improving climate smart traits will diminish adaptation of crops to these challenges.

**Recommendation 17: To address the limited use of national collections and to enhance crop diversity to mitigate the effects of climate change, the reviewers recommend that NACGRAB facilitate technical support in the evaluation, characterization, and multiplication of accessions of underutilized and climate-smart crops for direct use in the cropping system by the following actions:**

- **Together with the Technical Working Group of researchers/scientists, identify a core collection of underutilized and climate-smart crops (e.g. Bambara, sorghum, pearl millet, yams, popular vegetables landraces and some crop wild relatives) for use in crop improvement**
- **Multiply/bulk seed of selected accessions for distribution**
- **Together with breeders/researchers conduct phenotypic/genotypic characterization for climate smart traits**
- **With user groups provide technical support in the evaluation of characterized accessions for climate-smart traits with researchers, farmers' organizations, State Agricultural Development Programs (ADPs) and NGOs that can then facilitate access to seed and knowledge to farmers.**
- **With breeders to undertake introgression and genetic enhancement with selected accessions to develop diversified populations**
- **Conduct participatory selection with farmers to identify preferred resilient varieties (medium term)**
- **Seek registration and seed multiplication of selected varieties**
- **With support from farmers' organizations, ADPs and NGOs facilitate access to seed and knowledge to farmers (long term).**

#### **Comprehensive risks management**

There is no risk management plan at the institute level. The Maintenance Unit and Heads of Technical Department/Unit are responsible for conducting the risk assessment. Apparently, it is the same units that

advise on remedial actions. Intermittent and irregular power supply from the national grid, which leads to other risks, i.e. temperature fluctuation, high and irregular relative humidity in the storage rooms, is considered to be a major risk. The site reviewers were impressed by the amount of data recorded in logbooks and the apparent presence of procedures for monitoring and servicing of key equipment.

When new staff join, there is an induction process during which a handbook is shared that describes all the staff's rights (the handbook was not shared). The Human Resources Policy included:

- Health and worker safety
- Sexual harassment: identifying the process needed to file a petition and do an investigation
- Sanctions in relation to violations of the Public Service Rules
- Rights to Report policy that explains where staff can report corrupt practice or other concerns that go to the Anti-corruption Unit

There was no visible communication with staff on social and environmental standards, such as posters, notice boards, or brochures. There seems to be little effort made to raise awareness among staff on risks and the steps needed to mitigate them, except for fire. NACGRAB need to carry out a full analysis of the risks both to staff and the collection carefully considering the likelihood of events occurring (and pairs of events) and the potential severity of their effects. They then need to put measures in place to mitigate against these risks. There is a need to instill staff consciousness of risk issues and staff training regarding fire, field work (including operation of machinery and chemical spraying) and seed processing operations (e.g. preventing inhalation of dust). Laxity in consciousness about environmental, safety, health and social responsibility is of concern.

Formal risk assessment should include the status of implementation of regulations for the management of significant environmental, safety, health, and social risk. NACGRAB should make every effort to fully mitigate against these risks as required. In particular, NACGRAB need to ensure that there is proper staff training regarding fire, fieldwork, and seed processing operations. Safety equipment needs are referred to in sections above. Staff trained should include any out-of-hours staff.

No information or evidence was given in the baseline questionnaire or the review visits or shared in documents on guidelines and systems in place for preventing, reporting, and dealing with matters of discrimination, sexual harassment, sexual exploitation, sexual abuse and gender-based violence. NACGRAB also utilizes a quota system for recruitment that is monitored by the Federal Labour Commission. It requires that 65% of the staff must be hired from the local area.

No documentation was shared with the reviewers to support the statements NACGRAB made regarding compliance with policies and standards. No formal risk assessment or plan was shared, but it seems that the Maintenance Unit and the heads of technical departments and units are responsible for risk management. They review an informal risk assessment and management plan on an annual basis for both the institute and the seedbank. The primary risks recognized include:

- Inadequate funding to access adequate seedbank management, i.e. government not adequately supporting the center.
- Intermittent and irregular power supply from the national grid which leads to temperature fluctuation, high and irregular relative humidity in the cold and drying rooms.
- Lack of adequate funding to host and follow up with local communities.
- Reduced awareness of local farmers as a result of logistics and funding.
- Obsolete storage facilities.
- Fungal diseases.
- Insect pests, e.g. weevils, sound flies, fruit flies and bacteria.

It was noted that the seedbank facilities are also vulnerable to a range of threats such as freezer breakdown, unreliable power, fire, illegal harvesting, etc. A practical risk management plan for the conservation units such as the seedbank, field seedbank, and tissue culture facility to mitigate the primary risks needs to be developed as an urgent action. This should be done as part of the implementation of QMS and might involve the setting up of a standing committee on risk management with clear terms of reference. A number of the recommended actions given in the previous discussions was based upon the reviewers' consideration of risk. The review team has identified significant risks in Table 7 with level of risk before and after mitigation, suggested mitigation actions, likelihood of

successful mitigation, and who is responsible for the risk management. These risks fall into a few key categories that are given in the Table 7. There are risks that are external to NACGRAB and the seedbank. There are also risks that are internal to the institute such as issues related to finance, administration, and policy. Finally, there are risks that are related to the facilities, routine operations of the seedbank and its links to users. The suggested mitigation actions have also been taken into account in the development of the upgrade recommendation by the reviewers.

**Recommendation 18. The reviewers recommend that a detailed risk management matrix (such as Table 7) is agreed upon and used as the basis for monitoring risk for the seedbank on an annual basis with updates provided as needed by NACGRAB to the Crop Trust.**

Table 7. Risk Management Matrix

Source of risk	Level of risk	Mitigation actions	Level of risk after mitigation	Likelihood of successful mitigation	Responsibility for risk management
<b>External to NACGRAB</b>					
Loss of crop diversity in farmers' fields and in the wild	High	Long-term plan for collection of crop diversity with identification of priority gaps	Low	Medium	NACGRAB and Crop Trust
		Secure conservation of accessions ex situ			
		Rationalize current collection to manage redundancy with other conservers			
Increased incidents of drought	High	Access to irrigation in field seedbanks and in regeneration sites	Low	High	NACGRAB and Crop Research Institutes in Ministry of Agriculture
		Enhance testing and use of accession with drought tolerant traits by researchers and farmers			
Inadequate and expensive electricity supply	High	Greater investment into constant energy supply and alternative energy by FMST and Crop Trust	Medium	Medium	FMST, Crop Trust, NACGRAB
		Safety duplication of unique accessions to seedbank outside Nigeria			
High cost of fuel	High	Greater investment into energy efficiency and alternative energy by FMST and Crop Trust	Medium	Medium	FMST, Crop Trust, NACGRAB
		Safety duplication of unique accessions to seedbank outside Nigeria			
<b>Institutional administration, finance, and policy</b>					
Weak, unclear national policy for ABS for user access to conserved genetic resources	High	Ratification of the ITPGRFA	Low	High	FMST, NACGRAB
		Development of institutional MTA to clarify terms			
Inadequate and inconsistent annual government spending for NACGRAB in FMST	High	Ensure government funding obligation in the project agreement	Medium	Medium	FMST, NACGRAB, and Ministry of Finance
		Increase visibility for the seedbank, its value, and its needs to Ministries and Parliament			
		Greater cooperation of FMST and Ministry of Agriculture on conservation and use plant genetic resources			
		Ensure Government has passed on pension contributions to pension firm			
Inadequate project implementation and/or financial reporting	High	Quarterly technical and financial monitoring by Crop Trust	Medium	High	NACGRAB and Crop Trust
		Annual audit that includes adequacy of financial management			
		Annual review of implementation by Crop Trust			

Source of risk	Level of risk	Mitigation actions	Level of risk after mitigation	Likelihood of successful mitigation	Responsibility for risk management
		on site Clear terms and conditions in project agreement on disbursement of funds and replenishment Qualified accountant to oversee financial management and preparation of accounts on a timely basis			
Inadequate management of key project assets	Medium	Clear terms in project contract on management of assets procured, maintained, or repaired by project Qualified accountant to oversee implementation of a fixed asset register with proper internal controls around security of assets Clear terms for donation of assets to seedbank in NACGRB at end of project Regularly scheduled maintenance of equipment Timely repair when needed	Low	High	NACGRAB and Crop Trust
Bureaucratic procurement process	High	Crop Trust to handle project procurement directly Project agreement specifies custom clearance process for procurement, especially the payment of duties Procurement includes cost for shipping and custom clearance	Low	High	Crop Trust and NACGRAB
Inconsistent implementation and monitoring of compliance with environmental, human safety, and social risk according to government policy	Medium	Risk management plan for seedbank with annual monitoring Clear documentation and implementation tools regarding compliance with operational (e.g., procurement, health and safety, etc.) and ethical (e.g., anti-terrorism, sexual harassment, financial irregularities, etc.) requirements utilized at NACGRAB, including awareness raising among staff, defining ownership of reference documents, defining responsibilities, setting up processes to ensure compliance, defining ownership of these processes, ensuring annual reporting and updating	Low	High	NACGRAB
<b>Links to users</b>					
Inadequate engagement with stakeholder for long-term support for	Medium	Long-term plan (10-20 years) for NACGRAB seedbank with implementation monitored	Medium	High	NACGRAB, FMST

Source of risk	Level of risk	Mitigation actions	Level of risk after mitigation	Likelihood of successful mitigation	Responsibility for risk management
crop conservation and uses		transparently by key users and stakeholders			
		Increased collaboration with national crops centers, universities, State Agricultural Development Programs (ADP), NGO, farmers' organizations, and private sector to link to smallholder farmers and communities			
Inadequate communication on the seedbank, its accessions and any impacts to users, policy makers, and other key stakeholders	Medium	Communication strategy with implementation plan and key performance indicators	Low	High	NACGRAB and Crop Trust
Inadequate feedback to and from user	Medium	Establish a formal process to solicit feedback from recipient of accessions	Low	Medium	NACGRAB and Crop Trust
		Establish process to feedback on the value of accessions to both the donors and users of germplasm			
		Monitor and report on the impact of the use of conserved accessions			
		Greater engagement with users through stakeholder meetings or through advisory group for the seedbank			
Inadequate accession level information for users	Medium	Recovery of data generated by recipients of accessions in the past	Low	Medium	NACGRAB
		Formal agreements with research recipients on sharing research results and data for inclusion in seedbank information system			
		Collaboration with universities and others to increase opportunities for student projects			
		Access to accession level information increased with Genesys and NACGRAB own website			
<b>NACGRAB Facilities</b>					
Fire	High	Adequate firefighting equipment	Medium	High	NACGRAB and Crop Trust
		Internal and external alarms and sounders			
		Adequate fire safety training			
Theft and vandalism targeting ICT equipment, laboratory, conservation facilities, and seed samples	Medium	Increased security of key rooms and buildings with external locks, alarms, and sounders	Low	High	NACGRAB and Crop Trust
		Restricted access to the seed stores with keypad access			

Source of risk	Level of risk	Mitigation actions	Level of risk after mitigation	Likelihood of successful mitigation	Responsibility for risk management
Insecure long-term access to appropriate land resources for regeneration, multiplication, and other field related activities for the seedbank	High	Ensure clear commitment by relevant research institutes to make available appropriate land resources for long-term use by seedbank	Medium	Medium	NACGRAB, FMST, and the Federal Ministry of Agriculture
		Provide sufficient resources to NACGRAB and the relevant research institutes to maintain land resources and ensure seedbank access for the long term			
<b>Routine operations</b>					
Increased backlogs in routine conservation operations with need to focus on projects and income generation	High	Priority given to direct funding from government for secure, cost effective routine operations for conservation in annual workplans and budgets	Medium	Medium	Ministry of Finance, FMST, NACGRAB, and Crop Trust
		Clear costing for routine operations after upgrades			
		Annual transparent monitoring for key performance indicators for routine operations by Crop Trust and FMST			
Insecurity and encroachment at field seedbank site in Ibadan	High	Manage fallow field growth and undergrowth in forested areas to reduce risk of fires	Medium	Medium	NACGRAB and Crop Trust
		Secure field sites with fences			
		Increased use of regeneration sites outside Ibadan			
		Increase dialogue with local communities			
		Safety duplication of accessions to IITA			
Loss of viability of accessions in seedbank	High	Quality management system (QMS) implemented at seedbank	Medium	High	NACGRAB and Crop Trust
		Secure accessions in field seedbanks			
		<i>In vitro</i> conservation with virus cleaning			
		Upgrade of facilities, equipment, and processes			
		Regeneration at crop research institutes sites outside Ibadan			
Conservation and distribution of seed with unknown seed health, especially for seed-borne diseases or virus.	High	Upgrade facilities, equipment, and processes to monitor and document the plant and seed health status routinely	Low	Medium	NACGRAB and Crop Trust
Inadequate monitoring of seed quantity	High	Upgrade facilities, equipment, and processes to document 100/1000 seed weight and packet weight	Low	High	NACGRAB and Crop Trust
		Initiate processes to document any change in seed quantity with distribution			

Source of risk	Level of risk	Mitigation actions	Level of risk after mitigation	Likelihood of successful mitigation	Responsibility for risk management
Loss or change in genetic integrity for accessions with poorly established and managed regeneration sites.	High	Implement standard operating procedures for regeneration for a range of mating types by NACGRAB and its partners	Medium	High	NACGRAB and Crop Trust
		Develop five-year plan to regenerate at least 800 accessions per year securely			
		Establish formal collaboration with partners at field sites with the sharing of guidelines and training on secure regeneration/multiplication			
		Utilize isolation cages for insect-pollinated accessions			
Inadequate safety duplication	High	Prioritize unique accessions by crop and arrange for safety duplication with institutions outside of Nigeria to serve as a primary black box	Low	High	NACGRAB and Crop Trust
		Continue to dispatch seed to Svalbard			
Lack of management and monitoring of significant virus and disease issues of vegetatively propagated accessions	Medium	Initiate a long-term plan to utilize an <i>in vitro</i> conservation system to complement the field seedbank for the secure conservation	Low	High	NACGRAB and Crop Trust
		Implement protocol to monitor and clean up accession for viruses in field collection			
Insecure and inefficient routine management of conservation of accessions	High	Upgrade facilities, equipment, documentation, and processes for key routine operations	Low	High	NACGRAB and Crop Trust
Lack of a secure, dedicated seedbank information system to manage accession identity, facilitate secure and cost-effective routine operations, and enhance access by users to accession level information	High	Upgrade facilities and equipment for documentation	Low	High	NACGRAB and Crop Trust
		Install and fully utilize a seedbank information system such as GRIN-Global			
		Ensure secure back-up of documentation			
		Update data in Genesys and own website as required			

## Annex 1

### Terms of Reference

#### National seedbank review

The Global Crop Diversity Trust (Crop Trust) commissions the review of national and international genebanks as part of the process to assess their needs for upgrading and their eligibility to receive long-term support from its endowment fund. This review provides direct inputs to the development of subsequent seedbank upgrading workplans.

This initial national seedbank review is an activity of the “National Seeds Collections for Climate-Resilience Agriculture in Africa – Seeds for Resilience” project. “Seeds for Resilience” is funded by the Federal Republic of Germany, and its goal is to:

Empower national seed collections, by safeguarding them in perpetuity through an endowment fund, documenting and managing them appropriately for conservation and use, and promoting their use, to serve as a basis for climate change adaptation of vulnerable African cropping systems.

This review will take into consideration various aspects that affect the overall functioning of the seedbank, including technical, financial, organizational, regulatory, social and environmental aspects.

The objectives of the review are to:

- Determine the institutional arrangement and organizational capacity of the seedbank.
- Assess the basic organizational structure of the seedbank and its parent institute.
- Identify risks and constraints that prevent the seedbank from fulfilling its main objectives.
- Assess the seedbank’s environmental, social, health and safety risks and procedures.
- Determine the main funding sources of the seedbank and the proportion dedicated to germplasm conservation activities.
- Determine the number of potentially viable, available and safety duplicated accessions, disaggregated by species and crops.
- Determine the uniqueness of the collection in the context of the global system for long-term conservation of plant genetic resources for food and agriculture.
- Review the adequacy of the facilities, equipment and field sites for both long-term conservation and active use of the collections.
- Assess the capacity of the seedbank staff to carry out activities for both long-term conservation and active use.
- Assess written and actual procedures as demonstrated by staff and determine if the level of operation is adequate for long-term and active use of the collections.
- Assess the level of use of each crop collection and existing linkages with its users.
- Provide the Crop Trust with key findings, actionable recommendations actions for priority and suggestions for mitigating risks of all of the above.

The review is to be conducted in five preselected national seedbanks, prioritized according to the importance and potential uniqueness of their collections, and for being part of the donor’s “One world – no hunger” initiative.

#### Review implementation

A panel of external consultants, with relevant experience in the region and the aspects to be addressed in the review, will be appointed for the review. The project manager will facilitate the review providing background information from each seedbank, coordinating the development of the agenda, the execution of the overall review and assist the chair of the review panel in any aspects of the review and the completion of the final report. The Crop Trust will not take part directly in the formulation of the review report and recommendations.

The review comprises three phases:

#### I. General background and literature review

The reviewers will aid in the preparation of questionnaires to be sent to each national seedbank considered in the review. These questionnaires will aim to gather baseline information about the seedbank and its parent institute.

The reviewers will be provided with:

- The responses to the questionnaires.
- Genebank website and related materials.
- Relevant past reviews of the genebank commissioned by the Crop Trust.
- Any other materials provided by the genebank as background for the review.

All review panel members and the seedbank manager will be involved in the development of the agenda for the site visit. This is an important process during which specific issues and questions are identified for review and relevant stakeholders and users within and outside the Centre are identified for consultation.

At least two calls will take place in advance of the site visit, between the panel members and Crop Trust staff.

## **II. Site visits and seedbank review**

The panel members will conduct a site visit of the seedbank following the agreed agenda. Usually the site visit involves interactions between the panel members and senior management, researchers and the full genebank staff. There will also be at least one visit to field stations. The panel members should determine the scale of these interactions in the development of the agenda.

Given that discussions during the review are usually intensive, panel members may wish to review together the findings at the end of each day. There may also be a need to make adjustments to the agenda in order to pursue certain issues in greater detail. The draft recommendations will be presented to the seedbank staff and management on the last day of the site visit.

## **III. Completing the report and presenting the recommendations**

The review panel will follow the agreed review checklist and complete the report format, including a report of the evidence provided by the seedbank for each checklist item, compliance of the seedbank/host institute to standard policies and guidelines, and a statement to indicate how any recommendations should be closed. Any additional reporting should be limited and justified.

A response will be solicited from the seedbank by the Crop Trust. The Crop Trust will provide its own response to the recommendations. In the event of a lack of endorsement by the seedbank or the Crop Trust to a recommendation, further discussions may be necessary between the Crop Trust, panel members and the seedbank staff. If necessary, the other specialist bodies may be consulted

### **Content of the report**

The chair of the review panel will lead the preparation of an individual report of no less than 4,000 words per seedbank. The report will include the analysis of the various objectives of the review and key findings will be highlighted. The review panel is expected to make recommendations for the future management of the seedbank and its collections that should be actionable by the management of the seedbank, the Crop Trust, and the project.

### **Use of the review report**

The report will be submitted to the Crop Trust for initial review to ensure completeness and clarity. A response will be solicited from the seedbank's host institute. The Crop Trust will provide its own response to the statements and recommendations with the agreement of the host institute and reviewers.

The reports will be used specifically to inform the project with regards to the final selection of national seedbanks to continue with the upgrading phase and provide a basis for preparing recommendation action plans, workplans and activities to be considered during the upgrading phase.

## **Annex 2**

### **Seeds for Resilience**

October 9 - 14, 2019

Ibadan, Nigeria

Agenda

Time	Session	Items to be addressed	Participants	Facilitators	Location
<b>DAY 1: October 9</b>					
16:40 - 16:40	Arrival to Lagos				
<b>DAY 2: October 10</b>					
06:00 - 09:00	Travel Lagos - Ibadan				
09:30 - 10:00	Brief presentation by the Review Panel Chair and Q&A to all genebank relevant staff.	Introduction to the review panel and to the objectives of the review.	Head of genebank, genebank staff, review panel, Crop Trust project manager	Chair of review panel/Crop Trust project manager	NACGRAB
10:00 - 10:30	General introduction to the genebank	Introduction to the history of the genebank, current activities	Genebank staff, review panel, Crop Trust project manager	Head of genebank	
10:30 - 15:30	Tour of the genebank facilities and its operations	Getting to know the genebank and the people who work there.  Introduction to all genebank operations by the staff responsible and review of the basic operations and main activities of the past 5 years. Include (but not restricted to):  - Acquisition unit - Storage unit - Viability testing unit - Seed health unit - Distribution unit - Field operations (greenhouse unit) - Data management unit - In vitro (if available) - Characterization unit	Genebank staff, review panel, Crop Trust project manager	Genebank staff	
15:30 - 16:30		Call with IT reviewer			
16:30 - 17:30	Risk management & quality management system	General discussion on risk measures, implementation of a quality management system			
<b>DAY 3: October 11</b>					
09:00 - 11:00	Meeting with IITA	Introduction to the project and the review.  Reviewers to understand synergies and partnerships between IITA	Head of genebank, review panel, Crop Trust project manager, IITA representatives	Chair of review panel/Crop Trust project manager	IITA

		and Nigerian national genebank.			
11:00 - 12:30	Lunch at IITA House				
12:30 - 13:30	Return to NACGRAB				
13:30 - 15:30	Meeting with NACGRAB senior management	Reviewers are provided a description of the overall research strategy and where the genebanks fits into ongoing or planned research.  Reviewers will address various aspects related to the institutional and management arrangement of the institute.	<u>NACGRAB senior management:</u> Director General, Head of budgets/finances, Governance official, Director of research, head of genebank  Review panel, Crop Trust project manager	Chair of review panel/Crop Trust project manager	NACGRAB
15:30 - 17:00	Review of any outstanding issues with genebank staff		Genebank staff	Review panel	
<b>DAY 4: October 12</b>					
08:00 - 12:00	Visit to regeneration site (TBC)		Head of genebank, review panel, Crop Trust project manager	Head of genebank	NACGRAB
12:00 - 13:00	Lunch				
13:00 - 15:00	Tour of Ibadan city (optional)		Genebank staff	Review panel	
<b>DAY 5: October 14</b>					
06:45 - 07:30	Travel to NACGRAB				
07:30 - 09:30	Review of any outstanding issues with genebank staff		Genebank staff	Review panel	NACGRAB
09:30 - 11:00	Review panel internal meeting	Prepare presentation of preliminary recommendations			
11:00 - 13:00	Review panel wrap-up presentation	Presentation of preliminary recommendations and wrap-up	Senior Management staff, genebank staff, review panel, Crop Trust project manager	Chair of review panel/Crop Trust project manager	
13:00 - 14:00	Lunch				
14:00 - 17:00	Travel Ibadan - Lagos airport				

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