CIP Genebank Review 2019

Programme: Genebank Platform	
Genebank reviewed: CIP	**Site visit Dates:** 9-13 December 2019
	Review report Date: 03 April 2020
	Center and Crop Trust responses: 19 November 2020
Place: La Molina, Peru	
Genebank Manager	Noelle Anglin
Review Panel	Steve Adkins
	John Fitzsimon
	Jane Toll
Crop Trust staff	Charlotte Lusty

	Observation	Recommendation for clearance	Due date	Responses
1	4 Major observations & 1 Minor observation	Reduce the cost and orient towards a science-based Quality Management System (QMS) for genebank operations. It is recommended to: • Maintain good QMS principles but drop the ISO audit in order to develop a manageable cycle of review aligned with the Genebank QMS and genebank standards. • Provide details in SOPs behind key decision points ('why','what if' & 'who') that will guide staff. • Reduce the number of SOPs through consolidation, strict versioning and treat the Spanish version as the master.	Dec 2020	**CIP** Maintenance of ISO through UKAS certification has been an institutional decision to make sure that materials sent out from the genebank are of the highest possible standards (i.e. – free of diseases). It came about due to a problem CIP had years ago where clean material was sent to the USA and found to contain viruses which put our reputation at risk. We would not like to see a regression of this situation due to lack of quality control. ISO highly regulates the virus testing and germplasm distribution process to ensure a high level of success. In addition, CIP has managed to cover the costs of ISO over the years with several funding sources, particularly some bilateral projects. CIP suggests that before any change of this nature occurs, a thorough analysis of costs and benefits of alternative QMS options is done and evaluated by genebank specialists and management. If a suitable system is found, a transition plan can be established and time to cost out the transition process. We would also require some time where our current system and a new system would need to be implemented simultaneously in order to evaluate if a new system was as comprehensive and suited all of our needs. We have established an internal task force to look into other accreditations/providers,

				costs and coverage but it is still in the initial stages and requires more time. Therefore, this process would require more time than December 2020 to compile this kind of analysis and trial another option. Further, it appears due to COVID19, that our current QMS system will be continued through 2020 without cost nor a normal operational audit because of travel restrictions and lack of staff in the laboratories performing routine work. The number of SOPs was a product of the needs and activities from each group within the genebank team, ISO requirements, plus dealing with two languages (English and Spanish). The number of SOPs is based on what is needed for staff to implement their duties properly. The staff use them in their current formats to carry out their activities and know how to follow each one. Many of the key decision points during SOP implementation are specific to each species and we will promote enforcement of them to make processes effective and efficient. **Crop Trust** The arguments made in CIP's response were made to the reviewers and the conclusions of the reviewers have come from a consideration that the current ISO system is not producing the desired results for CIP and potentially hampering processes and certainly taking up a substantial amount of staff time. Crop Trust strongly agrees with the reviewers' recommendations and considers that change here is really necessary. Understandably the timetable can be reviewed given current circumstances.
2	1 Major observation	Revise regeneration priorities and standards to increase the availability of both wild potato and sweetpotato seed collections in a timely, cost-efficient and scientifically sound manner.	Dec 2021	**CIP** We have already reduced the requirements of seed availability for wild potato and sweetpotato seed to help increase their availability. They were adjusted from 6000 seeds down to 1000 and from 2000 down to 500 for potato and sweetpotato, respectively. This effectively raised availability by making these changes. Also, acceptable germination rates were lowered down below FAO guidelines to 75% to help increase availability for our users. Overall, our cultivated collection receives much more requests for distribution, so much of our focus has always been on making cultivated material available for distribution as the wilds generally receive less interest and requests. Further, we are open to a visit by Fiona Hays (seed physiology expert and leader of SQM projects) to further refine things such as this. **Crop Trust** Crop Trust agrees with the reviewers' recommendation. The details in CIP's response

				were considered in the review. This recommendation relates to the need to reconsider wholesale the processes for seed production and conservation at CIP. CIP's suggestion to seek and take up recommendations from Fiona Hay is a start. However, the reviewers are also calling for a strategic approach to seed conservation through clear prioritization. Considering CIP's response regarding the priority of the cultivated collection, it may be worth considering under One CGIAR whether another CG Centre can provide services for CWR on behalf of CIP.
3	4 Major observations & 2 minor observations	Review, revise and improve thresholds, standards, equipment and processes for seed processing and drying to optimize longevity in storage bringing them in line with best practice.	Dec 2021	**CIP** This will require some funding that we currently do not have especially in terms of equipment/remodeling. If we are to redo the drying room or convert cold chambers into drying rooms as was suggested in the checklist, this has a large cost implication. Thus, significant funding would need to come to CIP to make these changes and time to get contractors in place or buy equipment from overseas. We agree with conducting research, but funding needs to be secured in order to advance research on seed longevity. We are trying to actively participate in the SQM projects. However, CIP was removed from the second round of SQM projects for cryptic reasons making it difficult to learn from these research projects and advance on processing and drying conditions for potato and sweetpotato. We are always looking for funding in this area, but research is not included and supported in our routine funding so bilateral projects are required here. Further, we are open to a visit by Fiona Hays to further refine things such as this. **Crop Trust** Agrees with the reviewers' recommendation and reiterates the points made under recommendation 2. CIP's role in the first phase of the SQM project was affected by the loss of the staff member involved in the project. The second round of projects was determined from group discussions. As far as Crop Trust is aware there were no underlying reasons for CIP not being involved in the second phase other than not having a staff member clearly acting as focal point in the group. This can be followed up with Fiona Hay. CIP should not lose out and should be connecting with the SQM group and particularly CIAT and CIMMYT in this regard.
4	2 Major observations & 1 minor observation	Establish a base collection of 'most original sample' and active collection where seed quantity is aligned with	Dec 2021	**CIP** This has already occurred. Several years back, the former genebank manager discovered that there were multiple inventories stored as each

		predicted demand and reduce all other lots to ensure that only two require full monitoring.		individual pollination was saved in separate inventories for each accession which created too many packets of seed for each accession. In the past, the genebank was run more in the spirit of a breeding team. Each pollination was separated, and the resulting seed were placed in separate packets. It took approximately two years or longer for the staff to go through the entire collection and combine all of these inventories down and pool them together and rearrange the entire collection by CIP number instead of collector number. We currently have the most original sample and active inventories when an accession was regenerated. In some cases, original seed has been depleted which occurred a long time ago. However, base collection and active collection inventories are all in storage. We have routinely looked at if certain accessions are in demand more than others and have found no clear trends. It ebbs and flows each year and no single accession is targeted by our users over and over again. **Crop Trust** Crop Trust agrees with the reviewers' recommendation. The points made by CIP in its response were made during the review. Reviewers saw that there was not a clear distinction of MOS samples nor of actively managed samples in their review of processes, documents, labels and data management systems and they found multiple lots (inventories) still being managed in storage. Archiving will help here and careful distinction between active and base collections at all possible opportunities.
5	1 Major observation	Re-evaluate the status of the sweetpotato breeders' materials donated by IITA and WorldVeg to determine whether they warrant long-term commitment as part of the genebank collection.	Dec 2020	**CIP** We agree. We are already in the process of addressing this recommendation. Discussion with the sweetpotato breeders has indicated that this material has no potential use in the current breeding strategy. All of it was genotyped in a bilateral project and we used the molecular data to generate a diverse set (100 accessions) of the total IITA breeding collection. The diverse set will be maintained in vitro and the rest will be eliminated. However, given COVID19 restrictions and lack of ability to go to the facility, it would be advisable to move this deadline off to June 2021 as we do not expect full level of staffing to occur in 2020 which will hamper our ability to process required paperwork and eliminate all of this material. We predict we may get 50% or so of the staff back in hopefully in 2020, but our focus will really be on revamping the in vitro collection after this long period of it being overlooked due to quarantine. **Crop Trust**

				Agrees with the recommendation and pleased to hear CIP's positive response.
6	1 Major observation	Rejuvenate the tissue culture from field regenerated plants where there is poor performance and wind up the trueness-to-type activities.	Dec 2020	**CIP** We agree. Rejuvenation has been occurring regularly since the identity verification project began. Around 20% of the in vitro collection has been determined to be nTTT. All of the accessions nTTT are being replaced with the original mother plant which essentially is a rejuvenation and starting the clock over on that culture. Further, when some genotypes lose viability and we are unable to rescue them using various in vitro techniques, we move them back to the greenhouse and field for rejuvenation. This is ongoing activity and always has been and will continue to be so as long as we have an in vitro collection. Given quarantine, it is unlikely that significant rejuvenation of the collection will be very realistic in 2020. **Crop Trust** Agrees with the recommendation. The reviewers' concern was that some of the cultures appeared to be more than 30 years old according to the database system and there are recurring problems with mite infestation in vitro, plus there is a need for young cultures for cryo. A huge investment has been put into testing accessions in the field which is hard to sustain and certainly unsustainable on a long-term basis. The suggestion is, therefore, that a regular rejuvenation of the cultures in a phytosanitary secure way will serve both cryo, the health of the medium-term storage and eliminate the need for mass testing of TTT. It would be good to see CIP streamlining its workflow in this way.
7	2 Major observations	Reduce the duplicity of the virus indexing protocol so that testing becomes less of a backlog and obstacle to good genebank management.	Dec 2020	**CIP** Duplicity in virus indexing is a current requirement of ISO and the standards CIP has established. As long as we have this standard we are bound to this duplicity to have 100% assurance no false negatives slide through and virus positive material moves to other countries which is extremely critical in vegetatively propagated crops given the risk of introducing viruses nonexistent in the target countries. We are required to ensure that all material is clean and free of viruses and because all testing methods have some rate of false positives and false negatives, ISO requires duplicity. If an alternative QMS system ensures that the quality of material can be assured (100% certainty disease free), then this duplicity could be eliminated, but this is subject to a careful analysis of costs, risks, and benefits mentioned above. **Crop Trust** Agrees with the reviewers' recommendations. CIP's response describes details that were

				already discussed in the review. The current phytosanitary processes appear to be restricting good genebank management practice for gains that were not able to be clearly elucidated or quantified. This also relates back to Recommendation 1 on the application of ISO practice at CIP. The Germplasm Health Community of Practice and work towards a common CGIAR standard on phytosanitary controls will be useful in this instance.
8	2 Major observations	Focus on improving the *in vitro* protocols aiming to slow growth, reduce subcultures and improve culture health, especially for sweetpotato.	Dec 2021	**CIP** We strongly agree. We already have several bilateral projects working on meristem regrowth and liquid cultures to speed up the cleaning process of clonal material along with using next generation sequencing (NGS) to detect viruses. CIP has constantly been working to improve slow growth and loss of viability ever since the in vitro collection began in the 1980s. We mainly are hampered by limited opportunities to get funding to do research in this area since in general funding for this type of basic research is scarce. We are always trying to obtain bilateral projects or work with colleagues to improve slow growth conditions. Further, CIP has a threshold on project size of 100K/proposal which means this type of research really needs to be built into a much larger project which is more challenging. **Crop Trust** Agrees with recommendation and is sympathetic to CIP's response. However, there are some things that can be done and small experiments carried out without additional funding. A culture of scientific curiosity in the staff certainly helps here and possibly CIP's limitations on keeping technicians long-term may not be supportive of developing such a culture.
9	1 Major observation	Long-term conservation efforts and funding should be focused on the *in vitro* and cryo collections. It is recommended that activities revolving around the live plant/tuber collections are supported through more dynamic project-funded work to develop in situ/ex situ activities.	Dec 2020	**CIP** We agree. This has always been our focus. In vitro, cryo, phytosanitary, safety backup, media preparation groups are the lion share of the focus of our work and most of the routine funding goes to support these activities/teams. Further, most of our staff works in these areas that are associated with in vitro activities. As mentioned already, most of our distribution requests are for the material in vitro and not the seed collection. Additionally, the in vitro collection represents almost 70% of the total collection so it receives our focus (budget and staffing). However, field collections were required to carry out rejuvenations, characterizations, and clean up the extensive identity issues that existed in the CIP collection. Repatriation of material (in situ conservation) has solely been generated through characterization and genetic identity work which was bilaterally funded. We have been

				consistently reducing them each year and reporting those reductions in the ORT. **Crop Trust** Agrees with the recommendation and is hopeful that with CIP's agreement and efforts to prioritize in vitro and cryo conservation and streamline the workflows some gains may be evident here soon.
10	4 Major observations & 1 minor observation	Reduce the multiple levels of safety duplication so that one form, preferably cryopreservation (but where not available *in vitro*) or seed, is safety duplicated according to accepted standards.		**CIP** We can accept to reduce some level of safety duplication especially in potato due to our large cryopreserved collection as it is a huge effort to propagate the entire collection so frequently only for safety backup. However, given the cryo collection is not duplicated at a secondary site at this point and CIAT does not want to take responsibility for it until their new genebank has come online (see finding 11), we suggest this target date is delayed until the opening of CIAT's new facility which has now been delayed to Q1 2021 due to COVID19. Once there is a backup of the potato cryo collection, we could reduce international backups of all material that has been cryopreserved which would represent ~70% of the in vitro potato collection. **Crop Trust** Agrees with the recommendation and with CIP's response and understands that timing may be delayed to duplicate the cryopreserved samples. However, there remains the point that in some instances in vitro collections are backed up in two locations as well as at CIP-Lima. The reviewers are suggesting here that wholesale back up of the in vitro collection may be reduced to one site only, which would be more in line with what other CGIAR genebanks are doing.
11	2 Major observations	Take immediate action to ship the cryo safety duplicates to a geographically separate location.	July 2020	**CIP** We recognize and agree that CIAT is a good place to back up our cryopreservation collection. We have discussed this with CIAT previously to which they have tentatively agreed with the idea. However, because they are still building a new genebank and do not have their cryopreservation laboratory up and running, they do not want to take the material at this time. However, they are happy to be the backup for our cryo collection, once the new building is online. We suggest this deliverable be postponed to September 2021 or until the building is open and functional whichever occurs first. A further point of consideration is that Peruvian stakeholders have had serious issues with duplication the cryo collection outside of Peru. Therefore, in parallel we also need to explore the options of backing up cryo within Peru. **Crop Trust**

				Agrees with the recommendation and understands the delay in shipping the safety duplicates. The imposition of conditions on the safety duplication of the cryobank by Peru is not easily supportable from the perspectives of the Genebank Platform and the Crop Trust, given that this is an international collection under the auspices of Treaty. The politics obviously are important here and certainly the Platform should provide support to CIP in ensuring that the duplication occurs in the best possible way to ensure the safety of the duplicates (i.e. in an international genebank that can provide the necessary conditions and safety checks and is geographically sufficiently remote).
12	1 Major observation	In collaboration with the CIP Germplasm Acquisition and Distribution Committee, ensure that all relevant CIP staff are aware of the institutional policy on the distribution of germplasm and put in place measures to ensure that all germplasm distributions whether from the genebank or regional stations/offices comply with SMTA and phytosanitary requirements.	Dec 2020	**CIP** We have recently redrafted and had our distribution and acquisition policy reviewed by Janny et al. This policy is already freely available to all CIP staff on our website and upon request. We have shared it previously with CIP staff. We will share it again with key staff responsible for distributions at CIP stations in regional locations, with our Science Leadership Team (SLT), and regional directors. **Crop Trust** Agrees with the recommendation. The sentiment of the recommendation appears to be not just that the acquisition policy is shared but that all CIP distribution comply with SMTA and phytosanitary requirements, which demands active compliance and monitoring thereof.
13	1 Major observation	Devise and implement more proactive strategies to increase external use of genebank materials. Revise data recording of distributions to differentiate between the different types of requests.	Dec 2020	**CIP** This is a struggle for every genebank and an ongoing effort that has been in place for a long time. This is an area where we are always looking for new ideas since our distribution numbers tend to be low compared to the major crops (rice, wheat, maize, etc.) which is understandable if we compare the investments in breeding in major crops versus roots and tubers. We are constantly looking for ways to promote our germplasm including the standard mechanism of creating subsets which we have consistently done each year since the use module began. We also have created a website with pictures to promote the use of subsets and allow the public to search and order germplasm to help drive its use. We have developed and released catalogues of our material to drive use. We have also released core and mini core collections and made these available to the public. When we are involved in research projects with partners, we promote the use of the genebank material which also helps drive more use of the material. Further, our repatriation program which was developed through our curator realizing that the products of

				regeneration and characterization could be given back to the farmers instead of purely thrown away has spread by word of mouth throughout Peru and in 2019, we distributed more material by repatriation than any year in history, breaking a previous record. Repatriation represents a real proactive strategy to use germplasm and one that really reaches our target communities – subsistence farmers. Further, as part of the new breeding programs in the One CGIAR, there will be a specific attempt to promote more utilization of biodiversity in breeding and in general for nutrition and climate change responses. All distributions are already recorded and differentiated by different types of requests and aligned with questions on the annual report. This has been the case for years and we believe the reviewers got the wrong impression here. We have modeled our distribution system after the annual report\ORT system so that we can more easily compile and disaggregate distribution data. All that is required is to apply a filter and we can easily separate internal genebank distributions from CIP breeders, to outside users and other categories of users. This has been in place for years. **Crop Trust** Agrees with the recommendation and is supportive of the activities that CIP is pursuing. The recommendation stems from looking at actual distribution figures, which indicate quite clearly that distribution to users outside of Peru might be better promoted. A more detailed categorization of users and type of use (than is used in the ORT) will be important to understand better who is currently using the collection, what for and potentially where germplasm may be of interest to users outside of Peru.
14	1 Major observation	Exempt genebank staff from the 5-year contract limit rule to ensure that there is always a critical number of trained staff in all teams.	Dec 2020	**CIP** This process will take some time because we need to review all the staff and identify the core staff that requires stability to receive an exemption. In addition, an analysis of the Peruvian labor law would be needed. Based on this analysis, decisions will be made to justify why some staff in certain positions within the genebank can be exempted and others in different programs can't be exempted of the contractual rule of not going beyond 5 years of fixed term contractions. A further complication to this is in regard to the One CGIAR planning as we do not know the result of One CGIAR / GCO panel yet, so we are starting to plan for potential scenarios of budget reduction and assess team skills and competencies to adjust to any possible scenario.

				Crop Trust Agrees with this important recommendation and hopes that some action may be able to be reported by the end of 2020.
15	1 Minor observation	The accessions maintained on behalf of the breeders should be physically and visibly demarcated and the strategy and costs of providing this service should be re-assessed to ensure that breeders receive the service they need and pay full costs.	Dec 2021	**CIP** We recently re organized and re mapped all of the in vitro chambers which was a huge endeavor. This takes quite a lot of staff time to completely re-inventory and map all the accessions in the dbase. We can re map it all, but we prefer to do this next time it is necessary as it takes a ton of staff time for very little gain except a demarcation of genebank versus breeding material which already can easily be seen by looking at the label. At the moment, the breeding team is also revising its strategy, including the maintenance of the breeder's collections. Depending on this analysis, decisions regarding their maintenance will be forthcoming. **Crop Trust** Agrees with the recommendation. Reviewers visited the in vitro rooms and asked staff to indicate which accessions were part of the breeders' collection and which were part of the genebank. It is from that experience that they have made this recommendation. CIP quite rightly suggest addressing this at an opportune time when reorganization can be planned. However, there may be some quick measures – such as using clear colour-coded stickers – that could help address this concern. The analysis of costs is, of course, a separate issue and does need careful analysis. The breeders should be offered a service that is attractive to them – however, the full costs of that service need to be fully covered. This will need to be addressed by CIP.

Introduction

This technical review focused on operations and the quality management system (QMS) at the CIP genebank. The Reviewers were provided with Standard Operating Procedures, a self-assessment, 2015 technical review report, as well as annual reports (online reporting tool (ORT) reports, etc.). They also looked at data on the collections available through public portals, namely CIP website (Grin-Global), Genesys and Svalbard Global Seed Vault (SGSV) portal.

The Reviewers, accompanied by Charlotte Lusty (Crop Trust), visited the CIP genebank in La Molina from 9-13 December 2019. On arrival at CIP, they met with the DDG Oscar Ortiz, the Genebank Manager, Noelle Anglin and Norma Manrique, Manager of Conservation. Dr Ortiz explained that under CIP's new strategy, there are just three institutional programmes and the genebank is one of them "Biodiversity for the future". This reflects the importance accorded to the genebank by the institute. It features on the front page of CIP's website and one third of the staff working in La Molina work in the genebank.

The reviewers were briefed on the genebank's activities by Drs Anglin and Manrique, and the managers of the 11 areas/unit:

- Potato – Rene Gomez
- Wild potato – Alberto Salas (consultant) and Violeta Quiseppe
- Sweetpotato - Genoveva Rossel
- Andean Root and Tubers (ARTC) - Ivan Manrique
- In vitro conservation – Ana Panta
- Cryopreservation – Rainer Volmer
- Phytosanitary - Reynaldo Solis
- Data management – Edwin Rojas
- Safety backup – Luciana Alarcon
- Acquisition and Distribution – Rosario Falcon
- Herbarium - Fanny Vargas

The presentations covered activities at the regional stations, in Huancayo and San Ramon, which were not visited by the review. Over the 5 days, the reviewers had in depth discussions with the managers and their teams, ably facilitated by 2 translators. The genebank facilities at La Molina were inspected and the processes audited.

Findings

CIP is a world centre of knowledge for potato and sweetpotato diversity. It manages two global collections in trust and has an impressive herbarium that is particularly rich in specimens of wild potato species collected over decades by experts, including Dr. Salas who continues to work at CIP. The reviewers were impressed by the in vitro and cryo banking, the barcoding and data systems to manage these collections. The review recommendations address technical aspects but also strategic issues relating to the efficiency of the long-term conservation of the international potato and sweetpotato collections. The Review Checklist gives more detailed observations and findings. The collection of Andean Root and Tuber crops (ARTC) were not the focus of this review. On the morning of the final day, the provisional findings were shared with the genebank staff and discussed with the DDG.

The DDG and Genebank Manager highlighted the challenges that CIP faces to fund the genebank. South America is no longer a priority region for donors and recently GIZ has redirected funding away from the genebank. Furthermore, any long-term grant from the CropTrust will of necessity be restricted to sustaining operations that are

critical for guaranteeing conservation of the potato and sweetpotato collections on the long-term.

Currently, the genebank is well staffed, both in numbers and skills. However, it has several long-serving, very knowledgeable curators who are nearing retirement. Having succession plans in place for these and indeed all management posts is critical. The in vitro and cryo banking relies on technical staff doing repetitive but highly skilled tasks, such as excising meristems. Currently these positions are subject to maximum 5-year contracts, resulting in a high staff turnover and high training demand that incurs costs and risks in operation (Recommendation 14). Finding a solution to this employment restriction is paramount, and the reviewers were pleased that the DDG listened attentively to the concerns of the reviewers regarding the impact of the current policy and was supportive of the need to sustain skilled staff for critical roles in the genebank.

ISO certification has triggered improved discipline in the genebank operations but a lot of staff time is spent on documentation and internal and external audits at significant cost. Reaching ISO accreditation for critical operations has been a significant achievement but a more manageable cycle of review is needed and ideally aligned with the Genebank Platform quality management system (QMS). The improvement and further development of SOPs across all areas of genebank activity should be driven by scientific best practice, not auditing, with the focus on standards, process decision points and determining options (the ‘whys’ and ‘what ifs’) that will guide staff. Management of the SOPs needs to be streamlined by reducing the number through consolidation, having strict versioning and treating the Spanish version as the master (Recommendation 1).

The collections are duplicated in various ways and places. The seed collections are backed-up in the Svalbard Global Seed Vault. The in vitro cultures are duplicated both within and outside Peru, and the cryo-collection is being established in duplicate. Yet the cultivated potato and sweetpotato are also still in the field and stored as tubers. The impressive progress with potato cryopreservation now provides an opportunity to take a strategic look at how this collection is safeguarded (Recommendation 10). Sweetpotato cryopreservation is more challenging but there is commendable commitment to improve current protocols to address constraints to building up the number of accessions stored in this format.

Moving away from continual renewal of in vitro duplicates and grow-out of plants in the field will save staff time and reduce risks. An urgent first step must be to get the cryobank duplicate out of La Molina and out of Peru, with CIAT an obvious choice (Recommendation 11). Reducing the costs of safety duplication is another incentive for accelerating work on the cryo-protocol for sweetpotato. Maintaining a cryobank with in vitro culture for access would be the most cost-effective, sustainable strategy for ensuring the conservation and availability of the collections for the long-term. The reviewers appreciate the valuable work of repatriation of potato and sweetpotato to famers and the role of in situ/on farm management, but do not consider this should be part of the long-term conservation strategy and its budget (Recommendation 9).

The wild potato and sweetpotato seed collections are unique, valuable and likely to be increasingly in demand as breeders seek new diversity to adapt crops to climate change. These collections need greater attention. The procedures to prepare seeds for storage and monitor them in storage are not following scientific best practice. Current efforts to increase stocks are producing multiple seed lots, resulting in a conservation management burden given the inherent dormancy and low seed production of wild species, especially of sweetpotato. Cost-efficiencies could be found

in adjusting the regeneration strategy and targets. The reviewers have proposed some improvements but also recommend that CIP seeks expert hands-on advice from, for example CIAT which manages wild forage and bean species (Recommendations 2, 3 & 4).

The genebank is encouraged to investigate adjustments to the in vitro protocols that may further slow growth and improve culture health, thereby reducing the frequency of sub-culture and increasing cost-efficiency (Recommendation 8) To further increase efficiency, the reviewers also recommend re-culturing based on set replacement intervals rather than time-consuming visual assessment of complex factors. The trueness-to-type exercise should be wound up. It is continuing longer than expected and is a major consumer of funding. The reviewers were concerned with the age of the cultures and recommend rejuvenation from field plants, in particular for the remaining cases of non-true-to-type and where in vitro and/or cryo performance is poor (Recommendation 6).

The reviewers have the following additional findings relevant to scoping out the genebank's long-term conservation mandate and in seeking to put essential operations on a more sustainable basis. There are over 1600 accessions of sweetpotato breeders' materials donated by IITA and WorldVeg that are currently being managed as part of the genebank collection. The reviewers question whether all of these materials warrant a long-term conservation commitment and advise CIP to re-evaluate their status (Recommendation 5). The genebank facilities and staff are used to store and distribute the CIP breeders' collections, and the reviewers support this service arrangement in principle. However, they question whether the current cost-recovery is sufficient and advise that there be a clearer priority on the genebank collection in all activity, allocation of staff effort and use of the facilities. A physical separation of genebank and breeders' accessions is advised to facilitate prioritisation in the event of a genebank evacuation. (Recommendation 15)

Currently, the distribution of genebank collections outside of CIP and Peru is low, and the reviewers advise a more proactive stance with the distribution and use of the collections to underscore, even enhance, the genebank's international profile and reputation (Recommendation 13). However, the reviewers emphasize the importance for the genebank's reputation to ensure that all distributions of genebank materials must whether from the genebank or from CIP regional stations/offices, comply with SMTA and phytosanitary requirements (Recommendation 12).

The collection of Andean roots and tubers crops (ARTC) is fascinating with much potential, especially for the private sector. As the ARTC are not of global food security importance, the reviewers viewed them as falling outside of the scope of this review. The need for Peruvian investment in this collection in terms of its use and governance is evident and the reviewers were pleased to hear that CIP has plans for involving Peruvian institutes and the private sector in promoting the use of the ARTC collection and supporting its conservation. Whilst these plans develop and Peru develops the capacity to take on the collection, the reviewers recommend that CIP focus on conservation and not on disease cleaning and distribution.

The reviewers thank Dr Ortiz, Dr Anglin and all the genebank staff for their cooperation, transparency and patience throughout the review. They congratulate the staff on the excellent job they are doing and hope that their recommendations will help them continue to operate at the highest scientific standards and achieve sustainable long-term support for the genebank.