Plant Genetic Resources Research Institute (CSIR-PGRRI) Genebank Review 2020

Genebank reviewed	CSIR-Plant Genetic Resources Research Institute of Ghana
Site visit dates	November6 - 14, 2020
Review report date	9 December 2020
Institution and Crop Trust responses	19 April 2021
Place	Bunso and Nyankpala (Ghana)
Genebank manager	Lawrence Aboagye
Review panel	Robert Asiedu Michael Abberton
Crop Trust staff	Nora Castañeda

Nr.	Reviewers recommendation	Timeframe	Responses
1	**Establish a complementary site for CSIR-PGRRI at CSIR-SARI headquarters, Nyankpala, for conservation of genetic resources of cereal, legume and vegetable crops and selected clonal crops.** CSIR, the Council that manages both PGRRI and SARI, will sign an agreement with Crop Trust for the SFR project. Based on that agreement, the management of CSIR-PGRRI will be responsible for oversight of day-to-day operations and support to Tamale-based staff e.g. in accounting related to staff travel, minor vehicle and equipment maintenance, local purchases of supplies, and recruitment of field laborers. Additional responsibilities of the management of CSIR-PGRRI will include monitoring and supervising implementation of the project, appraisal/evaluation of regular staff, and major purchases for the project through CSIR headquarters.	Q2 - Q4 2021	CSIR-PGRRI: Agreed. Crop Trust: The Crop Trust agrees with the recommendation and CSIR-PGRRI response. Detailed information about the coordination of genebank routine activities taking place at Bunso and Nyankpala should be included in the project workplan.
2	Install some equipment that will be purchased under the SFR project specifically for medium term conservation (seed handling: i.e. threshing, seed drying) at the CSIR-SARI site, Nyankpala.	Q2 2021 - Q4 2022	CSIR-PGRRI: Agreed. Crop Trust: The Crop Trust agrees with this recommendation. It is important to note that it is key to ensure that the equipment provided by the Seeds for Resilience project is used exclusively for genebank activities. Proper installation, use and maintenance

			will provide CSIR-PGRRI the ability to continue addressing its current genebank operational backlogs.
3	Assess the status and provide cost estimates for renovation of the buildings offered by CSIR-SARI to make them fit for purpose and for lining the base of the water reservoir within the fenced field previously used by GCP cassava project and CIP sweet potato program with plastic sheeting to prevent leakage.	Q2 - Q3 2021	CSIR-PGRRI: Agreed. Clarity on who will bear the cost of the assessment has to be provided. Crop Trust: The Crop Trust agrees with the recommendation. In general, the Crop Trust will provide support for upgrading according to approved workplans. There is limited budget, therefore it may be useful to provide more than one cost option to cover renovation needs.
4	Acquire a four-wheel vehicle and two motorcycles for operations at the CSIR-SARI site, Nyankpala, to support activities under the SFR project.	Q2 - Q4 2021	CSIR-PGRRI: Agreed. Clarity on who will bear the cost of procuring the vehicle and motorcycles has to be provided. Crop Trust: The Crop Trust agrees with this recommendation. The number and type of vehicles (four-wheel truck or motorcycles) to be purchased with project funds should be reviewed in the context of the entire workplan and funding needs during the preparation of the project workplan. All major items to be purchased with Seeds for Resilience funding will be procured directly by the Crop Trust.
5	Establish facilities for medium-term conservation, germination monitoring, and distribution at CSIR-SARI, Nyankpala and continue to use CSIR-PGRRI, Bunso for long-term conservation for both seed and clonal crops. Meristems of clonal crops can be introduced in vitro at CSIR-SARI and cultures can then be transferred to Bunso for conservation, with initial priority on rescue of unique accessions.	TBD	CSIR-PGRRI: Agreed, Clarity on who will bear the cost of procuring and installing the facilities in question needs to be provided. Crop Trust: The Crop Trust agrees to the recommendation of establishing facilities for the medium-term conservation of selected seed crops. As evidenced in the initial review report (2019), the environmental conditions in Bunso might be inadequate to regenerate accessions of certain crops. To avoid duplication of costs, the Crop Trust encourages CSIR-PGRRI to seek means to rationalize the genebank operations in Bunso and Nyankpala, and find cost-efficient alternatives to handle germplasm collections in both sites. Details about the activities to be implemented and Seeds for Resilience budget availability to support such activities should be detailed in the project workplan.
6	Transfer field banks for all cereal, legume and vegetable crops, frafra potato, sweet potato and yam (except *D. cayenensis* and *D. esculenta,* which have long growth duration) to the complementary site at CSIR-SARI, Nyankpala.	Q2 2021 - Q2 2022	CSIR-PGRRI: Agreed. Crop Trust: The Crop Trust agrees with this recommendation. A detailed plan of this transfer needs to be included in the project workplan.
7	Ensure stable and reliable power source for the two genebank sites (CSIR-PGRRI, Bunso and CSIR-SARI, Nyankpala) by:	Q2 - Q4 2021	CSIR-PGRRI: Agreed.

	1. Obtaining the electricity tariff waiver through the government for the CSIR-PGRRI, Bunso site 2. Servicing and repairing the faults with the solar power installation at CSIR-PGRRI, Bunso 3. Installing solar panels for generation of complementary energy for the building(s) to be used by CSIR-PGRRI at CSIR-SARI, Nyankpala 4. Installing and using a dedicated meter(s) to monitor the power consumption from the national electricity grid of the CSIR-PGRRI space at CSIR-SARI, Nyankpala		Crop Trust: The Crop Trust agrees with this recommendation and CSIR-PGRRI's response.
8	Fix the cold room at CSIR-SARI, Nyankpala and ensure it runs consistently at 4^0 C as an alternative to, or to supplement, the use of freezers for medium-term storage of seeds.	Q2 - Q4 2021	CSIR-PGRRI: Agreed. Clarity on who will bear the cost of procuring the goods and services for fixing the cold room has to be provided. Crop Trust: The Crop Trust agrees with this recommendation. Details of the works to be conducted at Nyankpala and to be supported by the Seeds for Resilience project should be indicated in the project workplan.
9	Establish regular seed viability testing at the complementary site, Nyankpala with supervision from staff of the existing seed lab of CSIR-SARI, which is run by four scientists with expertise in seed science/technology (one at PhD and three at MPhil levels). Key equipment and consumables to procure for use in a dedicated germination room include shelves, germination boxes with cover, germination paper towel, autoclave, water distiller, temperature logger, and barcode reader.	Q2 - Q4 2021	CSIR-PGRRI: Agreed. Crop Trust: The Crop Trust agrees with this recommendation. We encourage CSIR-PGRRI to develop a written document in which the coordination of activities with CSIR-SARI is clearly explained (for example, data management at both sites needs to use the same database.) Genebank data management at Bunso and Nyankpala should be conducted in the same database. Details about the type of equipment and consumables to be procured through the project for each site (Bunso and Nyankpala) should be presented in the workplan.
10	Establish regular health testing and certification for distribution from the complementary site by the Plant Protection and Regulatory Services Directorate (PPRSD) of the Ministry of Food and Agriculture (MoFA).	Q2 - Q4 2021	CSIR-PGRRI: Agreed. Crop Trust: The Crop Trust agrees with this recommendation. Details of the activities to be carried out for addressing this recommendation should be included in the project workplan. We encourage CSIR-PGRRI to seek assistance from international genebanks experienced in conducting regular genebank material health testing (i.e. IITA) to set up phytosanitary measures.

11	Equip the plant health labs at CSIR-PGRRI, Bunso in support of maintenance of health of the collections (internal monitoring and quality control related to key pests and pathogens that threaten them in the field and storage) by providing equipment (and associated consumables) such as autoclave, trinocular stereo zoom microscope, moisture analyzer, vortex mixer, and laminar flow cabinet.	Q2 - Q4 2021	CSIR-PGRRI: Agreed. Crop Trust: The Crop Trust agrees with this recommendation. We encourage CSIR-PGRRI to document the roles of the plant health labs at CSIR-PGRRI and the PPRSD, to avoid duplication of efforts. Details of the equipment to be procured to strengthen the plant seed health lab at CSIR-PGRRI through the Seeds for Resilience project should be included in the workplan.
12	Ensure adequate staff strength (numbers and experience) for operation of the complementary site at CSIR-SARI, Nyankpala. In addition to those who will be recruited as CSIR-PGRRI staff at the complementary site, it would be necessary to relocate some staff based at CSIR-PGRRI, Bunso to Nyankpala, at least temporarily during peak periods of some field activities.	Project lifetime	CSIR-PGRRI: Agreed. Crop Trust: The Crop Trust agrees with this recommendation. It is important to note that some commitment of support to CSIR-PGRRI staff working at CSIR-SARI, Nyankpala, beyond the project lifetime, is key to ensure the long-term conservation of CSIR-PGRRI germplasm.
13	Adopt QMS, including SOPs for operations at the Bunso and SARI sites, using the same procedures where possible. With support from the Crop Trust, expand the development of SOPs to cover other genebank operations beyond conservation and distribution, which are currently being addressed. Train PGRRI staff in the application of the SoPs.	Q4 2022	CSIR-PGRRI: Agreed. Crop Trust: The Crop Trust agrees with this recommendation. We encourage CSIR-PGRRI to make sure that its genebank operation processes should be aligned as much as possible between Bunso and Nyankpala. The Crop Trust will continue to support CSIR-PGRRI in the development and adoption of a quality management system.
14	Ensure that priority accessions of clonal crops in the field bank are safety duplicated in vitro at CSIR-PGRRI-Bunso and at CSIR-CRI, Fumesua (as in-country backup). Also ensure safety duplication of unique accessions in international collections e.g. at IITA's Genetic Resources Centre. Subject to approval by CSIR-PGRRI management, some international distribution of accessions (after cleaning of viruses) could be done by IITA on behalf of CSIR-PGRRI in response to requests.	Q4 2023	CSIR-PGRRI: Agreed. Crop Trust: The Crop Trust agrees with this recommendation. Detailed information on safety duplicating priority accessions should be included in the project workplan.
15	Implement barcoding and electronic data capture coupled with regular data transfer to a single database for both sites that be maintained at CSIR-PGRRI, Bunso. This relates to labelling and recording during several genebank operations including regeneration, multiplication, characterization, evaluation, viability testing, storage, distribution and in the in vitro laboratory (Bunso). We strongly recommend the use of GRIN-Global Community Edition and encourage intensification of ongoing training. Staff at IITA's Genetic Resources Centre would be glad to assist through	Q2 2021	CSIR-PGRRI: Agreed. Crop Trust: The Crop Trust agrees with this recommendation and encourages CSIR-PGRRI to extend the use of GRIN-Global at the complementary site in Nyankpala.

	exchange visits and regular advice. This will raise efficiency and reduce errors in data transcription.		
16	Establish regular sharing of accession level information from CSIR-PGRRI through the CSIR website to ensure regular updating. This will raise the profile of the national genebank and promote its use. It will also support a more proactive stance of CSIR-PGRRI ensuring that e.g. stocks of all released crop varieties are conserved and other institutes are encouraged to submit genetic stocks and mapping populations of breeding/genetics programs (under cost recovery arrangement) or copies of germplasm collected for research.	Project lifetime	CSIR-PGRRI: Agreed. Crop Trust: The Crop Trust agrees with this recommendation and encourages CSIR-PGRRI to publish information about its accessions on Genesys (https://www.genesys-pgr.org/) on a regular basis.

Crop Trust – Seeds for Resilience

Review of CSIR-SARI as complementary site for germplasm conservation by CSIR-PGRRI

Report by Robert Asiedu and Michael Abberton

9 December 2020

Content

1. Executive Summary

A review of CSIR-SARI as complementary site for germplasm conservation by CSIR-PGRRI was carried out in November 2020. This involved visits to the headquarters of CSIR, CSIR-SARI, and CSIR-PGRRI. Based on background documents, site visits, and discussion with management and staff of the Institutes we recommend:

1. Establishment of a complementary site for CSIR-PGRRI at CSIR-SARI, Nyankpala for conservation of genetic resources of cereal, legume and vegetable crops and selected clonal crops
2. Installation at the CSIR-SARI site, Nyankpala, of some equipment that will be purchased under the SFR project specifically for seed handling
3. Cost estimation and renovation of the buildings and water reservoir (lining the base with plastic sheeting) offered by CSIR-SARI to make them fit for purpose
4. Acquisition of a four-wheel vehicle and motorcycle for operations at the CSIR-SARI site, Nyankpala to support activities of the SFR project
5. Establishment of facilities for medium-term conservation, germination monitoring, and distribution at the CSIR-SARI site, Nyankpala and continued use of CSIR-PGRRI, Bunso for long-term conservation of both seed and clonal crops
6. Transfer of field banks for all cereal, legume and vegetable crops, frafra potato, sweet potato and yam (except *Dioscorea cayenensis* and *D. esculenta,* which have long growth duration) to the CSIR-SARI site, Nyankpala
7. Effective actions to ensure stable and reliable power source for the two genebank sites (CSIR-PGRRI, Bunso and CSIR-SARI, Nyankpala)
8. Fixing the cold room at CSIR-SARI, Nyankpala to ensure that it runs consistently at 4 ^{0}C
9. Establishment of regular seed viability testing at the CSIR-SARI site, Nyankpala
10. Establishment of regular health testing and certification for distribution from the CSIR-SARI site, Nyankpalaby the Plant Protection and Regulatory Services Directorate (PPRSD)
11. Equipping the plant health labs at CSIR-PGRRI, Bunso to support maintenance of health of the collections
12. Ensuring adequate staff strength for operation of the CSIR-SARI site, Nyankpala
13. Adoption of QMS, including SOPs for operations at the Bunso and Nyankpala sites, using the same procedures at the two sites whenever possible
14. Ensuring that priority accessions of clonal crops in the field bank are duplicated *in vitro* at CSIR-PGRRI-Bunso and CSIR-CRI, Fumesua and unique accessions are safety duplicated in international collections
15. Implementation of barcoding and electronic data capture at both sites, coupled with regular data transfer to a single database to be maintained at CSIR-PGRRI, Bunso
16. Regular sharing of accession level information from CSIR-PGRRI through the CSIR website.

2. Narrative

2.1 Background to the Review

The CSIR-Plant Genetic Resources Research Institute (PGRRI) of Ghana was reviewed during October 2019. The reviewers proposed four potential modes of operation involving the use of a complementary site at the headquarters of the CSIR-Savanna Agricultural Research Institute (SARI), Nyankpala. The CSIR-PGRRI preferred Models 2 and 3to which they made slight modification as shown in red font in Table 1.

The objectives of the current assignment were to:

- Assess the facilities, equipment and field sites needed for medium-term storage and access to specific seed collections at the complementary site (e.g. cowpea, maize, rice and species of the genus *Solanum*) at Nyankpala (species of *Dioscorea* were also considered in the review).
- Identify risks and constraints of the proposed mode of operation that may prevent the genebank from fulfilling the long-term conservation of seed accessions.
- Assess the organizational structure of the proposed mode of operation.
- Provide the Crop Trust with key findings and suggestions for mitigating risks of the proposed mode of operation.

Table 1.Potential modes of operation of CSIR-PGRRI proposed in the review of October 2019

Processes	**Model 1**	**Model 2**	**Model 3**	**Model 4**
Regeneration/multiplication/characterization	SARI	SARI	SARI	SARI
Thresh/clean seed in crop work area	SARI	SARI	SARI	SARI
Drying with moisture testing	Bunso	SARI	SARI	SARI
Germination/seed count/packet weight	Bunso	SARI	SARI	SARI
Packaging	Bunso	SARI	SARI	SARI
Medium- and long-term storage	Bunso	Bunso and SARI	Bunso and SARI	SARI
Distribution	Bunso	Bunso	Bunso and SARI	SARI
Documentation	Bunso	Bunso	Bunso	SARI
Germination monitoring	Bunso	Bunso and SARI	Bunso and SARI	SARI
Plant/seed health	Bunso	Bunso	Bunso	SARI

2.2 Preparation

Wednesday (04 Nov) and Thursday (05 Nov)

Virtual meetings were held (Nora Castaneda-Alvarez, Robert Asiedu, and Michael Abberton) to prepare for field visits (*see Annexes 1 and 2 for itinerary and schedule*).

2.3 Visits

Friday 06 November:

Office of the Director General of CSIR
Persons met (*see Annex 3 for contact details*):
Prof. Victor Agyeman (Director General of CSIR)
Dr. Lawrence Aboagye (Director of CSIR-PGRRI)
Dr. Daniel Ashie Kotey(Deputy Director of CSIR-PGRRI)

The Director General of CSIR had been briefed on the project and he declared his full support for it. He explained that, with CSIR-SARI and CSIR-PGRRI as institutes within CSIR, there will be no inter-institutional challenges in project implementation. Effective collaboration between the CSIR-PGRRI and the CSIR-SARI for the smooth operation of the CSIR-PGRRI complementary genebank site at Nyankpala will be ensured by the CSIR-Head Office which has oversight responsibilities of the operations of the CSIR-PGRRI and the CSIR-SARI. A new scientist at PhD level will be recruited by CSIR to lead the work of CSIR-PGRRI under the Seeds for Resilience (SFR) project. He advised on the need for good advance planning and notification of CSIR directorate of plans for purchasing and importation of capital items to allow time to secure parliamentary approval of tax waivers. Equipment acquired for SFR will be identified and tagged as such. Clarity of financial management e.g. accounting, auditing, and handling of internally generated funds will be ensured through strict adherence to CSIR financial management procedures. Electricity supply at CSIR-SARI headquarters is quite good but backup supply from solar panels will ensure stability and lower cost. Dr. Aboagye explained that he could not join the trip to CSIR-SARI, and Dr. Kotey would represent CSRI-PGRRI.

Monday 09 November:
Office of the Acting Director, CSIR-SARI, Nyankpala
Persons met:
Dr. SaakaBuah, Acting Director, CSIR-SARI
Dr. Richard OtengFrimpong, Research Scientist (Groundnut breeder), CSIR-SARI [replaced Dr. Adjebeng]
Dr. Daniel Ashie Kotey, Senior Research Scientist (Entomologist) and Deputy Director, CSIR-PGRRI (Dr. Kotey kindly took most of the photos in the report)

Dr. SaakaBuah reiterated that a research scientist PhD level (Head of Station) will be placed at CSIR-SARI headquarters by CSIR (as regular staff funded by the Government of Ghana) to lead the work of CSIR-PGRRI at the station. He/she will be assisted by at least one technician and two laborers. Accommodation is available on CSIR-SARI campus, but it would require some renovation, furniture, and clearing of the bush around the house. Office space (at least 2 rooms) will be provided for the new staff. Internet connection is very good, but payment of the monthly fee is a challenge.

He advised that a cold room with a dedicated backup power generator is available and used by some of the breeders for seed storage, but a second room may be required to accommodate fridges and freezers.

Land is available for field activities (owned by CSIR-SARI or available from owners in nearby communities). Challenges may include limited soil fertility and need to protect plots from fire and damage by animals [this risk is mitigated by consultation with village elders for adherence to the rules

that control periods of free grazing by livestock]. Fencing of plots may be necessary. Dams are available from which water can be pumped to support irrigation of some of the fields.

Electricity supply is reasonably regular, but the charges are high. A separate energy meter(s) would need to be installed for the CSIR-PGRRI offices/labs to monitor the consumption of electricity more accurately. Solar power is being considered by SARI. The initial cost seems prohibitive but other CSIR institutes are also considering the installation of this source of energy. CSIR-PGRRI installed solar panels but the system has a fault and is therefore not functional.

There are laboratories at the station, some of which could support the work of CSIR-PGRRI. These include laboratories for Biotechnology, Inoculant Production, Soil Chemistry, Plant Pathology, Entomology, and Tissue Culture (for yam). Screenhouses are available, built by past and current projects, and can be shared but they do not have temperature control.

Visits to facilities at CSIR-SARI with Drs. Richard OtengFrimpong and Daniel Ashie Kotey

Laboratories (*see photos 1 to 4*)
The Biotechnology Laboratory, as explained by Assistant Manager Ms. Gloria Mensah, offers services to SARI staff (bench fee only) and outsiders (full commercial rates) in DNA extraction, DNA fingerprinting, confirmation of hybrids, etc. The Plant Pathology Laboratory has not been functional since the pathologist was promoted to the position of director (he retired recently). The key pieces of equipment have been moved to Manga, a CSIR-SARI outstation, where a pathologist (currently studying for a PhD) is based. There were significant ongoing activities in the Soil Chemistry and Soil Microbiology laboratories. Discussions were held with entomologists on activities in the Entomology building including their collaboration with the plant breeders.

Drying platform and warehouse (*See photo5*)
A broad concrete floor in front of a warehouse is used for drying of grain crops. Mechanical threshers were visible in the warehouse. Adjacent to this was observed an old seed cleaner that was reported to be not functioning well, and a pile of irrigation pipes that have not been used.

Cold room (*See photos6 to 13*)
Beside the warehouse is acold room with an independent power generator behind it. The cold room was refurbished by USAID in 2018. (***See photo 14***). The inside temperature was above 20^0 C as the compressors were not functioning well. Servicing is done by a company based in Accra and it is not done regularly. It would be good and helpful to current and potential users if it could be fixed to run at 4^0C. It is under the management of Dr. Doris KanvenaaPuozaa, Research Scientist.

Rice and Soybean Buildings (*See photo 15*)
Separate buildings for each crop with facilities for drying, processing, storage, etc

Yam research facilities (*see photos 16-19*)
Mr. IziblilaShaibu took us around the yam research facilities including an Aeroponics setup, a new yam barn at advanced stage of construction, a Tissue Culture laboratory with temporary immersion

bioreactors and equipment for conventional tissue culture. A screenhouse for yam propagation using vine cuttings was well stocked with recently planted cuttings for production of microtubers. A large overhead tank supplies water for irrigation.

10 November 2020

Field visits with Drs. Richard OtengFrimpong and Daniel Ashie Kotey

Visit to Golinga irrigation project about 30 minutes from SARI headquarters.
The Golinga dam is managed by the Ghana Irrigation Development Authority (GIDA). Local farmers use the water for their farming through gravity feed especially for cultivation of rice (main season) and vegetables (dry season). SARI scientists negotiate with individual farmers to get land for trials sometimes at 300 Ghana Cedisper acre. Road to the site is poor. Access by motorcycle is easier for technicians compared to four-wheeled vehicles.

Discussion with Dr. Doris KanvenaaPuozaa, Research Scientist (seed science and technology, and seed systems development), SARI on Seed Testing Lab*(See Appendix 1 for details of original concept. Estimated costs of equipment are also available separately)*
Dr. Puozaa was previously Seed Testing Lab Manager at the Ghana Seed Inspection Division under the Plant Protection and Regulatory Services Directorate (PPRSD) of the Ministry of Food and Agriculture. She has also served as Seed Production Specialist, West Africa Seed Program (Directorate for Research and Innovation) for the West Africa Council for Agricultural Development,(CORAF/WECARD) from 2015-2017. Qualified staff in her team include three scientists with MPhil degrees in Seed Science who could be given additional training as necessary in specialized areas of seed science and technology in support of genebank activities. DrPuozaa and her team are ready to work in collaboration with CSIR-PGRRI.

A project funded by USAID was to set up a well-equipped seed testing lab at SARI headquarters, but this was not done by the time the project ended in 2019. The intended activities at the proposed facility included:

1. “Set up and maintain an internal quality control and assurance system for seed lots produced by the institute
2. Conduct periodic variety purity checks using morphological, biochemical and molecular methods and make recommendations to the respective breeding programs
3. Monitor viability during storage will facilitate timely identification of accessions that require regeneration to ensure continued availability of seed stocks and conserved germplasm.”

Dr. Puozaa plans to convert existing rooms into a seed testing lab hoping to find resources to acquire equipment for testing seed moisture content, germination and health A small room dedicated to seedg ermination was visited (containers with seedlings were seen - *see photo 20*) and technical staff were seen handling seed and a barcode printer.

Meeting with Mr. RamsonAdombilla, Research Scientist (Irrigation Agronomy), SARI.
Also present at the meeting:
Dr. Richard OtengFrimpong, CSIR-SARI
Dr. Daniel Ashie Kotey, CSIR-PGRRI

Mr. Adombilla described various places where land is available for potential use in regeneration, characterization, and evaluation of germplasm accessions.T hese fields were visited.

Akukayili
Large area of land close to SARI headquarters. It will be necessary to pump water from Wambong dam into a reservoir to be created or a series of poly tanks to be purchased.

Rice fields
Large plots of land to the right of the tarred road from Tamale to Nyankpala shortly before reaching CSIR-SARI headquarters. Irrigation would be a challenge as quantity of water in the adjacent dam is limited and it also must be shared with the neighboring local communities during the dry season. (*See photos 21 and 22*)

Plot used by Cassava project and CIP sweetpotato program (*see photos 23 and 24*)
This site is approximately 15 minutes from main buildings of CSIR-SARI headquarters. It is well fenced and has daytime security. After the Cassava project, CIP used the site for work on sweetpotato until 2019. During the cropping season night-time security is also provided. A reservoir there looks good and will only need minor refurbishment (i.e. lining the concrete base and walls with plastic to avoid any leakages) to support irrigation. Two pumps are available at the site for the delivery of water from the dam to the field plots. The land is laid out as nine blocks of 1.5 acres each and has access roads. Water is pumped from Wambong dam to the reservoir. Diesel will have to be purchased for the pumping of water from Wambong and for distribution to the field plots. A plot with drip tapes was seen and other plots rely on overhead sprinkler irrigation.

A 10-hectare fenced area adjacent to Wambong dam with pump and irrigation facilities (*photos 25 to 27*).
SARI has a pump at this site. Six hectares are under sprinklers and 4 ha under flood irrigation. The land belongs to the neighboring community who often demand compensation for its use. The associated negotiations and disputes make it inconvenient to use the site. It is currently under use for production of rice seed.

Botanga dam
This is a large dam managed by GIDA. The area of land fed by this dam is all allocated to farmers so access will require negotiation with the holders/farmers.

Wrap-up discussion with Ag. Director of SARI
Persons present (*see photo 28*):
Dr. SaakaBuah, Acting Director, CSIR-SARI
Dr. Richard OtengFrimpong, CSIR-SARI
Dr. Daniel Ashie Kotey, CSIR-PGRRI
In response to a request for rooms (3-4) to be devoted to genebank activities, Dr. Buah allocated the buildings near to the current Entomology building for the SFR project. There are two main blocks (*see photos 29 to 33*) with a third detached unit (*see photos 34 and 35*) that was previously used as an

insectary all enclosed within a fence with a gate. At least one main block can be renovated for use as offices, stores, and laboratories as necessary for the activities of the genebank. Dr. Buah explained that the DG of CSIR is seeking approval for hiring technicians in addition to the graduate level professionals. He (Dr. Buah) promised that resources will continually be allocated by SARI in support of long-term operation of the Yam Tissue Culture laboratory and associated facilities. He is already planning to hire a young scientist with a PhD degree in plant breeding and experience in yam research to join the SARI yam team.

11 November 2020
Travel from Tamale to Accra and then to Bunso

12 November 2020

Visits at Headquarters of CSIR-PGRRI, Bunso
An introductory meeting was held with senior staff of PGRRI (*see photo 36*) after a courtesy call on the Director, Dr. Lawrence Misa Aboagye. The list of staff present at the meeting is shown in Annex 4.The three divisions of PGRRI (Plant protection, Plant genetic conservation, and Plant genetic diversity) were all represented. Dr. Aboagye had to leave for the quarterly CSIR Directors Management Committee meeting after introductions.

Tour of facilities at CSIR-PGRRIwith Drs. Richard OtengFrimpong and Daniel Ashie Kotey

Seed genebank(*see photo 37*)
Seed stores with active collections of 44 species (vegetables, legumes, and cereals) in seven freezers kept at -20^{0}C and long-term collection in three freezers at -20^{0}C were seen. Germination tests are conducted every three years and regeneration is done if the percentage germination falls below 85. A seed processing lab and a drying room (with old dehumidifier and a drum with silica gel but no artificial drying equipment) were visited. A walk-in cold room structure linked to a power generator was inspected. It has concrete walls no fittings, insulation, or equipment were seen.

Pathology lab (*see photos 38 and 39*)
The lab has limited facilities in a building that is not in good condition. The autoclave is old and not functional. A small laminar flow hood is in place (add photos) and Petri dishes for seed health tests were laid out on a bench (add photos). Germination tests are also done in the lab. Two mycologists (MPhil level) are at post. They make plant health assessments in the field and conduct seed health testing before storage. A virologist is also at post, but she has no laboratory and occasionally visits the laboratory of the Cocoa Research Institute (CRIG), which is about 14 km from Bunso, to work.

Entomology section
Activities include assessments of pest incidence in the genebank fields and implementation of pest management measures. Hermetic storage is used for materials from the field. A moisture meter is available and is used for large-seeded grains. Screening for host plant resistance to insect pests as well as for effectiveness of botanicals as pesticides are conducted. The insectary is no longer used because of

poor condition. The very high relative humidity at the site is a challenge so most successful work is done during the dry season (November to March).

Tissue Culture laboratory (*see photo40*)

The laboratory has media preparation, sterilization, and conservation rooms where cultures were seen of cassava, yam, taro, sweetpotato, frafra potato, medicinal plants, and timber species.Research there includes investigation of protocols for conservation towards improvement of practices. It is estimated that about 50-55% of accessions in the field are backed up in vitro. Yam accessions have been safety duplicated in other genebanks. A research scientist of the CSIR-PGRRI with training in cryo-conservation, Dr. Matilda Bissah, hopes that cryo-conservation can be implemented in the future. Liquid nitrogen (LN) tanks are available and the source of supply of LN would be Accra. There is no virus indexing of accessions now. Construction of three rooms adjoining the current lab for expansion of the facility is nearly complete. It was agreed that the accessions will be duplicated at the Tissue Culture laboratory at the headquarters of the CSIR-Crop Research Institute and safety duplicated at IITA's Genetic Resources Center. IITA can be given approval by CSIR-PGRRI director, on request, to distribute accessions on behalf of the Institute.

Field tour

Regeneration/characterization/evaluation plots which were visited include (*see photos 41 and 47*):

- Rice – 40 accessions planted in 3 replications
- Soybean – 10 accessions in 3 replications; no fertilizer applied; relatively poor growth compared to performance of similar accessions at Nyankpala according to Dr. Richard OtengFrimpong
- Maize – 58 accessions; fertilizer applied; good growth
- Cowpea – 16 accessions; had been sprayed with insecticide
- Taro (*Colocasia* sp.) – local and introduced (from SPC adapted to area) accessions; includes those selected for tolerance to taro leaf blight; propagules of some accessions had been distributed to farmers e.g. 68,000 given out to 655 farmers under a project of the Ministry of Food and Agriculture in Ashanti, Eastern, Western, and Central regions
- Cassava – 31 accessions
- Egg plants – different types planted for assessment of quality of extracted seeds; discussed challenges with sale of vegetable seeds as only seeds of released varieties can be sold
- Yam – 78 accessions of 6 species [10 *Dioscorea rotundata*; 49 *D. alata*; 2 *D. cayenensis*; 8 *D. esculenta*; 4 *D. bulbifera*; and 5 *D. dumetorum*]; high pressure of anthracnose disease on *D. alata*; late maturity of accessions of *D. cayenensis* and *D. esculenta*. Use of 1 m x 1 m spacing was unusual. The CSIR-PGRRI staff were unsure of success from propagating using minisetts but they were encouraged to try small setts and closer spacing as done at IITA. Young fruits were observed on female flowering plants of *D. rotundata* and *D. alata*. Bulbils were also observed on some of the *D. alata* accessions.
- Frafra potato – 49 accessions; shoots had either died off or had been weeded; small tubers could be extracted from the soil where plants previously stood.
- Sweetpotato – 12 genebank accessions and 4 released varieties; heavy foliage and difficult to distinguish vines from individual accessions; high risk of mixtures

- Cocoyam (*Xanthosoma* sp.) – 39 accessions; occasional flowering was reported
- Tree nurseries – citrus, coconut, mango, avocado, rambutan, Anon asp., Xylopia sp., etc.
- Tree collections – large areas of various commercial species were visited

Data management and communication

GRIN-Global is not active yet (Dr. Aboagye explained later that the Crop Trust is providing training to a staff of CSIR-PGRRI on this). Due to rationalization of institute based websites by the CSIR, there is currently no active website for the institute. However, a CSIR-PGRRI page can be accessed through the CSIR website although most data from the genebank is still not available there. IITA assistance in design of the website training, support and regular follow-up in data management would be appreciated. Breeding Management Systems (BMS) was mentioned by a staff as potentially helpful for some of the data management issues.

The Scientific Secretary currently doubles as the documentation officer and is currently part of staff being trained on QMS and GRIN-Global. CSIR-PGRRI scientists provide progress reports every three months so data could be made available for archiving. The expectation is to have a central database to which CSIR-PGRRI staff can feed data. Currently no tools for electronic data capture or barcodes are used. There is very limited feedback of data from users of materials collected from the genebank. Data on the actual numbers of existing accessions are also being updated and cleaned.

Wrap-up meeting with Director PGRRI

Dr. Aboagye was briefed on observations from the lab and field tours. He explained that the request to the government for the electricity tariff waiver is still pending. He also explained that they are waiting for the government's response to the request for renewal of lease of the land at PGRRI, Bunso. He emphasized that this should not be cause for any concern. The government will sort it out and it is impossible for the landowners to contemplate eviction of a statutory institute of the Government of Ghana (this was also later emphasized by the DG of CSIR).

13 November 2020

Wrap-up discussion with DG of CSIR

Persons met:

Prof. Victor Agyeman, DG of CSIR

Dr. Lawrence Misa Aboagye

Dr. Daniel Ashie Kotey, PGRRI

Dr. Richard OtengFrimpong, SARI

A summary was provided to, and discussed with, the DGCSIR on the feasibility of a complementary site for the national genebank at SARI headquarters, Nyankpala. Some of the key points were:

- A building with adequate number of rooms is available to be renovated for use as offices, labs (including seed processing), and stores. A screenhouse can be installed with the fenced area of the building if needed.

- A fenced field previously used for a Cassava project and later by CIP sweetpotato program is available and would be ideal for establishment of plots for regeneration, characterization, and evaluation of germplasm accessions. A water reservoir and pumps are available to support irrigation. Other fields are available as backup as needed.

- Support to the intended seed lab at SARI would help the work of germplasm management at the site. Dr. Puozaa is well qualified and is supported by three scientists with expertise in seed science/technology at MPhil levels. The DG explained the challenges that led to the non-establishment of the seed testing lab as a public-private-partnership within the USAID project at CSIR-SARI. He informed us that there is a chance to raise the issue with USAID again but only after appointment of a new substantive director for CSIR-SARI and staff changes and changing priorities of the funder could influence the chances of success.

- Staffing: a scientist (to be recruited), assisted by at least a technician and two laborers can form the initial core team. The terms of reference (ToR) for the incoming scientist will be shared with Crop Trust after April 2021 when it will be ready. It would be necessary to have some experienced staff from CSIR-PGRRI at the complementary site, at least initially, to ensure establishment of standard procedures there. Dr. Aboagye confirmed that some staff transfers are anticipated.

- The cold room at SARI needs to be investigated further in case it can be fixed and run at 4^0C as an alternative to, or to limit the number of, freezers that may need to be purchased for seed storage.

- Use of solar energy would be useful to support provision of electricity at the complementary site. Consumption of power from the national grid should be monitored through a meter dedicated to the facilities of the SFR project and separate from SARI lines.

- Data management and communication by PGRRI require improvement. The DG explained that internet access is a challenge at Bunso as it is not close to the fibre backbone. No cables have been laid to alleviate this and it poses a challenge in regular updating of information. Hosting the website within CSIR is possible but it would require information management with regular updating. Capacity building of dedicated staff would be necessary to perform this function.

The DG assured us of the full support of CSIR for the SFR project and he advised that CSIR-PGRRI can apply to National Research Fund for funding to support of some of their operations.

3. Major risks and constraints

Risk/constraint	Mitigation
1. Adequacy of staffing	There is assurance that a scientist (PhD) level will be recruited, and the terms of reference will be available after April 2021. Some core support staff (2 technicians, one Administrative assistant, one Accounts clerk, one Driver, one security man, and two laborers) are also expected. Recruiting and retaining

	qualified staff is not easy for the research institutes against competition from the universities but the conditions at Tamale (capital of northern region) and research environment at SARI headquarters are superior to those at PGRRI, Bunso. There is also assurance that some staff at Bunso can be transferred to the SARI site as necessary.
2. Paying for electricity charges	The tariff waiver for PGRRI at Bunso is still expected from the government but no waiver is expected for SARI. Installation of solar panels for complementary power generation and separate energy meters at the expected PGRRI facilities at SARI will alleviate this constraint.
3. Protection of field plots	Protection of research fields e.g. from fire, theft, animal damage, drought. SARI has years of experience in handling these at the site and PGRRI will benefit from this e.g. in ensuring security from potential theft of crops close to maturity, clearing bushes close to field plots to obviate risk of fire, fencing of field plots and arrangements with local communities for preventing damage from livestock, and access to adequate irrigation
4. Maintaining the *in vitro* collection	Priority attention can be given to regular rescue of unique and threatened accessions of clonal species for conservation in vitro and safety duplication in other genebanks (e.g. the IITA Genetic Resources Center) Additional support to the facility at Bunso will ensure completion of the transfer of accessions from the field bank to the *in vitro* collection. A system for virus indexing of, and virus elimination from, the accessions is necessary and it would ensure the establishment of clean stocks over time.
5. Ensuring seed quality	Facilities for artificial drying, measuring seed moisture content, and control of temperatures and humidity in storage of the active and long-term collections can be improved. Similarly, facilities can be improved for the monitoring of seed health in storage and plant health in the field using the available qualified staff.
6. Efficiency and effectiveness of data collection, management, and communication	Inventory of the collections is being updated and completion of this should be a high priority activity. Introduction of barcoding and electronic data capture (using computer tablets) coupled with rapid data transfer/backup to a database to be maintained at Bunso has to be established. Accession level information can be shared through PGRRI pages on the CSIR website.

4. Recommendations

CSIR-SARI headquarters, Nyankpala, offers the ecology, human resource (research) environment, available facilities, and enthusiasm of the Institute's management to serve as a complementary site for CSIR-PGRRI for conservation of genetic resources of cereal, legume and vegetable crops and selected clonal crops. Moreover, CSIR management fully supports the establishment of such a complementary site. CSIR, as the umbrella organization will sign the agreement with Crop Trust for the SFR project.

Recommendation 1. Establish a complementary site for CSIR-PGRRI at CSIR-SARI headquarters, Nyankpala, for conservation of genetic resources of cereal, legume and vegetable crops and selected clonal crops. CSIR, the Council that manages both PGRRI and SARI, will sign an agreement with Crop Trust for the SFR project. Based on that agreement, the management of CSIR-PGRRI will be responsible for oversight of day-to-day operations and support to Tamale-based staff e.g. in accounting related to

staff travel, minor vehicle and equipment maintenance, local purchases of supplies, and recruitment of field laborers. Additional responsibilities of the management of CSIR-PGRRI will include monitoring and supervising implementation of the project, appraisal/evaluation of regular staff, and major purchases for the project through CSIR headquarters.

Recommendation 2. Install some equipment that will be purchased under the SFR project specifically for medium term conservation (seed handling: i.e. threshing, seed drying) at the CSIR-SARI site, Nyankpala.

Recommendation 3. Assess the status and provide cost estimates for renovation of the buildings offered by CSIR-SARI to make them fit for purpose and for lining the base of the water reservoir within the fenced field previously used by GCP cassava project and CIP sweetpotato program with plastic sheeting to prevent leakage.

Recommendation 4. Acquire a four-wheel vehicle and two motorcycles for operations at the CSIR-SARI site, Nyankpala, to support activities under the SFR project.

Recommendation 5: Establish facilities for medium-term conservation, germination monitoring, and distribution at CSIR-SARI, Nyankpala and continue to use CSIR-PGRRI, Bunso for long-term conservation for both seed and clonal crops. Meristems of clonal crops can be introduced in vitro at CSIR-SARI and cultures can then be transferred to Bunso for conservation, with initial priority on rescue of unique accessions.

Recommendation 6: Transfer field banks for all cereal, legume and vegetable crops, frafra potato, sweetpotato and yam (except *D. cayenensis* and *D. esculenta,* which have long growth duration) to the complementary site at CSIR-SARI, Nyankpala.

Recommendation 7: Ensure stable and reliable power source for the two genebank sites (CSIR-PGRRI, Bunso and CSIR-SARI, Nyankpala) by:

1. Obtaining the electricity tariff waiver through the government for the CSIR-PGRRI, Bunso site
2. Servicing and repairing the faults with the solar power installation at CSIR-PGRRI, Bunso
3. Installing solar panels for generation of complementary energy for the building(s) to be used by CSIR-PGRRI at CSIR-SARI, Nyankpala
4. Installing and using a dedicated meter(s) to monitor the power consumption from the national electricity grid of the CSIR-PGRRI space at CSIR-SARI, Nyankpala

Recommendation 8: Fix the cold room at CSIR-SARI, Nyankpala and ensure it runs consistently at 4^0 C as an alternative to, or to supplement, the use of freezers for medium-term storage of seeds.

Recommendation 9: Establish regular seed viability testing at the complementary site, Nyankpala with supervision from staff of the existing seed lab of CSIR-SARI, which is run by four scientists with expertise in seed science/technology (one at PhD and three at MPhil levels). Key equipment and consumables to procure for use in a dedicated germination room include shelves, germination boxes with cover, germination paper towel, autoclave, water distiller, temperature logger, and barcode reader.

Recommendation 10: Establish regular health testing and certification for distribution from the complementary site by the Plant Protection and Regulatory Services Directorate (PPRSD) of the Ministry of Food and Agriculture (MoFA).

Recommendation 11: Equip the plant health labs at CSIR-PGRRI, Bunso in support of maintenance of health of the collections (internal monitoring and quality control related to key pests and pathogens that threaten them in the field and storage) by providing equipment (and associated consumables) such as autoclave, trinocular stereo zoom microscope, moisture analyzer, vortex mixer, and laminar flow cabinet.

Recommendation 12: Ensure adequate staff strength (numbers and experience) for operation of the complementary site at CSIR-SARI, Nyankpala. In addition to those who will be recruited as CSIR-PGRRI staff at the complementary site, it would be necessary to relocate some staff based at CSIR-PGRRI, Bunso to Nyankpala, at least temporarily during peak periods of some field activities.

Recommendation 13: Adopt QMS, including SOPs for operations at the Bunso and SARI sites, using the same procedures where possible. With support from the Crop Trust, expand the development of SOPs to cover other genebank operations beyond conservation and distribution, which are currently being addressed. Train PGRRI staff in the application of the SoPs.

Recommendation 14: Ensure that priority accessions of clonal crops in the field bank are safety duplicated in vitro at CSIR-PGRRI-Bunso and at CSIR-CRI, Fumesua (as in-country backup). Also ensure safety duplication of unique accessions in international collections e.g. at IITA's Genetic Resources Centre. Subject to approval by CSIR-PGRRI management, some international distribution of accessions (after cleaning of viruses) could be done by IITA on behalf of CSIR-PGRRI in response to requests.

Recommendation 15: Implement barcoding and electronic data capture coupled with regular data transfer to a single database for both sites that be maintained at CSIR-PGRRI, Bunso. This relates to labelling and recording during several genebank operations including regeneration, multiplication, characterization, evaluation, viability testing, storage, distribution and in the in vitro laboratory (Bunso). We strongly recommend the use of GRIN-Global Community Edition and encourage intensification of ongoing training. Staff at IITA's Genetic Resources Centre would be glad to assist through exchange visits and regular advice. This will raise efficiency and reduce errors in data transcription.

Recommendation 16: Establish regular sharing of accession level information from CSIR-PGRRI through the CSIR website to ensure regular updating. This will raise the profile of the national genebank and promote its use. It will also support a more proactive stance of CSIR-PGRRI ensuring that e.g. stocks of all released crop varieties are conserved and other institutes are encouraged to submit genetic stocks and mapping populations of breeding/genetics programs (under cost recovery arrangement) or copies of germplasm collected for research.

Annexes

Annex 1. Itinerary

Date	Description	Travelers
Nov-06	Bunso - Accra (by PGRRI car)	Lawrence and Daniel
Nov-09	Accra - Tamale (flight)	Robert and Daniel
Nov-09	Tamale - Nyankpala - Tamale (by IITA car)	Robert and Daniel
Nov-10	Tamale - Nyankpala - Tamale (by IITA car)	Robert and Daniel
Nov-11	Tamale - Accra (flight)	Robert, Daniel, Richard
Nov-11	Accra - Bunso (by IITA car)	Robert, Daniel, Richard
Nov-12	Bunso	Robert, Daniel, Richard, Lawrence
Nov-13	Bunso - Accra (by IITA car)	Robert, Daniel, Richard, Lawrence
Nov-13	Accra - Bunso (by PGRRI car)	Daniel and Lawrence
Nov-14	Accra - Tamale (flight)	Richard
Nov-14	Accra - Ibadan (flight)	Robert

Annex 2. Schedule

Period	Topic	Participants	Location
Nov. 6 (Friday)			
1400 - 1600	Introductory discussion with CSIR management	CSIR DG, CSIR PGRRI manager, CSIR SARI manager, CT reviewer	Accra
Nov. 9 (Monday)			
Morning	Flight from Accra to Tamale	CSIR PGRRI manager, CSIR SARI manager, CT reviewer	
Morning	Visit to CSIR-SARI (Meeting with Director SARI)	CSIR PGRRI manager, CSIR SARI manager, CT reviewer	Nyankpala
Morning and Afternoon	Visit to CSIR-SARI (fields and infrastructure)	CSIR PGRRI manager, CSIR SARI manager, CT reviewer	Nyankpala
Evening	Debrief with CT and reviewers	Nora, Robert and Michael	Skype
Nov. 10 (Tuesday)			
Morning and Afternoon	Visit to CSIR-SARI (fields and infrastructure)	CSIR PGRRI manager, CSIR SARI manager, CT reviewer	Nyankpala
Evening	Debrief with CT and reviewers	Nora, Robert and Michael	Skype
Nov. 11 (Wednesday)			
Morning	Flight from Tamale to Accra	CSIR PGRRI manager, CSIR SARI manager, CT reviewer	
Morning	*CT reviewer goes for COVID-19 test*	*CT reviewer*	Accra
Afternoon	Road travel from Accra to Bunso	CSIR PGRRI manager, CSIR SARI manager, CT reviewer	

Evening	Debrief with CT and reviewers	Nora, Robert and Michael	Skype
Nov. 12 (Thursday)			
Morning and Afternoon	Visit to CSIR-PGRRI (fields and infrastructure)	CSIR PGRRI manager, CSIR SARI manager, CT reviewer	Bunso
Evening	Debrief with CT and reviewers	Nora, Robert and Michael	Skype
Nov. 13 (Friday)			
Morning	Road travel from Bunso to Accra	CSIR DG, CSIR PGRRI manager, CSIR SARI manager, CT reviewer	
Afternoon	Wrap-up with CSIR management	CSIR DG, CSIR PGRRI manager, CSIR SARI manager, CT reviewer	Accra
Evening	Debrief with CT and reviewers	Nora, Robert and Michael	Skype
Nov. 14 (Saturday)			
	Travel back to Nigeria	CT reviewer	
	Travel back to Tamale	CSIR SARI manager	

Annex 3. Contact details of key persons met:

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Annex 4. Staff of CSIR-PGRRI met at Bunso in meeting on 12-11-2020

S/N	Name	Designation
1	Daniel Ashie Kotey	SRS PGRRI
2	Rashied Tetteh	RS PGRRI
3	Robert Darko	CTO PGRRI
4	Edward K. Darko	Marketing Officer, PGRRI
5	Richard AduAmoah	RS PGRRI
6	Augustine Bosomtwe	PT PGRRI
7	Bright AduGyamfi	PT PGRRI
8	Gyasi Eric	PT PGRRI
9	Matilda Bissah	RS PGRRI
10	Barnabas A. Adongo	PT PGRRI
11	Fuleratu Adams	PT PGRRI
12	Sophia Ansah	PT PGRRI
13	Monkpebor N. Martin	PT PGRRI
14	Nketiah Victor	PT PGRRI
15	Naomi Asomani Antwi	RS PGRRI
16	Eric OsafoAnsah	PT PGRRI
17	Yaw Kwateng	SS PGRRI
18	Samuel KwasiBoateng	SRS PGRRI