Table 2b. Potential risks and management options for clonal banks.

Activity	Risk Sources/Indicators	Risk/Consequence	Responsible Unit
ACQUISITION			
Collecting	Narrow genetic variability and large gaps in germplasm collection	Failure to capture diversity in field	GRU
	Untrained personnel in collecting and documentation	Failure to capture diversity in field and document important information	GRU
	Misidentification of germplasm	Misleading information	GRU
	Lack of simple collection protocol and documentation forms	Failure to capture diversity in field	GRU
	Agricultural intensification, replacement of traditional varieties with modern ones, urbanization, land use change, and climatic events	Loss of germplasm in habitat	GRU
	Strict country and international laws on access and use of germplasm	Poor access and use of germplasm in unexplored areas	GRU
	Breach of country and international treaties	Legal consequences. Damaged reputation and relationship	Center top mgt; new employees orientation;GRU
	Ambiguous position of countries regarding international treaties	Poor access and use of germplasm in unexplored areas	Center partnership and collaboration office, GRU
Donation	Received foreign materials carry pests and diseases	Introduction of pest and diseases to host country	GRU; Germplasm Health unit
	Limited germplasm testing capability	Restricts international germplasm exchange	GRU; Germplasm Health unit
	Reluctance to share germplasm due to IP rights	Restricts international germplasm exchange	GRU
	Working collections not duplicated in major genebanks	Failure to capture elite germplasm	GRU
CONSERVATION			
Registration	Unverified passport and other data submitted	Incorrect or unreliable passport data, and poor quality of scientific reports	GRU
	Received materials have low viability	Loss of germplasm	GRU
	Limited storage space for clonal materials		
Conservation in *in vitro* Banks			
Sample Processing	Untrained or inefficient personnel in sample processing	Reduction of good quality propagules and accidental mixtures	GRU
	Source of material is infected	Loss of viability of propagules	GRU; Germplasm Health unit
	Poor quality and/or suboptimal size of propagule	Loss of meristems	GRU
	Weak mother plants	Short lifespan of propagules in storage	GRU
	Ineffective pest and disease screening procedures during sample processing	Reduction of good quality propagules	GRU; Germplasm Health unit
	No efficient tissue sterilisation procedures	Poor quality of propagules	

	Lack of proper disposal procedures of contaminated plant materials	Increase in invitro contamination with pests and diseases and dissemination to new areas	GRU; Germplasm Health unit
	Ineffective thermotherapy procedure	Failure of explants to multiply	GRU
	Inappropriate media and conditions for culture initiation	Failure of explants to multiply	GRU
Germplasm Testing	Untrained personnel in health testing of propagules	Pest and disease damage and spread in collection	GRU; Germplasm Health unit
	Improper screening methods and monitoring regime	Pest and disease damage and spread in collection	GRU; Germplasm Health unit
	Microbes and pests are not apparent at initial testing but appear later.	Pest and disease damage and spread in collection	GRU; Germplasm Health unit
	Untrained personnel in transgene detection	Loss of genetic integrity of other accessions	GRU/Biotechnology unit
	Inadvertent presence of transgene	Loss of genetic integrity of other accessions	GRU/Biotechnology unit
	Lack or improper determination of transgene presence	Inaccurate or wrong information regarding transgene presence	GRU/Biotechnology unit
	Limited quantity of high quality propagules	Loss of accession	GRU
	Ineffective sterilization techniques	Loss of accession	GRU
	Misapplication of antibiotics	Loss of accession	GRU
	Somaclonal variation	Loss of genetic integrity	GRU
Conservation Procedure	Errors in media preparation	Loss of accession	GRU
	Ineffective pre-treatment	Short lifespan of propagules in storage	GRU
	Chemical imbalance during culture	Abnormal growth of material	GRU
	Suboptimal culture methods for a broad range of genotypes		GRU
	Short storage life of propagules	Loss of viability	GRU
	Delayed inventory	Loss of material	GRU
	Late subculturing	Loss of viability	GRU
	Backlog in regeneration	Loss of viability	GRU
Storage Facility	Unsterile transfer facilities	Loss of accession	GRU; Germplasm Health unit
	Unsuitable tissue culture containers for in vitro samples	Loss of accession	GRU
	Poor laboratory maintenance	Contamination and loss of materials	GRU
Safety Duplication	Safety duplication site is vulnerable to natural calamities	Inaccessible or loss of safety duplication	GRU
Regeneration	Regeneration failure	Loss of germplasm	GRU
Conservation in Cryo bank - Long Term Storage (LTS)			
Sample Processing	Incorrectly identified material is stored	Wrong germplasm stored and distributed	GRU
	Isolation of material is not done correctly, meristems are damaged and regrowth as callus	Increased chance of variation	GRU
	Chemical cryoprotectants injure plant cells during pre-treatment	Reduced viability during storage	GRU
	Plants are sensitive to preculture method	Loss of viability	GRU

	Technique does not work for all plants in the collection	Gaps in collection	GRU
Germplasm Testing	Thawing/rewarming is done improperly	Underestimate of post-thaw regeneration rate	GRU
	Water bath may be contaminated	Damage to samples	GRU
	New material in cryo-collection is not viable	Loss of samples	GRU
Conservation Procedure	Dewars may fail.	Damage to samples	GRU
	Unreliable supply of liquid nitrogen (LN)	Damage to samples	GRU/Purchasing
	Rapid loss of LN in dewar	Damage to samples	GRU
	Improper placement on cryocane and to multiple rewarming and cooling cycles during sample retrievals	Loss of biological stability	GRU
	Compromised integrity of cryovials	Contamination and loss of biological stability	GRU
	Insuffiicent number of stored propagules	Loss of germplasm	GRU
Conservation on field banks			
Sample Processing	Low initial quality of explants.	Short lifespan of germplasm in storage	GRU
	Improper conditioning and propagation of vegetative material	Short lifespan of germplasm in storage	GRU
	Failure in propagation and storage of propagules	Loss of germplasm	GRU
Germplasm Testing			
Health Diagnosis	Failure to detect and remove samples with pests and diseases and improper disposal of contaminated materials	Increased pathogen or pest population in the facility, thereby jeopardizing the health of other accessions in the collection as well as introducing new pest or diseases in new regions/countries.	GRU; Germplasm Health unit
	Ineffective screenhouse to control insects		GRU/ Physical Plant unit
	Backlogs in pest and disease monitoring	Loss of field bank samples	GRU
	False positive and false negative results during plant health testing.	Loss of materials due to false positive results. Dissemination of diseased materials due to false negative results.	GRU; Germplasm Health unit
Storage Monitoring	Limited numbers of viable plants	Loss of germplasm	GRU
	Mechanical mixtures or invasive plants	Loss of genetic integrity	GRU
	Late rejuvenation or multiplication (plants lost their physiologic vigour or accumulated pests and diseases)	Loss of materials	GRU
Conservation Procedure	Inadequate selection, pre-conservation or pre-treatment of propagules	Poor plant establishment	GRU
	Failure in propagation and storage of propagules	Loss of germplasm	GRU
	Inadequate number of replicates per accession.	Loss of germplasm	GRU
Field Bank Specifications			
Field Monitoring	Unsuitable conditions in conservation site	Poor or suboptimal growth	GRU
	High pest and disease pressure in field site	Loss of germplasm	GRU; Germplasm Health unit; Physical Plant unit

Field Planting	Pollen exchange with plants within and outside collection.	Loss of genetic integrity	GRU
	Misidentification	Loss of germplasm	GRU
	Mixtures of clones	Loss of genetic integrity	GRU
	Contamination with volunteer plants.	Loss of genetic integrity	GRU
Field Maintenance& Management	Mixtures of fruits and germplasms	Loss of genetic integrity	GRU
	Poor adaptation	Loss of germplasm	GRU
	Disparate location of physiologically similar accessions	Inefficient management	GRU
	Poor management of weeds and low soil fertility	Loss of germplasm	GRU
Post-harvest Handling	Persistence of disease organisms and insects after harvest	Deterioration of propagules and spread of pests and diseases during storage	GRU; Germplasm Health unit
	Mishandling	Deterioration of propagules during storage	GRU
Characterization and Evaluation	Inefficient and erroneous data gathering and encoding	Backlog and inaccurate characterization data	GRU
	Descriptors that have no clear-cut correspondence to current international standard descriptors	No or limited usefulness of characterization data	GRU
	Limited text-based description	Incomplete and inaccurate morphological description	GRU
	Lack of diversity assessment of collection	Unknown level of breadth, duplication and gaps in collection, and conservation of unnecessary duplicates	GRU
DISTRIBUTION			
Policies	Lack of knowledge or negligence on germplasm exchange Protocol and International Treaty	Distribution without accompanying MTA. Inadvertent distribution of restricted germplasm (e.g. Non-MLS materials). Wrong information on the exchange status (MLS) of the germplasm.	GRU; Plant Breeding; Training
	Recipients of “designated” germplasm or “non-designated” germplasm attempt to claim IP rights over the germplasm	Restrictions on future access and use of germplasm	GRU; Center Mgt; FAO
	Plant health restrictions of importing country	Low level of exchange and utilization of germplasm.	
	Non compliance with phytosanitary regulations	Germplasm distributed from genebank with diseases or pest contamination.	GRU; germplasm Health
User Service	Germplasm distributed are weak	Dissatisfied recipients of germplasm	GRU
Germplasm Preparation and Dispatch	Misclassification and wrong characterization and germplasm stocks data	Delayed identification and preparation of requested germplasm	GRU, Library, Communications Office
	Inefficient and slow processing of requests for samples.	Dissatisfied recipients of germplasm	GRU; germplasm Health
	Errors in preparing or labeling samples	Wrong germplasm distributed by the genebank	GRU
	Insufficient germplasm stock for distribution	Delay in serving germplasm request	GRU
	Bulky tissue-cultured explants	Expensive shipping cost and vulnerability of material to disintegration	

	Unfavorable conditions during transport	Delay in delivery , reduction of viability or loss of materials	GRU
INFORMATION MANAGEMENT AND DISSEMINATION			
	Inefficient recording and database management	Backlog and inaccurate characterization data	GRU, IT unit
	Mishandling of information and disorganized data sets (e.g. information system, field/ lab observation)	Loss or inaccessibility of information	GRU, IT unit
	Improper recording of moisture content, germplasm inventory, viability, storage location, and characterization data.	Inaccurate or wrong information	GRU
	Lack of adequate information about important characteristics of each accession.	Low interest and utilization of germplasm	GRU
	Mislabelling of new bags and other containers for the germplasm accession and samples are placed in the wrong container.	Loss or misplacement of materials	GRU
	Lack of secure back-up	Loss of genebank data	GRU, IT unit
	Important data and information remain in unuseful form.	Low level of utilization of germplasm and information.	GRU, Library, Communications Office
	Outdated or inaccessible procedures manual	Loss of improvements in procedures	GRU
	Inconsistent protocols	Much variation in quality of process outputs	GRU
	Lack or complicated tracking and inventory system	Loss or misplaced samples and failure to regenerate and serve germplasm request on time	GRU
	Insufficient data on accession identity and culture conditions	Underestimate of germplasm viability or failure to propagate by recipient	GRU
	Limited ICT capability; server, network and IT related problems	Lack or poor accessibility of germplasm and important data to potential users	GRU, IT unit
	Malfunctioning equipment, hardware and software problems	Failure to update data by genebank staff. Delays in recording of accessions and declaring them to FAO & SINGER	GRU
INFRASTRUCTURE/PHYSICAL FACILITY			
	Storage conditions at genebank not suitable (temperature, humidity, light conditions, exposure to contaminating organisms, pests)	Reduction or loss of viability	GRU, Physical Plant
	Poor organization of storage trays, shelves and compartments	Loss or misplacement of germplasm	GRU
	Deterioration of facilities and equipment	Reduction or loss of viability	GRU
	Cold room malfunction	Reduction or loss of viability	GRU, Physical Plant
	Power supply cut-off	Reduction or loss of viability	GRU, Physical Plant
	Theft or vandalism	Loss of germplasm	GRU, Physical Plant, Security
	Environmental risks/weather elements, earthquakes, other catastrophic events (civil war,…), and fire	Reduction or loss of viability	GRU

Safety Duplication	Safety duplication site is vulnerable to natural calamities	Inaccessible or loss of safety duplication	GRU
	Changing policies, financial and technical capabilities of governments hosting safety duplication	Inaccessible or loss of safety duplication	Center top mgt; SGRP; GRU
PERSONNEL AND SUPPORT SERVICES			
	Inadequate complement of technical staff	Inefficient operations	GRU; HR unit
	Incompetent staff	Inefficient operations	
	Routine tasks and uncompetitive remuneration	Fast staff turnover	GRU
	Exposure to occupational hazards	Reduced manpower capability	GRU, Pest Control unit
	Suffocation/asphyxiation and frostbite and cold injury from LN exposure. Mechanical injury incurred on explosion of a pressurized vessel containing LN.		GRU
	Inefficient human resources services	Delayed hiring of required manpower	HR
	Inefficient purchasing and repair services	Delayed delivery/repair of required supplies and equipment	GRU
	High cost of genebank operations	Loss of donor and user support	GRU; Center mgt