

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

Activity	Risk Sources/Indicators	Risk/Consequence
ACQUISITION		
Collecting	Narrow genetic variability and large gaps in germplasm collection	Failure to capture diversity in field
	Untrained personnel in collecting and documentation	Failure to capture diversity in field and document important information
	Misidentification of germplasm	Misleading information
	Lack of simple collection protocol and documentation forms	Failure to capture diversity in field
	Agricultural intensification, replacement of traditional varieties with modern ones, urbanization, land use change, and climatic events	Loss of germplasm in habitat
	Strict country and international laws on access and use of germplasm	Poor access and use of germplasm in unexplored areas
	Breach of country and international treaties	Legal consequences. Damaged reputation and relationship
	Ambiguous position of countries regarding international treaties	Poor access and use of germplasm in unexplored areas
Donation	Received foreign materials carry pests and diseases	Introduction of pest and diseases to host country
	Limited germplasm testing capability	Restricts international germplasm exchange
	Reluctance to share germplasm due to IP rights	Restricts international germplasm exchange
	Working collections not duplicated in major genebanks	Failure to capture elite germplasm
CONSERVATION		
Registration	Unverified passport and other data submitted	Incorrect or unreliable passport data, and poor quality of scientific reports
	Received materials have low viability	Loss of germplasm
	Limited storage space for clonal materials	
Conservation in <i>in vitro</i> Banks		

<u>Sample Processing</u>	Untrained or inefficient personnel in sample processing	Reduction of good quality propagules and accidental mixtures
	Source of material is infected	Loss of viability of propagules
	Poor quality and/or suboptimal size of propagule	Loss of meristems
	Weak mother plants	Short lifespan of propagules in storage
	Ineffective pest and disease screening procedures during sample processing	Reduction of good quality propagules
	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.
	Ineffective thermotherapy procedure	Failure of explants to multiply
	Inappropriate media and conditions for culture initiation	Failure of explants to multiply
<u>Germplasm Testing</u>	Untrained personnel in health testing of propagules	Pest and disease damage and spread in collection
	Improper screening methods and monitoring regime	Pest and disease damage and spread in collection
	Microbes and pests are not apparent at initial testing but appear later.	Pest and disease damage and spread in collection
	Untrained personnel in transgene detection	Loss of genetic integrity of other accessions
	Inadvertent presence of transgene	Loss of genetic integrity of other accessions
	Lack or improper determination of transgene presence	Inaccurate or wrong information regarding transgene presence
	Limited quantity of high quality propagules	Loss of accession
	Ineffective sterilization techniques	Loss of accession
	Misapplication of antibiotics	Loss of accession
	Somaclonal variation	Loss of genetic integrity

<u>Conservation Procedure</u>	Errors in media preparation	Loss of accession
	Ineffective pre-treatment	Short lifespan of propagules in storage
	Chemical imbalance during culture	Abnormal growth of material
	Suboptimal culture methods for a broad range of genotypes	
	Short storage life of propagules	Loss of viability
	Delayed inventory	Loss of material
	Late subculturing	Loss of viability
	Backlog in regeneration	Loss of viability
<u>Storage Facility</u>	Unsterile transfer facilities	Loss of accession
	Unsuitable tissue culture containers for in vitro samples	Loss of accession
	Poor laboratory maintenance	Contamination and loss of materials
<u>Safety Duplication</u>	Safety duplication site is vulnerable to natural calamities	Inaccessible or loss of safety duplication
<u>Regeneration</u>	Regeneration failure	Loss of germplasm
Conservation in Cryo bank - Long Term Storage (LTS)		
<u>Sample Processing</u>	Incorrectly identified material is stored	Wrong germplasm stored and distributed
	Isolation of material is not done correctly, meristems are damaged and regrowth as callus	Increased chance of variation
	Chemical cryoprotectants injure plant cells during pre-treatment	Reduced viability during storage
	Plants are sensitive to preculture method	Loss of viability
	Technique does not work for all plants in the collection	Gaps in collection
<u>Germplasm Testing</u>	Thawing/rewarming is done improperly	Underestimate of post-thaw regeneration rate
	Water bath may be contaminated	Damage to samples
	New material in cryo-collection is not viable	Loss of samples
<u>Conservation Procedure</u>	Dewars may fail.	Damage to samples
	Unreliable supply of liquid nitrogen (LN)	Damage to samples

	Rapid loss of LN in dewar	Damage to samples
	Improper placement on cryocane and to multiple rewarming and cooling cycles during sample retrievals	Loss of biological stability
	Compromised integrity of cryovials	Contamination and loss of biological stability
	Insufficient number of stored propagules	Loss of germplasm
Conservation on field banks		
<u>Sample Processing</u>	Low initial quality of explants.	Short lifespan of germplasm in storage
	Improper conditioning and propagation of vegetative material	Short lifespan of germplasm in storage
	Failure in propagation and storage of propagules	Loss of germplasm
<u>Germplasm Testing</u>		
<i>Health Diagnosis</i>	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.
	Ineffective screenhouse to control insects	
	Backlogs in pest and disease monitoring	Loss of field bank samples
	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.
<i>Storage Monitoring</i>	Limited numbers of viable plants	Loss of germplasm
	Mechanical mixtures or invasive plants	Loss of genetic integrity
	Late rejuvenation or multiplication (plants lost their physiologic vigour or accumulated pests and diseases)	Loss of materials
<u>Conservation Procedure</u>	Inadequate selection, pre-conservation or pre-treatment of propagules	Poor plant establishment
	Failure in propagation and storage of propagules	Loss of germplasm
	Inadequate number of replicates per accession.	Loss of germplasm
<u>Field Bank Specifications</u>		

<i>Field Monitoring</i>	Unsuitable conditions in conservation site	Poor or suboptimal growth
	High pest and disease pressure in field site	Loss of germplasm
<i>Field Planting</i>	Pollen exchange with plants within and outside collection.	Loss of genetic integrity
	Misidentification	Loss of germplasm
	Mixtures of clones	Loss of genetic integrity
	Contamination with volunteer plants.	Loss of genetic integrity
<i>Field Maintenance & Management</i>	Mixtures of fruits and germplasms	Loss of genetic integrity
	Poor adaptation	Loss of germplasm
	Disparate location of physiologically similar accessions	Inefficient management
	Poor management of weeds and low soil fertility	Loss of germplasm
<i>Post-harvest Handling</i>	Persistence of disease organisms and insects after harvest	Deterioration of propagules and spread of pests and diseases during storage
	Mishandling	Deterioration of propagules during storage
Characterization and Evaluation	Inefficient and erroneous data gathering and encoding	Backlog and inaccurate characterization data
	Descriptors that have no clear-cut correspondence to current international standard descriptors	No or limited usefulness of characterization data
	Limited text-based description	Incomplete and inaccurate morphological description
	Lack of diversity assessment of collection	Unknown level of breadth, duplication and gaps in collection, and conservation of unnecessary duplicates
DISTRIBUTION		
<u>Policies</u>	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.

	Recipients of “designated” germplasm or “non-designated” germplasm attempt to claim IP rights over the germplasm	Restrictions on future access and use of germplasm
	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.
<u>User Service</u>	Germplasm distributed are weak	Dissatisfied recipients of germplasm
<u>Germplasm Preparation and Dispatch</u>	Misclassification and wrong characterization and germplasm stocks data	Delayed identification and preparation of requested germplasm
	Inefficient and slow processing of requests for samples.	Dissatisfied recipients of germplasm
	Errors in preparing or labeling samples	Wrong germplasm distributed by the genebank
	Insufficient germplasm stock for distribution	Delay in serving germplasm request
	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
INFORMATION MANAGEMENT AND DISSEMINATION		
	Inefficient recording and database management	Backlog and inaccurate characterization data
	Mishandling of information and disorganized data sets (e.g. information system, field/ lab observation)	Loss or inaccessibility of information
	Improper recording of moisture content, germplasm inventory, viability, storage location, and characterization data.	Inaccurate or wrong information

	Lack of adequate information about important characteristics of each accession.	Low interest and utilization of germplasm
	Mislabelling of new bags and other containers for the germplasm accession and samples are placed in the wrong container.	Loss or misplacement of materials
	Lack of secure back-up	Loss of genebank data
	Important data and information remain in unuseful form.	Low level of utilization of germplasm and information.
	Outdated or inaccessible procedures manual	Loss of improvements in procedures
	Inconsistent protocols	Much variation in quality of process outputs
	Lack or complicated tracking and inventory system	Loss or misplaced samples and failure to regenerate and serve germplasm request on time
	Insufficient data on accession identity and culture conditions	Underestimate of germplasm viability or failure to propagate by recipient
	Limited ICT capability; server, network and IT related problems	Lack or poor accessibility of germplasm and important data to potential users
	Malfunctioning equipment, hardware and software problems	Failure to update data by genebank staff. Delays in recording of accessions and declaring them to FAO & SINGER
INFRASTRUCTURE/PHYSICAL FACILITY		
	Storage conditions at genebank not suitable (temperature, humidity, light conditions, exposure to contaminating organisms, pests)	Reduction or loss of viability
	Poor organization of storage trays, shelves and compartments	Loss or misplacement of germplasm
	Deterioration of facilities and equipment	Reduction or loss of viability
	Cold room malfunction	Reduction or loss of viability
	Power supply cut-off	Reduction or loss of viability
	Theft or vandalism	Loss of germplasm
	Environmental risks/weather elements, earthquakes, other catastrophic events (civil war,...), and fire	Reduction or loss of viability

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