ICRAF SEED LABORATORY SAFETY MANUAL

Genetic Resources Unit
World Agroforestry Centre

United Nations Avenue, Gigiri
P O Box 30677 00100, Nairobi, Kenya
Tel: 254 20 7224268 or via USA 1 650-833-6645
Fax: 254 20 7224001

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Introduction

Laboratory activities and demonstrations represent an essential part of effective science teaching and although many science activities present potential hazards, reasonable and prudent safety practices greatly reduce the likelihood of accidents. While written materials and pictures convey enormous amount of information, laboratories have high potential for fires chemical burns, toxic fumes and other hazards that can be eliminated with proper safety techniques. For these main reasons, the primary objective of this document is to provide general safety guidelines to be observed while working in the Agroforestry Tree Seed Laboratory by ICRAF seed laboratory staff, students, and all other scientists whose research activity is done at the laboratory. This document provides the minimum set of guidelines, regulations, and recommendations to be observed in order to maintain a safe working environment.

This document must be given to new member staff joining the Seed Laboratory, student intern, and researcher before performing any seed laboratory work. Each person shall make a commitment to abide by the safety procedures by signing a declaration in Appendix 2 of this document.

Key statement

Maintain Agroforestry Tree Seed Laboratory as a place for knowledge and not the first step towards a trip to the emergency room by implementing proper safety precautions.

Safety Procedures

1. Laboratory design

ICRAF Seed Laboratory is housed in the research building room G 161. The laboratory started operations in the current location in 1997. The area covered by the laboratory is 48 square meters. It has one large island bench and one side bench top made of technical ceramic materials resistant to acids. One under bench sink is mounted on the Island bench top while two are mounted on the side bench. The fume hood is located on the left hand side from the main entrance of the laboratory for use while handling toxic and volatile chemicals. There are two exit doors. At the left hand corner is a concrete bench specially designed for extraction of hard seeds and fruits. There is an emergency shower and eye wash fountain for use in case of accidental contact with harmful chemicals. Drawers and cabinets are positioned below the bench tops for ease of access of working tools.

2. Seed storage design

ICRAF operates a medium term cold storage and a drying room facility consisting of cooling modules with prefabricated panels equipped with cooling systems and dehumidifiers. The facilities are housed at ICRAF research building rooms G162 and G163 and occupy an area of 44 square meters. The drying room is maintained at 15^{o}C and 15% humidity. The cold store has temperature maintained at 5^{o}C and 15% Relative humidity used as seed store for orthodox seeds. The two stores are equipped with fixed and mobile shelving systems with external temperature system and alert alarm controls to detect temperature fluctuations.

3. Seed testing equipment

3.1. List of main seed testing equipment

1. Plant growth chambers/Germination incubators - Used for germination testing
2. Electric oven- Used for drying seed samples for moisture content analysis
3. Microwave oven – warming reagents
4. Balances- Used for taking weights for testing
5. Electric kettle- Used to boil water for seed dormancy breaking
6. Grinding Mill- used to grind seeds for moisture tests
7. Microscope- Used for examining small seeds/internal structures.
8. Sealers – Used to heat seal aluminum sachets for packing.
9. Seed extractor- Cracking hard nuts
10. Fume chamber
11. Equilibrium relative humidity (eRH) meter – determining the equilibrium relative humidity for seed before storage.
12. Seed counter – counting seed for weight determination tests.

3.2. Care of the equipment

Equipment should be kept clean at all times and maintained in good working condition. Clean off the dust on a daily basis and use bio-clean reagents to clean the equipments. Plant growth chambers, drying room and cold room which run throughout the year should be serviced at least

once in every six months. Proper power back-up should be installed to prevent power surges. The microscope should always be covered while lens are wrapped in cotton clothing. Balances are placed on the side bench top where there is minimum air movement, the conventional oven and microwaves should be switched off when not in use.

4. Personal safety when operating the equipment

Equipment are strategically positioned on the bench top where they are accessible to the user. Protective clothing should be worn at all times when operating the equipment.
Extra care should be taken when handling hard fruits and seed while using the manual seed extraction tools (hammers, vice, cutters) and grinding mill by wearing protective goggles and mechanical hand gloves to avoid personal injury. In case particles fly into your eyes during extraction, flush them out of your eyes in running water from the emergency fountain. In case of accidental hand injury from the extractor equipment, get someone to administer first aid.

5. Personal safety when treating seeds with acid

All concentrated acids such as sulphuric acid, hydrochloric acid and Nitric acid are corrosive and toxic and should be handled with extra care. The acids are carefully kept under lock and key and managed by a qualified seed technician. The technician should wear hand gloves, goggles when treating seed with acid. Simple procedure of treatment is to operate the treatment process under a fume chamber. Seeds samples for treatment are placed in the fume chamber while acid is poured on the seeds put in the Kilner jar depending on the stipulated time of treatment. The acid should be stirred regularly using a glass rod during the treatment process. When disposing acid after use, dilute the acid by gently pouring plenty of water into the acid in a basin. **Never pour concentrated acids into water!!. This may lead to an explosion!!**

6. Personal safety when preparing stock solutions

Because all chemicals are toxic under some conditions, and relatively few have been thoroughly tested, it is good strategy to minimize exposure to all chemicals. In practice this means having a good, properly installed hood; when working in a hood, leave enough room for your hands to fit into the hood and do your work comfortably BUT make sure that the glass window covers your eyes and nose. The fume hood fan should always be turned in the ON position before the chemical bottle is opened. NEVER remove anything containing fuming chemicals from the hood. **Never pour anything down the sink in the fume hood – it is not connected!**
All operations on preparation of stock solutions used in seed treatment should be done in the hood. This includes tetrazolium salt, buffers, dilute acids and bases and other solutions used in the Seed Laboratory, ; For protection of your eyes, when using solid chemicals and bases use safety goggles and/or full face shield to avoid chemical dusts or splashing of solutions into eyes. Maintain eye wash fountain and quick-drench facilities in work area.
Always wear impervious protective clothing, gloves, lab coat, apron or coveralls, as appropriate since some chemicals such as tetrazolium salt (TTZ) can penetrate the skin, wear, to prevent skin contact.

All chemicals including solution of hydroxides, nitrates, carbonates, sulphates and chlorides should be considered potentially dangerous and the safety hazards associated with any chemical

should be reviewed before working with them especially during preparation (please refer to the hazards associated with some of the chemicals used in the seed laboratory in Appendix 1 below. Such information may also be obtained from Material Safety Data Sheets for respective chemicals.
In case of contact, immediately flush eyes or skin with plenty of running water for at least 15 minutes. Remove contaminated clothing and shoes. Wash clothing before reuse. If inhaled, move to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen and seek medical attention immediately.

7. Personal protection and safety implications

When working in the seed storage rooms the worker should be in good health. Persons with chronic diseases such as Asthma, chest problems and other respiratory associated ailments should avoid getting into the cold store. Workers are advised to take shortest time possible in the cold room. If more extended time is required in the cold storage, the equipment could be switched off.
Basic requirements when working in the cold storage;

i. Heavy and warm overall should be worn at all time
ii. Warm comfortable hand gloves
iii. Worker should be of good health
iv. Flat warm comfortable shoes
v. Sometimes a dust mask may be required

8. Storage of laboratory chemicals and glassware

Seed laboratory drawers and cabinets are located beneath the bench top. Chemicals are arranged placed in dark cabinets, are well labeled for easy identification and are always checked to wipe out any form of spills or dust. Glassware such as pipettes, burets and glass rods are placed on tissue paper and arranged in drawers.
Beakers, flasks, round bottomed cylinders, glass slides, kilner jars and petri dishes are kept in the lower cabinets beneath the island bench top.

9. Care of glassware and other items

Glassware and plastic containers such as open trays, hand sprayer and moisture tins are well cleaned and wiped after use and arranged in drawers.
Care is required when handling the following items in the seed laboratory to avoid injury.

- Knives
- Nail cutters
- Forceps
- Scoops
- Secateurs
- Manual seed counters

10. First line safety measures and locations

Accidents occur when we are tired, on edge, or just busy with our mind on something else. The seed lab is equipped with a small first aid kit for accidents such as minor scrapes, cuts, burns,

headaches located at a cabinet accessible to staff . The eyewash and safety showers are located at an accessible position for all laboratory users. The faucet to the eyewash can be pulled out for easier access to the hurt individual. If one gets chemicals splash into your eyes, IMMEDIATELY notify someone in lab and ask them to help you get to the eyewash fountain. The fire extinguisher is located very close to the seed laboratory accessible to all GRP1 staff. In case of fire any staff member can access and operate this equipment.

11. Personal Safety Practices

As a rule in every lab, protective clothing must be worn at all time when in the laboratory. Free working space and comfortable shoes to move around the lab must also be worn at all times.
Each individual working at the seed laboratory is responsible for performing his/her job safely by following safety rules closely.

Summary notes of various protective measures that one should adhere to when working in the seed laboratory;

A. Wearing protective clothing

- Wear heavy and warm coat when getting accessions from the cold storage.

B. Wearing of Safety goggles

- Wear safety goggles when treating seeds with acid, using manual seed extractor and preparing solutions requires eye protection

C. Dust masks

- Wear dust masks when grinding or extracting seeds for moisture content test.
- **First Aid kit**
- Keep the first aid kit at an accessible place filled with basic aid items at all times.

D. Cleanliness and safeness of work area

- Always maintain a clean and uncluttered work area. Be sure to clean and return all materials to the appropriate storage space, turn off the water taps before leaving the lab.

E. Handling & disposal of chemicals

- Dispose all reagents, acids and solution as required accordingly on a case-by-case as per the disposal mechanisms given in Appendix 1.

F. Understanding Prohibited items and warning signs

Do not smoke anywhere near the buildings at ICRAF that houses the laboratories. Understand the BDH charts displayed at the seed laboratory.

Appendix 1: Chemicals used at the Agroforestry Tree Seed Laboratory, their hazards and storage and disposal mechanisms

Chemical name	Hazards	Storage method	Disposal mechanism
Acetone	Extremely flammable liquid, vapours may cause flush fires	Should be stored in a dark cupboard away from nitric acid, sulfuric acid, and hydrogen peroxide.	When released into the air, this material is expected to be readily removed from the atmosphere by wet deposition.
Chromic acid	Carcinogenic	Should be stored in secondary containers	Disposed as a hazardous waste
Potassium dichromate	Human carcinogenic	Should be stored in secondary containers	Disposed as a hazardous waste
Magnesium hydroxide	May cause irritation to the skin, eyes, and respiratory tract	Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage.	Sweep up and containerize for disposal
Nitrates	Low hazards	Stored away from combustible materials, esters, phosphorous and water.	Disposed as a hazardous waste
Potassium Permanganate		Benzaldehyde, ethylene glycol, glycerol, sulfuric acid.	Disposed as a hazardous waste
Sulfuric Acid and Hydrochloric acid	Corrosive	Store in a dark cupboard away from Chlorates, perchlorates, permanganates, compounds with light metals such as sodium, lithium, and potassium.	Disposed as special liquid waste. Pour used acid into water
Hydrogen peroxide (anhydrous)	Corrosive, harmful, oxidant	Store in a cool well-ventilated dark area separated from combustible substances, reducing agents, strong bases, organics	Dilute with a large amount of water and hold in a basin half filled with water until the peroxide decomposes followed by discharge into a suitable treatment system
Nitric acid	Volatile, corrosive, fuming acid, toxic, oxidant	Should be stored in a vented cabinet	Disposed as special liquid waste. Pour used acid into water.
Formalin	Poisonous,	Should be stored in a	Disposed as special liquid waste

	carcinogenic, irritant to the eyes and skin	cool and ventilated cupboard	
Nicotinamide adenine di-nucleotide	Irritant to the eyes, respiratory system and the skin	Should be stored at -20^{o}C	Should be swept up, placed in a bag and hold for waste disposal
Potassium di-hydrogen phosphate	Not hazardous, but may react with strong bases	Protect from moisture(airtight container)	Flush plenty of water when disposing
Silica gel	The dust can cause irritation to your skin and eyes	Should be stored in an airtight container and placed in a dry location.	Is reusable by oven-drying. Over used silica gel is placed in a waste bag for disposal
Barium chloride dehydrate	Toxic, irritant to the eyes and skin	Keep in a tightly closed container.	should be handled as hazardous waste
p-dimethylamineobenzaldehyde	Moderately toxic	Keep in a tightly closed container	Should be handled as hazardous waste.
Potassium carbonate	Irritant to the eyes, skin and mucous membrane	Should be stored in dry clean place	Disposal as other chemical waste
Potassium sodium tartrate	Not hazardous but irritant when taken inhaled in large doses	Should be stored in dry clean place	Disposal as other chemical waste
Copper II sulphate 5-hydrate	Dust is irritant to the eyes, mucous membrane	Store in a cool, dry, Well- ventilated, locked store room away from incompatible materials.	Sweep up spill and place in sealed bag or container for disposal
Sodium hydroxide ,Magnesium hydroxide, Ammonium hydroxide and Potassium hydroxide	can cause burns on skin	Keep in a tightly closed container. Protect from physical damage. Store in a cool, dry place	Add the caustic to water while stirring; never the reverse. To dispose use recommended waste disposal methods.
Potassium iodide	Irritant to the eyes, respiratory system and the skin	Keep in a tightly closed container. Protect from physical damage. Store in a cool, dry	Sweep up and containerize for reclamation or disposal. Vacuuming or wet sweeping may be used to avoid dust dispersal.
Barium hydroxide	Irritant to the eyes, respiratory system and the skin	Keep in a tightly closed container, stored in a cool, dry, ventilated area	Sweep up spill and place in sealed bag or container for disposal
Silver nitrate	poison, corrosive, causes severe burns	Keep in a tightly closed container, stored in a cool, dry. Avoid storage on wood floors.	Pick up spill for recovery or disposal and place in a closed container
Ammonium sulphate and Copper II	Irritant to the eyes, respiratory system	Keep in a tightly closed container,	Sweep up and containerize for reclamation or disposal. Vacuuming or

sulphate 5-hydrate	and the skin	stored in a cool, dry, ventilated area	wet sweeping may be used to avoid dust dispersal.
Magnesium Chloride AR	May be harmful if swallowed	Keep in a tightly closed container, stored in a cool, dry, ventilated area	Sweep up and containerize for reclamation or disposal.
Calcium chloride	May be harmful if swallowed	Keep in a tightly closed container, stored in a cool, dry, ventilated area	Dispose of any liquid chlorine in a rigid leak proof container labeled as hazardous waste
Sodium dihydrogen orthophosphate	May cause respiratory tract irritation	Store in a tightly closed container. Store in a cool, dry, well-ventilated area away from incompatible substances.	Collect in a beaker, dissolve in a large amount of water
Gibberelic acid	low hazard	Store in a refrigerator at 4^{o}C	Sweep up material and place into a suitable disposal container
Sodium di-hydrogen phosphate	May cause skin irritation.	Store in a cool, dry, well-ventilated area away from incompatible substances.	Sweep up material and place into a suitable disposal container. Clean up dust immediately, using the appropriate protective equipment
Ammonium nitrate	Low hazard	Keep in a tightly closed container, stored in a cool, dry, ventilated area	Wash down area and prevent run-off into drains
Chloroform	Irritant to the respiratory tract over exposure may affect the CNS	Keep in a tightly closed light-resistant container, stored in a cool, dry, ventilated area	Collect liquid in an appropriate container or absorb with an inert material (e.g., vermiculite, dry sand, earth), and place in a chemical waste container
Di-Sodium hydrogen phosphate (an hydrous AR)	May cause eye and skin irritation when over exposed to skin	Store in a cool, dry, well-ventilated area away from incompatible substances	Sweep up material and place into a suitable disposal container. Clean up dust immediately, using the appropriate protective equipment
Lactic acid	Corrosive, causes burns to areas where in contact	Keep in a tightly closed container, store in a cool, dry, ventilated area.	Collect liquid in an appropriate container or absorb with an inert material (e.g., vermiculite, dry sand, earth), and place in a chemical waste container.
Bayleton , Ridomil, Benlate, Antracol (systemic fungicides)	Exposure may cause poisoning accompanied by hypersensitivity followed by sedation	Store in a cool dry place and in such a manner as to prevent cross contamination with other pesticides and fertilizers	May be disposed on site at an approved waste disposal facility
Furadan(Nemiticide and insecticide)	Highly toxic if swallowed	Store in a cool, dry, well-ventilated place. Do not use or store near heat, open flame or hot surfaces. Store in original containers only	Method of disposal is to incinerate in accordance with local, state and national environmental laws.

Ferric chloride	Corrosive, causes burns to any areas on contact on the skin	Keep in a tightly closed container, stored in a cool, dry, ventilated area.	Pick up and place in a suitable container for reclamation or disposal, using a method that does not generate dust
Tetrazolium salt	Toxic, irritant	Store at room temperature (15 to 25°recommended). Keep well closed and protected from direct sunlight and moisture	Dispose by flushing plenty of water t as special waste. Sweep or scoop up and containerize for disposal. Rinse out empty containers thoroughly before disposal.
Sodium hydrogen carbonate	Has low hazard	Keep in a well closed container stored under cold to warm conditions, 2 to 4^0 C	Sweep up and containerize for reclamation or disposal.
Poly vinyl alcohol and Iso propanol alcohol	May cause nuisance dust in the air	Keep in a tightly closed container, stored in a cool, dry, ventilated area. Avoid dust formation and control ignition sources.	Clean up spills in a manner that does not disperse dust into the air. Use non-sparking tools and equipment.
Potassium carbonate	May cause eye and skin irritation when over exposed to skin	Keep in a tightly closed container, stored in a cool, dry, ventilated area.	Pick up and place in a suitable container for reclamation or disposal, using a method that does not generate dust.
Fast blue B salt	Slightly hazardous in case of skin contact (irritant), of eye contact (irritant), of inhalation	Keep container dry. Keep in a cool place.	Finish cleaning by spreading water on the contaminated surface and allow to evacuate through the sanitary system.
Charcoal decolorizing powder	Low hazard but extreme exposure may be irritant to mucous membrane and eyes	Keep in a dry and well-ventilated location at normal room temperature between 5^oC and 30^oC.	Pick up and place in a suitable container for reclamation or disposal.
Tri-ethamolamine	Not classified as hazard	Keep tightly closed when not in use. Store away from sparks, naked flames / incandescent material	Transfer to a container for disposal. Small spillages flush away with water
Potassium acetate	Irritant to the eyes and respiratory tract.	Keep in a tightly closed container, stored in a cool, dry, ventilated area	Wet sweeping may be used to avoid dust dispersal.
Phenol detached crystals	Hazardous to skin, corrosive to the eyes	Store as toxic storage in a cool dry place.	Sweep up and containerize for reclamation or disposal.
Nutrient gelatin	Low hazard	Once opened keep powdered medium closed to avoid hydration	Dispose used nutrient gelatin by autoclaving
1- Naphthylacetic acid	May cause eye irritation	Store at room temperature. Keep containers tightly closed and	Dispose using recommended disposal methods

		upright when not in use.	
Talc fine powder	Chronic inhalation may create respiratory hazards	Keep in a tightly closed container, stored in a cool, dry, ventilated area	Sweep up and containerize for reclamation or disposal. Talc accumulations on walking surfaces will cause very slippery conditions.
Sodium bromide	Harmful when swallowed, affects the CNS	Keep in a tightly closed container, stored in a cool, dry, ventilated area	Should be managed in an appropriate and approved waste disposal facility
Ethanol	Low hazard but highly flammable	Keep in a tightly closed container, stored in a cool, dry, ventilated area	Dispose using recommended disposal methods

Source: www.osha.gov

Appendix 2: DECLARATION

New Employee/Visiting scientist/Student laboratory orientation and compliance checklist

- I _____ have read and understood the ICRAF Tree seed Laboratory safety manual as required by the particular task(s) and areas I will be involved with.
- Have read the pertinent sections of the Laboratory Safety Manual relating to the work I will be performing.
- Have been given a walk-through of the work areas and have been shown the location and use of emergency eye wash stations, emergency showers, emergency exits, emergency spill kits and their application, fire extinguisher locations, safety board and personal protection equipment (PPE) required.
- I have been given a hazard awareness walk through my work location(s) identifying any hazards and precautions to be taken.
- I have been shown the location of and how to access Material Safety Data Sheets (MSDSs).
- I have been shown the location of and how to access Standard Operating Procedures (SOP's) relating to the task(s) I will perform.
- I have been given the names and phone numbers of all safety representatives in the laboratory.
- I undertake to report any near misses or hazardous occurrences to the laboratory technician/instructor.
- I have been shown where to meet outside in case of a fire emergency for attendance to be taken.
- I have completed the evaluation to ensure competency on the above OHS issues has been achieved.

_____	_____	_____
Employee/students name	Signature	Date

As a supervisor, I have confirmed the employee/student/visiting scientist has performed the above tasks. Part of my ongoing duties is to observe the worker for compliance to safe work practices.

_____	_____	_____
Supervisor name	Signature	Date