

ESTABLISHMENT OF SEED TESTING SYSTEM

Seed Quality Control Unit



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FAO/GERMANY COOPERATIVE PROGRAMME
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FOOD SECURITY



Federal Ministry
of Food, Agriculture and
Consumer Protection

ACKNOWLEDGEMENT

I would like to express my sincerest gratitude and appreciation to the Food and Agriculture Organisation (FAO) of the United Nations for funding this initiative and my travel, to the Task Force team and to all relevant institutions in Sierra Leone for the role that they played.

I thoroughly enjoyed the visits to the main seed testing laboratory and other offices at Sierra Leone Agricultural Research Institute (SLARI) headquarters, Makeni, Njala, Rukopr and Kobia. Not only did the staff of the this institution gain knowledge with regard to the international standards for seed testing but I also gained valuable insight into the current status of seed production and seed testing system in this country.

The various SLARI staff members are once again congratulated for their enthusiasm exhibited in this initiative.

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ABBREVIATIONS

| | | |
|-------|---|---|
| NSS | - | National Seed Secretariat |
| SQCU | - | Seed Quality Control Unit |
| SIDU | - | Seed Industry Development Unit |
| NSB | - | National Seed Board |
| VRC | - | Variety Release Committee |
| ISTA | - | International Seed Testing Association |
| FAO | - | Food and Agricultural Organisation of the UN |
| SLARI | - | Sierra Leone Agricultural Research Institute |
| CV | - | Curriculum Vitae |
| OECD | - | Organization for European Community Development |
| EU | - | European Union |
| TZ | - | Tetrazolium |
| MAFF | - | Ministry of Agriculture, Forestry and Food Security |
| SEED | - | Seed Enterprise Enhancement and Development |
| ELISA | - | Enzyme Linked Immunosorbent Assay |
| NARC | - | Njala Agricultural Research Centre |
| RARC | - | Rokupr Agricultural Research Centre |
| NUV | - | Near Ultra Violet light |

1.0 BACKGROUND

The National Seed Secretariat (NSS) of Sierra Leone is being reorganised and it will be transformed into a Sierra Leone Seed Certification Agency (SLeSCA) with four functional departments. These include Seed Testing and Seed health, Seed Systems and Inspection, Variety Testing and Registration and Finance and Human Resources. The departments will carry out responsibilities for seed quality control including laboratory seed testing, field inspections and seed trade monitoring; variety release and registration; facilitation of National Seed Board (NSB) and Variety Release Committee (VRC) activities; and seed industry development activities.

It is well known that the establishment of seed testing forms an integral part of quality assurance procedures and is usually a pioneering introduction to the initial strategies of any agricultural development programme. Seed quality forms a basic strategy for the development and sustainability of plant and crop production in any country. The mainstreaming of international procedures for seed testing is vital in the establishment of any seed testing laboratory to effectively regulate the national seed industry and provide for international seed trade.

2.0 OBJECTIVE

The overall objective of the assignment was to systematically assess, assemble, layout and pre-test the procured laboratory equipment and train the laboratory technicians in the application of International Seed Testing Association (ISTA) Rules and procedures for conducting the mandatory and other seed quality tests.

2.1 Specific objectives:

- a) Establish a function plan for the laboratory so that it can operate in the most efficient way.
- b) Layout the procured laboratory equipment to international standard and pre-test the functionality of the equipment.
- c) Develop procedures for each of the required compulsory tests that include germination, physical purity, moisture content and other seeds according to International Seed Testing Association (ISTA) rules.
- d) Develop procedures for other often requested seed testing aspects including seed health and seed vigour.
- e) Provide practical training for each procedure with the laboratory personnel to improve human skills in seed testing.
- f) Recommend any addition supplies and equipment that is needed and human capacity building required to aspire for ISTA accreditation.
- g) Establish the seed laboratory management system with the required paper trails for seed sampling and testing procedures and reporting.
- h) Establish the seed lot sizes for efficient seed sampling as per ISTA rules.

3.0 SEED TESTING ACTIVIES IN SIERRA LEONE

There had been some seed testing activities going on in the past but on a relatively small scale and limited pieces of laboratory equipment. Furthermore, the activities were being carried out with very little or no reference to international procedures. However, the government of Sierra Leone has seen it prudent to establish vibrant and sustainable seed industry and are receiving support from the cooperating partners such as Food and Agriculture Organisation (FAO) of the UN and other organisations,

The following are other issues discovered on the ground: -

1. Personnel (Head, Deputy and two Technicians) are currently available for general seed quality control activities at the main laboratory at SLARI headquarters. The others are at different outside stations away from the headquarters (Refer to appendix 7 for the list and their CVs). Generally, all personnel available have basic knowledge in seed testing and plant physiology which is important for effective seed testing.
2. Seed testing activities that had been going was being handled under the Seed Multiplication Project - a government entity that used to produce seed as well. The laboratory seed testing activities had been mainly on rice, vegetable seeds and to some extent, root and tuber crops (in terms of seed health).
3. There is adequate space for seed testing activities (excluding seed health testing) at Sierra Leone Agricultural Research Institute (SLARI) and this has been earmarked to be the main seed testing laboratory.
4. Various pieces of laboratory equipment purchased for SLARI headquarters laboratory and outside stations had been received. The equipment was received in March 2012 and that meant for satellite laboratories is still in boxes awaiting delivery to respective stations.
5. Only one portable germination chamber is available at the main laboratory and requires the use of distilled water for effective operation (according to equipment's operating instruction guides)
6. Sand (especially river sand), as a cost effective germination substrate for most crop seeds such as rice, maize, groundnuts and beans is highly available.

4.0 INTERNATIONAL PROCEDURES IN SEED TESTING

The ISTA is one of the associations established in order to promote uniform seed testing internationally. ISTA's current mission is to develop, adapt and publish standard procedures for sampling and testing of seeds, and to promote uniform application of these procedures for evaluation of seeds moving in international trade. The need for seed testing methods that are reliable and reproducible among its accredited member laboratories is therefore a basic need for ISTA.

The primary aim of ISTA Rules is to provide testing methods for seeds designated for growing of crops or production of the plants. In addition, most of the testing methods can also be applied for evaluation of the quality of seeds used as food or for technical purposes.

The ISTA's seed sampling and testing methods have been developed by its members since its formation in 1924. ISTA also recommends that the ISTA Rules be used by all seed testing laboratories (including non – ISTA member laboratories) when testing seed for trade transactions which do not require the use of an ISTA certificate (e.g. within a country) and for the enforcement of national laws for the control of seed quality.

The three aspects of the ISTA Rules that are considered to be the most important are:

- Sampling (warehouse and laboratory)
- Purity analysis
- Germination test.

5.0 STANDARD PROCEDURES FOR MANAGING A SEED TESTING LABORATORY

5.1 SEED SAMPLING

The first step in managing the seed testing laboratory, starts with seed sampling management. Sampling forms a very significant link between seed inspections and seed testing, therefore the importance of correct sampling in the seed certification process cannot be overemphasized. Indeed laboratory test results will represent the entire seed lot from which the sample has been drawn only when sampling has been correctly and properly carried out. The ISTA attaches so much importance to both seed sampling and testing methodologies.

5.1.2 Objective of seed sampling

To obtain a sample of a size suitable for tests, in which the probability of a constituent being present is determined only by its level of occurrence within the seed lot.

The fundamental problem in seed sampling is that it is practically impossible to obtain a perfectly uniform seed lot. If this were possible, it would be sufficient to take a single small sample from the most convenient point. But since this is not the case, it becomes imperative that sampling techniques are devised that can be relied upon to give samples that as much as possible represent the seed lot, provided the seed lot is homogeneous (Refer to appendix 8 for sampling procedures)

5.1.3. Tools for Seed Sampling

The following are the tools that may be used for seed sampling.

1. Sleeve Trier (for sampling seed in big containers)
2. Nobbe Trier (for sampling seed in relatively small containers such as bags)
3. Hand (recommended for sampling chaffy seed such as Rhode sgrass (*Chloris gayana*) or fragile seeds such as groundnuts)
4. Automatic Samplers
5. Cargo sampler (bulk sampler)

5.1.4 Seed lot uniformity

The seed lot to be sampled has to be uniform in terms of composition and size of containers and has to be arranged in such a way in order for the sampler to have access to each and every container.

The sampler cannot make any check for homogeneity in purity or germination, but he should try to check the uniformity on the basis of those characters he can evaluate under practical conditions. If heterogeneity is detected during sampling, sampling has to be stopped. The company or individual seed dealer could also ask for a heterogeneity test to be carried out according to the ISTA Rules and the result of this test dictates whether the seed lot can be sampled or not. Alternatively, the

seed dealer could withdraw the application for sampling and e.g. re-condition the seed lot and reapply for sampling after mixing or blending of the seed lot.

5.2 MAXIMUM SEED LOT SIZES

Maximum lot size has always been one of the basic requirements for seed lots for which an ISTA Certificate is issued and this is where even the issuance of national certificates in many cases is based. In the ISTA Rules 2012, maximum lot size is defined for specific groups of species, or even for single species, to take into account the seed properties as well as the seed trade practices. Since seed trade practices change with time, ISTA maximum lot sizes have also changed several times and will keep on changing. However, the principle to limit seed lot size has always been part of the ISTA sampling system. The ISTA maximum seed lot size is usually echoed by the OECD Seed Schemes, the EU Directives and several national regulations. The seed lot shall not exceed the quantity indicated in the ISTA Rules, subject to a tolerance of 5% (Refer to appendix 6)

Consignments that exceed these maximum sizes shall be sub-divided into separate, identifiable seed lots which do not exceed the maximum seed lot size. Maximum seed lot size is a precautionary measure to avoid heterogeneity in seed lots. The efficiency of this measure has been demonstrated in several scientific studies which indicate that with increasing lot size the heterogeneity of the lots increases proportionally

5.2.1 Preparation of a seed lot and conditions for sampling

At the time of sampling, the seed lot shall be as uniform as practicable. If there is documentary or evidence of heterogeneity, or the seed lot is found to be obviously heterogeneous, sampling must be refused or stopped. The containers must be labelled or marked before or just after sampling is completed.

The seed lot shall be arranged that each part of the seed lot is conveniently accessible.

5.2.2 Sampling Intensity

Sampling intensity is based on size of the seed lot and it refers to the **minimum** number of bags or containers of seed that should be sampled from a specific seed lot. For seed lots in bags or containers that are of uniform size and are 15kg to 100kg capacity (inclusive), the following is the minimum requirement:

- 1-4 containers, take 3 primary samples from each container.
- 5-8 containers, take 2 primary samples from each container.
- 9-15 containers, take 1 primary sample from each container.
- 16-30 containers, take 15 primary samples in total from the seed lot.
- 31-59 containers, take 20 primary samples in total from the seed lot
- 60 or more containers, take 30 primary samples in total from the seed lot

For seed lots in containers smaller than 15kg capacity, containers shall be combined into sampling units not exceeding 100kg, e.g. 20 containers of 5kg, 33 containers of 3kg or 100 containers of 1kg. For sampling purposes, each unit is regarded as one container and the sampling intensity prescribes for big containers will apply.

5.2.3 Procedure for sampling

5.2.3.1 Taking Primary Samples

- 1) When defining the number and/or the size of primary samples, the sampler needs to ensure that the minimum amount of seed required for the requested test(s) is sent to the seed testing laboratory and enough seed remains available for obtaining duplicate samples if requested. Primary samples must be of approximately equal size regardless of the method used.
- 2) When the seedlot is in containers or bags, the bags to be sampled shall be selected at random throughout the seedlot and the primary samples shall be drawn alternatively from the top, middle and bottom.
- 3) When the seedlot is in bulk, the primary samples shall be drawn from random positions and depths, using a sleeve trier.
- 4) In case of chaffy seeds such as most **pasture grasses** that are not free flowing, the primary samples may be drawn by hand. **Groundnuts, soyabeans, fussy cotton, beans** and similar crops may also be drawn by hand to avoid damage to the seed.
- 5) Before drawing primary samples from a seed lot, the seed sampler has to examine the seed lot to make sure that it meets the requirements as laid down in the ISTA Rules. The requirements are defined regarding marking, sealing, maximum size, homogeneity and presentation of the seed lot.
- 6) All primary samples are then thoroughly mixed into a composite sample from which a submitted sample can be drawn.

The information that should be recorded by the sampler include:

- a) the address of the applicant
- b) the date and place the sample was obtained,
- c) the size of the lot,
- d) the number and the size of the containers,
- e) the type of the container,
- f) the species,
- g) the variety name,
- h) the seed lot reference number,
- i) the name of chemical treatment if applied.

The seed sampler should sign the sampling form which then accompanies the sample that is submitted to the seed testing laboratory. The sampler is advised to remain with a copy of the sampling report for record keeping of what has been sent to the laboratory.

5.2.5 Marking and sealing

It is a basic requirement in seed testing that samples are identified unambiguously at any time. This means also that they can be related to the seed lot from which the seed originated, implying the seed lot itself must be physically identifiable by marking or labelling and sealing of the containers. Before starting to draw primary samples from a seed lot, the seed sampler has to check that all required equipment and material for sealing and marking/labelling are available. After sampling, each container of the seed lot must be sealed and marked or labelled according to the ISTA Rules. Where the seed lot is already sealed, the seed sampler has to check whether sealing fulfils the requirements. If the seal has to be broken for sampling, the containers must be re-sealed. The seed sampler therefore must ensure that appropriate tools and seals are available to re-seal the containers after sampling.

Within a national seed certification system, the necessity to seal the lot may depend on the stage in seed processing at which samples are drawn and if the lot is not obviously uniquely labelled or marked, sampling must be refused or the seed lot must be marked or labelled according to the requirement.

5.2.6 Despatch of submitted sample

The submitted sample must be marked with the same identification as the seed lot and must be sealed to minimise adulteration.

5.3 SAMPLE RECEPTION

Submitted seed samples are received by the Seed Analyst at the sample reception of the seed testing laboratory. Upon receipt, the samples are checked for the condition of the packaging material and sample weight is recorded. The submitted sample should meet the minimum prescribed weight in the current version of ISTA rules. Thereafter, the bags are opened and sampling reports are scrutinized. If submitted sample is below minimum prescribed weights, it is rejected and the sampler/client is informed immediately. A sample in *damaged* container is also not accepted and the supervisor or seed analysts at the reception requests for a fresh sample from the respective Sampler. Accepted submitted samples are registered in the seed-testing laboratory register.

The submitted sample is assigned a test number, for identification, which is written on both the sampling report and the container of the submitted sample (a sticker may be used to write on, and stick the test number onto the sample container).

Information on the sampling report is entered in the sample register book and electronic register at the reception (if available). The sampling report is filed in a sampling report file at the reception.

The laboratory test number is given and should be unique. The test number can bear a country code, year of testing and the laboratory serial number. For example, SL12/120, where SL stands for Sierra Leone, 12, the last two digits of the year of testing and 120 is the 120th sample to be tested by the laboratory in 2012.

The analysis card is created and should bear all the information from the sampling report except the name and address of the client. This is done in order not to create biasness in seed testing.

5.4 SEED SUB – SAMPLING

The objective of sub - sampling is to get minimum size working sample from the submitted sample, which is representative of the seed lot.

In using all sample reduction methods, the sampler/seed analyst is advised to aim at taking out a quantity representative (and slightly more than the required weight.)

One of the following methods must be used when sub sampling: -

- a) Mechanical divider method (Soil divider)
- b) Spoon method
- c) Hand halving method

5.5 SEED TESTING

The following are some of the seed quality tests carried out in the seed testing laboratory:

1. Moisture content
2. Analytical purity
3. Other seeds by number
4. Germination
5. Viability Test/TZ
6. Seed Vigour
7. Seed Health

It is entirely up to the nation to recommend which of the above tests can be compulsory for any seed lot to be certified. Usually, the first four tests are taken as compulsory and performed on freshly harvested and processed seed. The last three (Viability, seed health and Vigour) can be carried out on request.

5.5.1 Moisture content test

Moisture content is of importance to the processor and the store manager. It is the key factor in determining whether or not seed will retain its germination from harvest to sowing time. Moisture content is also important to the farmer – because any kind of damage reduces the possibility of good field establishment.

The sample for moisture content should be submitted in moisture proof container. The test is carried out in duplicate on two independently drawn working samples.

There are two types of moisture testing: -

- a) Moisture meters – this is a less accurate method
- b) Oven method – this is the standard method

When using the oven method, the loss of weight of a sample when dried under specific conditions is considered as the moisture content and is expressed as percentage by the initial weight. Moisture content is reported in percentage corrected to one decimal place.

5.5.2 Purity Analysis

Analytical purity indicates how much of the material in the lot is intact seed of species named on the label or being examined. The test is an important aspect of seed quality because it assesses the cleanliness of the seedlot. Seed must be without other impurities such as broken seed, soils, chaff and weeds etc.

In the analysis, impurities are separated from pure seed as follows: -

- a) Seed of other species
- b) Weed seeds and
- c) Inert matter (broken seed, chaff, pieces of leaves, soil particles etc).

When separation is completed, all individual components including pure seed is weighed and expressed as percentage by weight of the whole sample using the following formula:

$$\frac{\text{Weight of Pure Seed component}}{\text{Total weight of components}} \times 100$$

NOTE: The percentages are calculated out of the total weight of components and not the original weight of working sample. The nature of the impurities has to be taken into consideration as well.

5.5.3 Other Seeds Determination

Other seeds refer to species other than those under test. The sample examined for analytical purity is relatively very small e.g. in wheat – 120g. There might be impurities present in a seedlot, which may be at too low a level to be detected in the purity analysis. These impurities could therefore, not be detected while at the same time a farmer may be sowing in excess of 100 seed of these impurities

The number of seeds found for each species sought is counted. The result is then expressed as the number of seeds on the weight of seed examined e.g. 2 per kg

5.5.4 Germination test

Germination in a laboratory test is the emergence and development from the seed embryo, of those essential structures which make up the seedlings and which indicate the ability to develop into normal plants under satisfactory conditions in the soil.

Although the test cannot precisely forecast field emergence, it indicates that under certain set conditions, a seedlot of relatively high quality will emerge better than a seedlot of lower (poor) quality.

400 seeds are planted in replicates of 25, 50 or 100 (depending on crop species) in rolled paper towelling, sand or top of paper and put in walking germination rooms, incubator or table germinators for a specific period as stipulated in ISTA Rules for seed testing.

The germination test is evaluated into: -

- a) **Normal seedlings:** - Show the capacity for continued development into normal plant when grown in soil with favourable conditions. Normal seedlings are completely intact or have slight defect or secondary infection.
- b) **Abnormal seedlings:** - These seedlings do not show the capacity to develop into normal plants when grown under favourable conditions. Abnormal seedlings may have one or a combination of defects on essential structures, deformed or unbalanced structure, and diseased or decayed due to primary infection.
- c) **Hard seeds:** - These remain hard after a germination test meaning that they are not able to imbibe water under favourable conditions. “This is associated with dormancy in seed and prominent in legume seeds. With time they are able to break the dormancy and germinate and so are treated as viable seeds.”
- d) **Fresh seeds:-** These seeds imbibe water but remain firm and apparently viable after a germination test but unable to develop further (dormancy). This phenomenon is associated with grass and cereal seeds.
- e) **Dead seeds:-** These show no sign of development – usually look soft, discoloured or rotten.

The results of a germination test are given as a percentage by number of normal seedlings, abnormal seedlings, hard seeds, fresh ungerminated and dead seeds. The higher the percentage of the normal seedlings, the better is the field establishment.

5.5.5 Viability Test

Seed viability is a measure of whether seed is alive or dead. It is designed to estimate the percentage viability of the seed sample and by inference of the seed lot. This is a Rapid Test developed to assess Viability using Tetrazolium (TZ) salt.

The TZ test is based on the principle that respiration processes, which are active within viable tissues and not dead tissues, involve a group of enzymes, which catalyze chemical reductions. These enzymes are collectively called Dehydrogenase. The hydrogen released during respiration within the viable tissues of seed combine with the colourless Tetrazolium solution to form a red colour within the tissues.

Viable seeds relate to those that are capable of producing normal seedlings in a germination test under favourable conditions, after dormancy has been broken, and, if diseased, after the seed has been properly disinfected.

At end of the evaluation, the results are reported in two categories

- ✓ % Viable seeds
- ✓ % Nonviable seeds

5.5.6 Seed Vigour

Vigour indicates the ability of a seedlot to establish seedlings in poor conditions. ISTA defines seed vigour as “the sum total of those properties of the seed which determine the activity and performance of the seedlot during germination and seedling emergence” related to the deterioration, which occurs in seedlot as it ages, not necessarily in time, but in its ability to carry out all the physiological functions that allow it to perform.

A number of tests have been developed internationally such as the radical emergence test for maize and conductivity test for peas.

The primary objective of such tests is to indicate to the seed purchaser, or seed storage manager, whether or not trouble may be expected from a high germinating seedlot if placed under environmental stress in the field, in storage or during transit.

Evaluation of results for vigour tests is mainly classified between vigorous and non-vigorous seedlings.

5.5.7 Seed health test

Seed certification schemes in many countries are formulated to ensure that seed offered for sale contains the true characters of the variety and also conforms to acceptable levels of mechanical purity and potential germination. They usually prescribe different aspects of seed quality to be inspected and tested. Assessment of the health status of seeds needs both **field inspection and laboratory testing**.

Determination of seed quality in a seed health-testing laboratory is important: -

- For evaluation of planting value of the seed lots. Laboratory detection of the absence or presence of micro-organisms can help to predict field performance of seed samples relative to emergence and disease produced in the next generation, including expected losses. A seed lot may be downgraded basing on the infection percentages of a given pathogen. Infected seed samples may be rejected for planting.
- Determining whether or not seed lots should be treated with a fungicide or other treatment based on the nature and degree of seed infection.
- For determination of the quality of chemical seed treatments, especially for seed moving in international markets. Treated seed is tested to establish the health condition of the seed and to evaluate the capacity of the germicide to destroy pathogens.

Using incubation procedures in the laboratory, seeds are given the best possible conditions for the pathogens to show up, such that adequately conducted laboratory seed health testing yields reproducible results in reflection of the actual health condition of a given seed lot.

5.6 REPORTING OF TEST RESULTS AND VALIDITY

After all the tests are done, the test results are entered on the analysis cards. Information on the analysis card is used to prepare seed analysis certificates. The test number at this stage becomes the certificate number.

6.0 CHALLENGES TO EFFECTIVE IMPLEMENTATION OF INTERNATIONAL STANDARDS AT SLARI SEED TESTING LABORATORIES

Even though the Ministry of Agriculture, Forestry and Food Security (MAFFS) is eager to establish the seed testing laboratory and start the seed testing activities according to international standards, the following are some challenges that may hinder effective and efficient laboratory seed testing activities: -

1. Some of the pieces of equipment purchased so far is not suitable and adequate for seed testing (refer annex 1 for details)
2. Some basic pieces of equipment needed for seed testing and seed health testing have not been procured (Refer to annex 2 and 3 respectively for details of recommended basic equipment)
3. Staffing levels are not adequate, especially at the main laboratory at SLARI, for effective seed testing (including seed health testing)
4. Distilled water needed for effective functioning of the germination chamber may not be easily found in the country or may even be expensive.
5. Lack of sand sterilizer may hamper effective seed testing. This piece of equipment is needed to sterilize the sand as most of the seed testing for germination will be in sand. Appropriate type of paper substrate (rolls or sheets) may be difficult to obtain on a sustainable basis due to the cost implications.

7.0 CONCLUSION

Despite the challenges noted, limited seed testing activities such as purity analysis, germination test and moisture content (on species that do not require grinding before moisture content is measured such as onion, carrot, and millets) can commence with the available staff and pieces of equipment.

8.0 RECOMMENDATIONS

The following needs to be considered for effective seed testing activities and to enable the laboratory aspire for ISTA accreditation: -

1. To purchase, fix and maintain airconditioning system in the walk – in germination room. This will maintain temperature and humidity in the room at acceptable levels according to international standards.
2. Procure other necessary pieces of equipment that is missing. There is also need for sand storage room to be located closer to the laboratory.
3. To consider purchasing latest versions of ISTA hand books for reference. E.g.
 - ISTA Rules for Seed Testing
 - Purity test handbooks
 - Seedling evaluation handbooks
 - Moisture content test handbooks
 - Seed identification handbook
 - Seed Health testing hand book (Annexe to ISTA Rules)
4. Consider increasing manpower at SLARI headquarters seed testing laboratory. (One Supervisor for seed testing activities, Two Seed Analysts and a Laboratory handyman would be adequate to conduct the seed testing activities mentioned in this report, except for seed health testing)
5. The policy of SQCU should be to offer quality seed services in accordance with the international rules and standards for seed testing. The available trained and qualified personnel under the SQCU is an added advantage in ensuring quality seed testing services. However, these officers will need regular reorientations as seed technology is quite dynamic.
6. Qualified and well-trained personnel and motivated are essential for producing quality analytical results. All staff to be employed should have a qualification in an Agricultural related field and more especially in crop science. In addition, the seed analyst responsible for seed health testing should have knowledge in seed health testing.
7. Some pieces of equipment such as the germination chamber will be running throughout the day and night, therefore, there is need for constant supply of electricity to the laboratory. It is recommended that a standby generator be procured for the seed testing laboratory.
8. Initial steps must be taken to affiliate the seed testing laboratory to the International Seed Testing Association (ISTA).

9.0 APPENDIXES

Appendix 1: Terms of Reference

Appendix 2: List of equipment received

Appendix 3: List of recommended basic equipment for seed testing

Appendix 4: List of basic equipment/materials for seed health testing

Appendix 5: Maximum Seed Lot sizes

Appendix 6: Seed laboratory floor plan

Appendix 7: List of available staff with their CVs

Appendix 8: Standard Operating Procedures for seed sampling and seed testing

Appendix 9: Equipment Operating Guides for pieces of available equipment

Appendix 1: Terms of Reference



Food and Agriculture organization of the United Nations Terms of Reference for Consultant/PSA

| | | | |
|---|----------------------------|------------------|-----------------------------|
| Name: | Mable Simwanza | | |
| Job Title: | Seed Testing Consultant | | |
| Division/Department: | FAO/AGP | | |
| Programme/Project Number: | GCP/SIL/032/GER | | |
| Location: | Freetown in Sierra Leone | | |
| Expected Start Date of Assignment: | Upon signature of contract | Duration: | 21 days on WAE basis |
| Reports to: | <i>Name:</i> Thomas Osborn | <i>Title:</i> | Senior Agricultural Officer |

General Description of task(s) and objectives to be achieved

The NSS will be structurally and functionally differentiated into two units: the Seed Industry Development Unit and the Seed Quality Control Unit which together will fulfil the mandate of the NSS in carrying out the required responsibilities for seed quality control including laboratory seed testing, field inspections and seed trade monitoring; variety release and registration; facilitation of NSB and VRC activities; and seed industry development activities. To ensure consolidation and sustainability of the sub-units of NSS, they will be established progressively over time as the required resources are made available. The establishment of an independent Seed Quality Control Unit under SLARI during the implementation period of this project is deemed as first priority in order to delink the commercial interests in seed production and marketing from the regulatory aspects. It has therefore become important that international procedures for seed testing are inherently mainstreamed in the establishment of the SQU using the procured equipment. This transition is supported by the Seed Enterprise Enhancement and Development (SEED) project, which is funded by the Government of Germany and implemented by the FAO.

Overall objective of the assignment: to systematically assess and pre-test the procured laboratory equipment and train the laboratory technicians in the application of ISTA rules and procedures for conducting the mandatory and other seed quality tests.

Tasks: Under the direct supervision of the FAO Representative through the Project Team Leader and the Lead Technical Officer for Component 3 of the SEED project, and in close collaboration with the relevant national counterparts, especially the Head Seed Quality Control Unit and laboratory technicians, the consultant will carry out the following tasks:

- 1) Establish a function plan for the laboratory so that it can operate in the most efficient way.

- 2) Layout the procured laboratory equipment to international standard and pre-test the functionality of the equipment.
- 3) Develop procedures for each of the required compulsory tests that include germination, physical purity, moisture content and other seeds according to International Seed Testing Association (ISTA) rules.
- 4) Develop procedures for other often requested seed testing aspects including seed health and seed vigour.
- 5) Provide practical training for each procedure with the laboratory personnel to improve human skills in seed testing.
- 6) Recommend any addition supplies and equipment that is needed and human capacity building required to aspire for ISTA accreditation.
- 7) Establish the seed laboratory management system with the required paper trails for seed sampling and testing procedures and reporting.
- 8) Establish the seed lot sizes for efficient seed sampling as per ISTA rules.

Output

- 1) Develop a report in hard and soft copy that describes the procedures for conducting each seed testing aspect with the procured equipment, seed lot sizes, seed sampling procedures and the required paper trails for managing a seed testing laboratory. The report should also highlight equipment and human capital gaps if any to aspire for ISTA accreditation.
- 2) Develop a report in hard and soft copy of the minimum standards for seed testing so that they can be included in the draft Seed Regulations to support the Seed Law.
- 3) Develop a report in hard and soft copy of the training manual in seed testing for seed analysts.

key performance indicators

| Expected Outputs: | Required Completion Date: |
|--|---------------------------|
| - Lay out of the seed testing laboratory. | - 14 days WAE from EOD |
| - Draft reports (soft copy) as described above ; | - 18 days WAE from EOD |
| - Presentation of the draft reports to a group of project stakeholders (SQCUC, NSS and FAO): | - 19 days WAE from EOD |
| - Final reports in hard and soft copy | - 21 days from EOD |

Appendix 2: List of Laboratory Equipment Received and suitability

| LIST OF LABORATORY EQUIPMENT RECEIVED AND SUITABILITY | | | | | |
|--|---|---|-----------------------------|--------------------------------|--|
| QTY | NAME OF ASSET | SEED MULTIPLICATION /REARCH CENTRE | SEED INSPECTION UNIT | SEED TESTING LABORATORY | REMARKS |
| 3 | Seed Germinator single chamber | | | X | Ok |
| 3 | Rice Sheller | X | | | Ok |
| 3 | Seed Blower (Dakota type) | X | | | Not appropriate for seed testing laboratory |
| 61 | Plastic Bags: Table Top Hand Sealer | X | X | | Not for seed testing activities |
| 120 | Petri Dishes | | | X | Ok |
| 300 | Beakers- 100ml,50ml | | | X | Ok |
| 100 | Glass Cylinders 500ml, 100ml,50ml, 10ml,5ml | | | X | Ok |
| 6 | Riffle type Divider with 4 Pans | | | X | Ok |
| 100 | Filter Paper | | | X | Ok |
| 90 | Test Tube Stand Wooden with Plastic side supports | | | X | Ok, for seed health testing |
| 12 | Hand Tally Counter | | X | | Ok |
| 30 | Forceps | | | X | Ok |
| 30 | Spatula Plastic | | | X | Ok |
| 6 | Measuring Tap | | X | | Ok |
| 60 | Sample Container | | | X | Ok. But appropriate for oven method and need to be lettered on both lid and bottom with similar number each set. |

| | | | | | |
|-----|-------------------------------|--|----------|----------|--|
| 3 | Desiccator | | | X | Ok. Requires silica gel & suitable for oven method MC testing |
| 6 | Stereoscope Microscope | | | X | Ok. For both seed health and purity analysis |
| 9 | Purity Work board | | | X | Ok |
| 150 | Seed Sample Pan | | | X | Ok |
| 12 | Seed Trier | | X | | Ok |
| 12 | Seed Probe | | X | | Ok |
| 3 | Magnifier Lamp | | | X | Ok |
| 3 | Steel Trolley? | | | X | Ok |
| 3 | Quick Seed Moisture Tester | | X | X | Ok. Though not suitable for some crops like maize and rice that require grinding |
| 3 | Top Loading Balance | | | X | Ok |

Appendix 3: Basic minimum equipment recommended for a seed testing laboratory

| BASIC MINIMUM EQUIPMENT FOR A SEED TESTING LABORATORY | |
|--|--|
| ITEM | SPECIFICATION/DESCRIPTION/USE |
| Purity equipment | |
| Binocular Stereo Microscope | Minimum magnification 8x, maximum 40x, eye piece 10x |
| Balances | Precision, $\pm 2000g$ with 2 decimal place |
| | Analytical, $\pm 200g$ with 4 decimal places |
| Calibration weights | 5 weights max. 1kg, min. 0.5g |
| Seed blower (Cambridge type) | Power: 220-240 V, 1ph, 50Hz. Gross Weight-25 kg, dimensions, mm-380, 235, 860 + spare glass tube |
| Seed Divider | Boerner/Soil/Centrifugal/Riffle |
| Sampling pans/trays | Several types of pans, wide metal trays |
| Seed scoops, scalpels, spatulas, containers for the purity | Set |
| Work board | For purity analysis |
| Sieves – A set of 36 | Set with different mesh sizes. (200mm brass with stainless steel mesh, aperture 38microns to 16 mm diameter, + lid and receiver |
| Seed Collection | With minimum of ISTA Universal species to aid in seed identification during purity analysis |
| Germination Testing | |
| Incubation apparatus | |
| - Walk –in germination chambers | Walk in germinator with options to control temperature (20 – 30 degrees) |
| - Table germinators | Temperature Range °c 10-50, Heating power-750W, Cooling power-450W, Over temperature protection-adjustable resettable cutout, Electrical power, 220-240V 50 Hz: 1.2 kW, Dimensions (L x W x H) mm. Tank-1220 x500 x 65, Support Frame-1220 x 500 x812, Glass Plates-495 x90 x 6. |
| - Growth chamber | Growth chamber, with light, 400L (alternating temp) |
| - Incubator | Incubator, 700L (constant temp) |
| Pre-chilling | -5 – 10°C, 200L |
| Germination containers | To hold the germination substrates - sand or paper substrate |

| | |
|---|--|
| Forceps, syringes, beakers, Petri dishes, scissors, | Several sets |
| Germination paper | Anchor circles (90 mm & 125 mm) or rolls. |
| Sand | River sand of right particle size (as in ISTA rules) |
| Sand Sterilizer | With adequate space and heating capacity up to 200 degrees centigrade. Used for sterilizing sand |
| Propagator/Germination Trays | Planting trays with transparent lid covers, Dimensions mm-375x 240 x 55 |
| Moisture Test | |
| Laboratory oven | ± 100L (constant temp type) |
| Grinding mills and discs | Operation –Direct Drive, capacity-50 g in 10-15 seconds, Dimension, (h x d x l), mm-560 x 445 x 220, Disc diameter, mm-3 phase, 100 watt input, 600 watt output, Noise output, DB-100, Power-single phase 230 V, 50 Hz, Net weight-34 kg. + Grinding discs, Fine, Medium and Coarse. |
| Desiccators | Knob lid, Borosilicate glass, lid and perforated disc, diameter mm-300. + Silica Gel |
| Calibration equipment for germinators | Thermometers, data logger |
| Moisture meters | Portable types – for instant moisture content testing |
| Moisture Content tins | Circular Tins, - aluminum; 55mm x 35mm + lids lettered /number top and bottom |
| ISTA handbooks | Various – for purity test, germination, seedling evaluation, weed identifications, etc. |

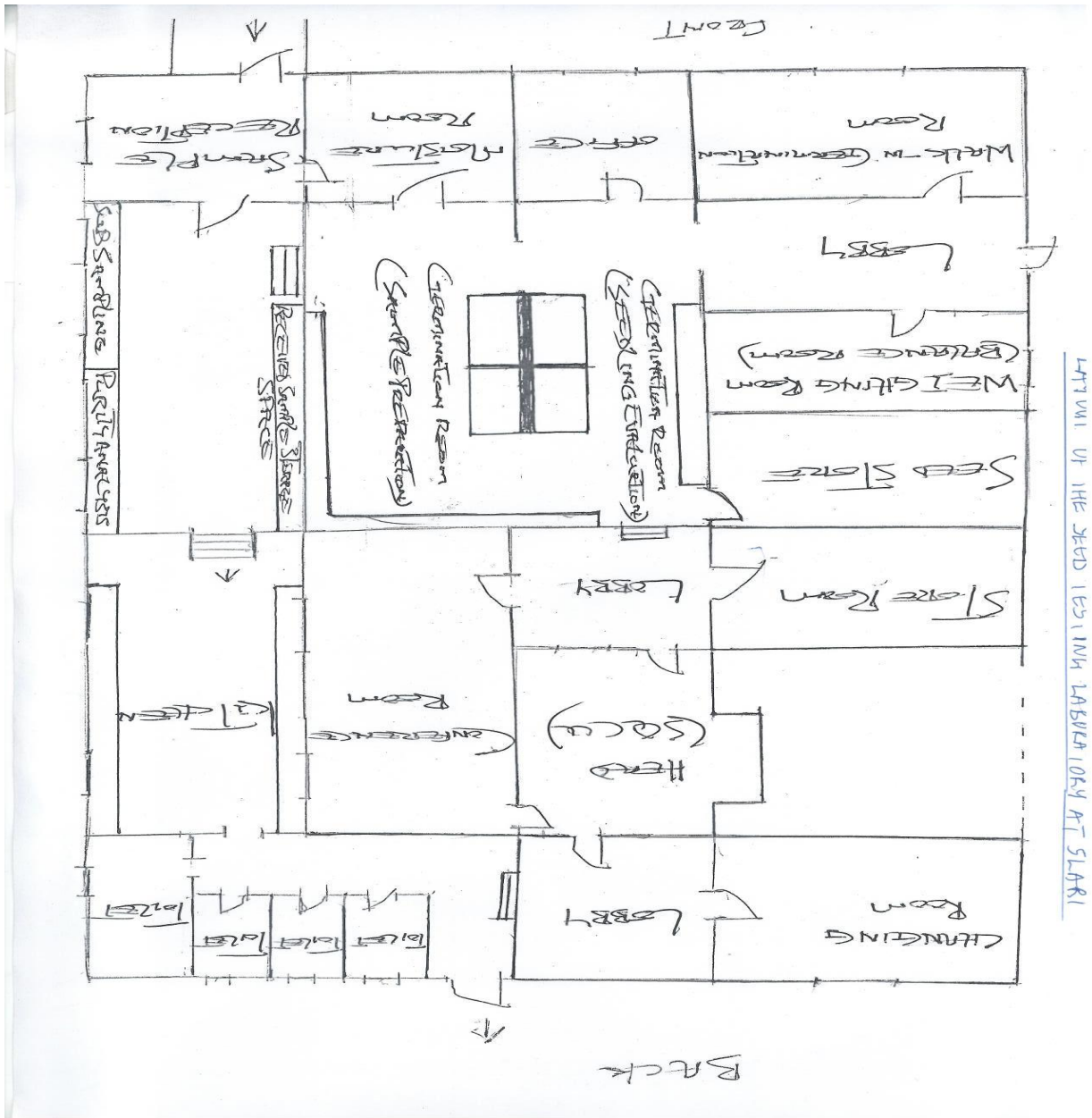
Appendix 4: Recommended basic minimum equipment and materials for laboratory seed health testing

| BASIC MINIMUM EQUIPMENT / MATERIALS NEEDED FOR LABORATORY SEED HEALTH TESTING | |
|--|---|
| ITEM | SPECIFICATION/DESCRIPTION/USE |
| Reference materials | Handbooks on various seed -borne pathogens The use of reference cultures or other appropriate materials is recommended |
| Substrate | Blotters or filter papers, 9.0cm, circular (e.g. Whatman No 1 or equivalent), free from microorganisms and inhibitors 3 per plate. |
| Plates | 9.0 cm sterile Petri dishes (One plate for 10 seeds) |
| Incubator | Operating at $20 \pm 2^{\circ}\text{C}$, equipped with timer – controlled Near Ultraviolet lights (NUV, peak at 360nm, e.g. color number 08, Philips, Sylvania) |
| Freezer | Operating at $-20 \pm 2^{\circ}\text{C}$ |
| Reagents | Basic reagents such as Nutrient Agar, Malt Agar, Glucose Agar, V-8 agar, Ethanol, Sodium hypochlorite for fungal and bacterial detection ELISA Reader and printer, ELISA kit for the specific virus to include: capture and detection antibodies, Enzyme conjugates, buffers (coating, washing, substrate and extraction) Micropipettes and micropipette tips, 96-well microtiter plates for virus detections. |
| ISTA handbooks | Annexe to Chapter 7 of ISTA Rules for Seed Testing (<i>Seed Health Testing Methods</i>) |

Appendix 5: Maximum seed lot sizes (in general terms) as recommended under ISTA

| MAXIMUM SEED LOT SIZES AS RECOMMENDED UNDER ISTA | | |
|--|---|---|
| Crop species | Nominal size | Plus 5% tolerance |
| Maize (<i>Zea mays</i>) | 40,000 kg | 42,000 kg |
| Cereal seed and seed larger than cereal seed (e.g. wheat, groundnuts, rice, soyabeans, barley, beans, peas, sorghum, etc.) | 30,000 kg | 31,500 kg |
| Cotton, Sunflower, | 25,000kg | 26,250kg |
| Seed the size of cereal seed (other than cereal seed) e.g. pigeon peas, | 20,000 kg | 21,000 kg |
| Seed smaller than cereal seed (e.g. onion, sunhemp, watermelon, tomato, etc.) | 10,000 kg | 10,500 kg |
| Large seeded tree species (e.g. <i>Corylus avallana</i>) | 5,000 kg | 5,250 kg |
| Small seeded tree species | 1,000 kg | 1,050 kg |
| Large seeded flower species (e.g. <i>Helianthus debilis</i>) | 10,000 kg | 10,500 kg |
| Small seeded flower species | 5,000 kg | 5,250 kg |
| Coated seed | 1,000,000,000 units but not more than 40,000 kg | 1,050,000,000 units but not more than 42,000 kg |

Appendix 6: SKETCH OF SEED LABORATORY FLOOR PLAN



Appendix 7: AVAILABLE PERSONNEL FOR SEED QUALITY CONTROL UNIT

| NO | NAME OF OFFICER | JOB TITLE | CV | STATION |
|-----------|--------------------------|--------------------------|---|--------------------|
| 1. | Mrs. Annie Kallon | Head of Unit | <ul style="list-style-type: none"> - 60 years old - MSC in Plant Physiology - BSC in Plant Science, Biology and Chemistry - Diploma in Seed Pathology - Certificate in Seed Testing - Certificate in General Agriculture - Experience in seed multiplication, seed health testing, seed testing, research, project proposal writing, rapid multiplication of planting materials, training and administration | SLARI Hq, Freetown |
| 2. | Mr. Edward Ojo Dixon | Laboratory head | <ul style="list-style-type: none"> - 48 years old - Form V - BSC in General Agriculture - Knowledge in seed testing - Experience in seed multiplication, production, marketing, field inspections/supervision and administration | SLARI Hq, Freetown |
| 3. | Mr. Edward Ahmed Kalokoh | Seed Analyst | <ul style="list-style-type: none"> - 47 years old - Form V - Diploma in Agriculture (Agronomy) - Experience in seed multiplication - Experience in field inspections, sampling and hands on in seed testing activities (genetic purity, analytical purity, germination, seed vigour, moisture content test, seed health) | NARC - Njala |
| 4. | Mr. Abdul Rahman Fofie | Laboratory Superitendant | <ul style="list-style-type: none"> - 30 years old - Form V - Certificate in General Agriculture - Diploma in General Agriculture - Certificate in Seed Quality Assurance and Seed Enterprise Quality Management - Experience in conducting field trials, seed | RARC – Rokupr |

| | | | | |
|-----|-----------------------------|-----------------------------|---|--------------------|
| | | | <p>multiplication of breeders and foundation seeds</p> <ul style="list-style-type: none"> - Experience in hands on in seed testing activities (genetic purity, analytical purity, and germination and moisture content tests. | |
| 5. | Ms. Patricia Mbalu Nicol | Secretary/Typist | <ul style="list-style-type: none"> - 54 years old - Form V - Certificate in Business Management and Administration - Diploma in Business Management and Administration - Certificate in Computer studies | SLARI Hq, Freetown |
| 6. | Mr. Ernest G. Kamara | Laboratory Officer | <ul style="list-style-type: none"> - 44 years old - Form V - M.Sc Seed Science and Technology - M.Sc Crop Science - B.Sc Education (Biological Sciences) - Experience in Seed Quality Assurance and Seed Enterprise quality Management - Experience in Maize seed Production and Marketing - Experience in Agricultural Research and Science Methodology | NARC – Njala |
| 7. | Ms. Aminata K. Turay | Field /Laboratory Assistant | <ul style="list-style-type: none"> - Data not given | RARC – Rokupr |
| 8. | Mr. Issa Sesay | Field /Laboratory Assistant | <ul style="list-style-type: none"> - Data not given | RARC – Rokupr |
| 10. | Ms. Tikidankay C. Y. Kallon | Field /Laboratory Assistant | <ul style="list-style-type: none"> - Data not given | RARC – Rokupr |
| 11. | Mr. Micheal P. Lebbie | Field /Laboratory Assistant | <ul style="list-style-type: none"> - Data not given | NARC – Rokupr |
| 12. | Mr. George V. Puvande | Field /Laboratory Assistant | <ul style="list-style-type: none"> - Data not given | NARC – Njala |
| 13. | Ms. Fatmata Abass | Accounting | <ul style="list-style-type: none"> - Data not given | RARC – Rokupr |

| | | | | |
|-----|-------------------|---------------------------|--|--------------------|
| | Kamara | Assistant | | |
| 14. | Mr. Samuel Munu | Seed Laboratory Assistant | <ul style="list-style-type: none"> - 39 years old - Form V - Certificate in Agriculture - Diploma in Agriculture | Makeni |
| 15. | Mr. Alex Conteh | Seed Laboratory Assistant | <ul style="list-style-type: none"> - Data not given | Makeni |
| 14. | Ms. Mary Bongay | Accounting Assistant | <ul style="list-style-type: none"> - Data not given | NARC – Njala |
| 15. | Mr. Sorie Bangura | Laboratory Handyman | <ul style="list-style-type: none"> - Data not given | SLARI Hq, Freetown |

Appendix 8: STANDARD OPERATING PROCEDURES FOR SAMPLING AND VARIOUS TESTS

| STANDARD OPERATING PROCEDURE 1. SEED SAMPLING | | |
|---|--|---|
| | PROCEDURE FOR SEED SAMPLING Page 1 of 2 | Purpose: To obtain a representative sample in an effective, unbiased and timely manner. |
| | Step | Procedure |
| 1 | Sampling tools: | A seed lot is sampled using a nobble or sleeve trier or by hand. Primary samples are collected in a transparent bucket and submitted sample packed in <i>breathable</i> containers (cotton <i>or</i> paper bags). |
| 2 | Sampling notes | Seed sampling is done in accordance with International Seed Testing Association (ISTA) rules and procedures. The seed sampler must first identify the seed lot and obtain information such as the applicant; origin, species, variety, size of the lot, type of chemical treatment and laboratory tests required. |
| 3 | Seed lot arrangement | Sampler ensures that the applicant or seed grower has arranged a seed lot to be sampled in such a way that each individual container is easily accessible to the sampler |
| 4 | Seed lot identification | The Sampler establishes size and identity of the seed lot. Where the seed lot does not have an identity the Sampler allocates <i>a</i> seed lot number. Every year <i>a</i> sampler is allocated a range of seed lot numbers. The lot numbers are coded as follows: for example the year 2013 bears the lot numbers starting with twelve '12'. For example sampler number 1 with serial numbers 001-200, the first lot number will be 12001. Sampler number 17 with lot numbers 2201-2250 would have the following range of lot numbers 122201-122250. The first digit being the year the seed lot was provided with that identification number (lot number). |
| 5 | Sampling intensity | After establishing the size of the seed lot, a sampler determines the sampling intensity in accordance with current version of ISTA rules as follows; 1-4 containers: Take three (3) primary samples from each container 5-8 containers: Take two (2) primary samples from each container 9-15 containers: Take <i>one</i> (1) primary sample from each container 16-30 containers: Take <i>fifteen</i> (15) primary samples in total from the seed lot 31-59 containers: Take <i>twenty</i> (20) primary samples in total from the seed lot 60 or more containers: Take <i>thirty</i> (30) primary samples in total from the seed lot |

| | | |
|---|--------------------------------------|--|
| 6 | Sampling intensity for small packets | For seed in small packages such as tins and cartons the following procedure is recommended. A 100 kg weight of seed is taken as a basic unit and the smaller packages are combined to form sampling units not exceeding this weight e.g. 20 packages of 5 kg, 33 packages of 3 kg or 100 packages of 1kg. For sampling purposes each unit is regarded as one container and the sampling intensity as described above is applied. |
| 7 | Sampling report | Carefully fill in the sampling report. Provide the original copy of the sampling report to the applicant while a duplicate is put into the container of the sampled seed. A sampler retains the third copy. |
| 8 | Dispatch of submitted samples | Primary samples are bulked to form a composite sample which is sent to the seed testing laboratory within 48 hours of sampling. The sample is reduced into appropriate submitted sample size in accordance with ISTA Rules. Each sample is marked or labeled for future identification of the seed lot. |
| 9 | Important for noting | The seed lot must be uniform and of the size not exceeding the maximum prescribed seed lot weight of the species in question. However, a tolerance level of 5% is acceptable. The lot must be in bags or containers that are self sealing (or capable of being sealed) and labeled and marked with a seed lot number. The submitted sample is sealed, handled gently and submitted to seed testing laboratory within 48 hours of sampling. A Sampler is answerable should a primary, composite, unsealed samples or seals come into the hands of unauthorised persons. Failure to adhere to these conditions may result in disciplinary action that may include withdrawal of the sampling seed lot numbers. |

| | | |
|---|--------------------------------|--|
| STANDARD OPERATING PROCEDURE 2. SEED SAMPLE RECEPTION | | |
| | PROCEDURE FOR SAMPLE RECEPTION | Purpose: To ensure effective and timely registration of submitted seed samples |
| Step | Procedure | |

| | | |
|---|------------------------------------|--|
| 1 | Reception of submitted samples | Submitted seed samples are received by the Seed Analyst at the reception. Upon receipt, the samples are checked for the condition of the packaging material and sample weight. The submitted sample should meet the minimum prescribed weight in ISTA rules. Thereafter, the bags are opened and sampling reports are scrutinized. A sample in <i>damaged</i> container, is not accepted and the Seed Analyst at the reception should request for a fresh sample from the respective Sampler. Accepted submitted samples are registered with the seed-testing laboratory. |
| 2 | Registration of a submitted sample | The submitted sample is assigned a test number, for identification, which is written on both the sampling report and the container of the submitted sample (a sticker may be used to write on, and stick the test number onto the sample container). Information on the sampling report is entered in the sample register book or electronic register at the reception. The sampling report is filed in a sampling report file at the reception. The laboratory test number bears a country code, year of testing and the laboratory serial number. For example, SL12/10, where SL stands for Sierra Leone, 12, the last two digits of the year of testing and 10 is the 10 th sample to be tested by the laboratory that year. |
| 3 | Use of the analysis card | The analysis card bears all the information from the sampling report except the name and address of the client to protect identity. After all tests are done, the test results are entered on the analysis cards. Information on the analysis card is used to prepare seed analysis certificates. The test number at this stage becomes the certificate number. |

STANDARD OPERATING PROCEDURE 3. SEED SUB-SAMPLING

| | | |
|---|---------------------------------|--|
| | PROCEDURE FOR SEED SUB-SAMPLING | Purpose: To obtain a representative working sample for various laboratory tests. |
| | Step | Procedure |
| 1 | Mechanical halving method | This method is applicable to all kinds of seed except for very chaffy seed in accordance with the current ISTA rules. From the sample reception the analysis card with a respective submitted sample is carried to the laboratory <i>sub</i> -sampling section. The working tables and divider are thoroughly cleaned. The submitted sample is then poured either into the receiving funnel or hopper depending on the seed species being worked on. The valve is released in case of the conical divider and for the soil divider the hopper is swung over the receiving channels. |

| | | |
|---|----------------------|--|
| | | Seed is collected into two collecting pans for both equipment. One of the receiving pans is removed and seed is poured back in the hopper for 3 times to ensure thorough mixing. Halving continues until the working sample weight prescribed for that particular crop species is obtained. The weighed working sample is poured into a working container (plastic plates/boxes) with an analysis card on top ready for the test. To obtain the approximate prescribed working sample size, up to 2% may be added during the sub-sampling process. The weight of the working sample is counter checked by repeated weighing on a balance. |
| 2 | Hand halving method: | <p>This method is applicable to chaffy seed in accordance with the current ISTA rules.</p> <p>From the sample reception the analysis card with a respective submitted sample is carried to the laboratory <i>sub</i>-sampling section.</p> <p>The working tables and divider are thoroughly cleaned. The sample is then poured onto the table and made into a mound using a flat edged spatula and hands. Thereafter the mound is divided into two (2) halves and each half is divided again and the four- (4) portions are re-divided to have eight (8) portions in total. The eight portions are in two rows of four. Alternate portions are combined to have again four portions. The remaining portions are poured back into the original container.</p> <p>The process is repeated for the combined portions by pouring back the retained portions into the original container until the required working sample is obtained. Thereafter the working sample is poured into a working container (plastic plate/plastic box) accompanied by the analysis card and is ready for the test.</p> <p>To obtain the approximate prescribed working sample size, up to 2% may be added during the subdividing process.</p> <p>The weight of the working sample is counter checked by repeated weighing on a balance.</p> |
| 3 | Spoon method: | <p>This method is normally used on small seeded samples.</p> <p>From the sample reception the analysis card with a respective submitted sample is carried to the laboratory <i>sub</i>-sampling section.</p> <p>The submitted sample is thoroughly mixed by shaking the seed in the container.</p> <p>The sample is poured evenly on a tray either in the forward and backward movements or sideways movements.</p> <p>Then with the spoon in one hand and spatula in the other hand, small portions from not less than five random places on the tray are removed until the working sample weight is obtained.</p> <p>To obtain the approximate prescribed working sample size, up to 2% may be added during the sub-sampling process.</p> <p>The weight of the working sample is counter checked by repeated weighing on a balance.</p> |

| STANDARD OPERATING PROCEDURE 4: MOISTURE CONTENT TESTING (MOISTURE METER) | | |
|---|--------------------------------|---|
| | | PROCEDURE FOR MOISTURE CONTENT TESTING |
| | | Purpose: To determine moisture content of seed. |
| Step | Procedure | |
| 1 | Collect sample | Collect the moisture samples immediately upon arrival at the sample reception. Ensure that the sample has a test number. The moisture samples are taken to the moisture room where they are arranged in the order of test numbers. Care should be taken to avoid moisture gain or loss. The sample should be mixed thoroughly as prescribed by the current version of the ISTA rules. A moisture sample shall be tested as soon as possible , ideally within 24 hours of receipt at the laboratory |
| 2 | Check status of moisture meter | Clean the working surface area, ensure that the moisture meter is free from previous analysis, check the power supply |
| 3 | Switch on moisture meter | Switch on the ON/OFF switch Select the appropriate commodity from the on-screen menu by pressing UP/DOWN arrow keys. |
| 4 | Prepare sample | Prepare a duplicate of two independent working samples in accordance with the current version of the ISTA rules. Ensure that the duplicate sample is not exposed to the atmosphere for more than 30 seconds. |
| 5 | Load sample | Pour the first duplicate to fill the hopper of the moisture meter and compress sample as per instructions manual of the moisture meter and record measurement as M1 on the analysis card. Pour the second duplicate to fill the hopper of the moisture meter and compress sample as per instructions manual of the moisture meter and record measurement as M2 on the analysis card. |
| 6 | Calculate results | Calculate the mean moisture content using the observed percentage of M_1 and M_2 , to one decimal place using the formula below; $(M_1+M_2)/2$ Where: M_1 = moisture content of first duplicate sample. M_2 = moisture content of second duplicate sample The result is expressed as a percentage to one decimal place |
| 7 | Interpret results | If the difference between the replicates does not exceed 0.2%, then the arithmetic mean is taken as the result. In the event that the 0.2% exceeded then a duplicate test is conducted |

| STANDARD OPERATING PROCEDURE 5: PURITY ANALYSIS | | |
|---|---|---|
| | PROCEDURE FOR PURITY ANALYSIS | Purpose: to determine the percentage composition of pure seed by weight of the sample being tested and by inference the composition of the seedlot |
| Apparatus and accessories: (in accordance with the current version of ISTA Rules) Soil divider, purity plates, analytical balance, chaff tins spatulas, purity boxes, purity boards, magnifying glasses, microscopes and seed collections | | |
| | Step | Procedure |
| 1 | Check status of apparatus and working areas | Make sure that all work areas are cleaned especially the working tables and apparatus |
| 2 | Prepare the working sample | Ensure that you thoroughly mix the submitted sample 3 or more times before obtaining the working sample |
| 3 | Weigh the sample | Weigh the obtained working sample to 4 significant figures according to the specified weight in the current version of ISTA rules. |
| 4 | Prepare the working area | Ensure that you have purity table, spatula, chaff tins, microscope or magnifying glass, magnifying lamp and purity card |
| 5 | Sample analysis | Physically separate the pure seed, inert matter and other crop seeds. Use the microscope or magnifiers to aid in the identification of some contents of the working sample. |
| 6 | Seed identification | Make use of the herbarium (seed collections) to help you identify other seed species. |
| 7 | Weigh the components | After sample analysis, weigh the components separately and record the weight of each component on the analysis card. |
| 8 | Calculation and expression of results | Add together the weights of all the component fractions from the working sample. The sum should be compared with the original weights as a check against gain or loss. The percentage by weight of each component shall be expressed to one decimal place. Percentages must be based on the sum of the weight of the components as in the formula provided below; (Weight of each Component ÷ sum of weight) × 100 |

| STANDARD OPERATING PROCEDURE 6: DETERMINATION OF OTHER SEEDS BY NUMBER | | |
|---|--|---|
| | PROCEDURE FOR DETERMINATION OF OTHER SEEDS BY NUMBER | Purpose: To estimate the number of seeds of other species found in the quantity examined and by inference to the seed lot. |
| APPARATUS: sieves, purity table, chaff tins, seed collections and spatulas. | | |
| Step | Procedure | |
| 1 | Check status of working area and apparatus | Ensure that all working surfaces and apparatus are clean and free from other seeds. |
| 2 | Prepare working sample | Weigh a uniformly mixed working sample according to the prescribed weights in the current version of the ISTA rules. The actual weight of seed is examined. |
| 3 | Determination of other seeds by number | The working sample is searched either for seeds of all other species or certain stated species as required by the sender. The number of seeds found of each species sought is counted. |
| 4 | Calculation and expression of results | The results are expressed as the number of seeds belonging to each stated species or category found in the actual quantity examined. In addition the number per unit weight is calculated in kilogram |
| 5 | Reporting results | The scientific name and number of seeds of each species sought and found in the examined sample is reported on the international or National Seed Analysis Certificate. |

| STANDARD OPERATING PROCEDURE 7: GERMINATION TEST | | |
|---|-------------------------------------|---|
| | PROCEDURE FOR GERMINATION TEST | Purpose: To assess the maximum germination potential of the seed sample and by inference the planting value of the seed lot. |
| Apparatus: (in accordance with the current version of ISTA Rules) Apparatus and Accessories: counting boards, vacuum counters spatulas, Table germinator, germination cabinet, oven, fridge, planting pots, thermometers and walk in germinators | | |
| | Step | Procedure |
| 1 | Preparation of working sample | 400 seeds are counted at random from the well-mixed pure seed fraction. Care is taken to ensure that there is no selection of seeds that may cause biased results. Replicates of 100 seeds are normally used, spaced sufficiently far apart on the substrate to minimize the effect of adjacent seeds on seedling development. To ensure adequate spacing, split replicates of 50 or 25 seeds may be necessary, particularly where seeds are infected by a seed borne disease. When the seeds are heavily infested and seeds tested on a paper substrate, it may also be necessary to change the substrate at intermediate count. |
| 2 | Test conditions for paper substrate | <p>Paper substrates are used for the following methods:</p> <p>a) TP (top of paper) Seeds are germinated on top of one or more layers of moistened paper, which are either placed on the Table germinator apparatus, or transparent boxes or petri dishes placed in germination chamber.</p> <p>b) BP (between paper) The seeds are germinated between two layers of paper. This is achieved by:- Loosely covering the seeds with an additional layer of filter paper By placing the seeds into folded moistened rolled paper towel which may be placed in an upright position in a planting pot covered with a ventilated transparent plastic cover The substrates are kept in closed boxes wrapped in plastic bags and placed in the germination cabinet or walk-in germinator.</p> <p>c) PP (pleated paper) The seeds are placed in a pleated, accordion like paper strip with 50 pleats, usually 2 seeds per pleat so that you have 100 seeds per box with a flat strip often wrapped around the pleated paper to ensure uniform moisture condition. This method may be used as an alternative where TP or BP is prescribed. The substrates are kept in closed boxes wrapped in plastic bags or covered with transparent lids and placed in the germination cabinet or walk-in germinator</p> |

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| 3 | Test conditions for sand | <p>Sand is sieved, washed through a mesh size of diameter 0.8mm and retained by mesh size of diameter 0.05 mm, the sand is sterilized at 200°C for 6 hours. The sand is used as follows: -</p> <p>a) TS (top of sand) The seeds are pressed into the surface of the sand on a tray or in the planting pots.</p> <p>b) S (in sand) The seeds are planted on a levelled layer of moist sand and covered with 10-20mm of uncompressed sand depending on the size of the seed. To ensure good aeration it's recommended that the bottom layer of sand be loosened by raking before sowing.</p> <p>For other test conditions refer to current version of ISTA rules.</p> <p>The planted seeds are kept in pots wrapped in plastic bags or covered by transparent lids and placed in the germination cabinet or walk-in germinator</p> |
| 4 | Duration of tests | Duration of the test for individual species is indicated in Table 5A of the current version of ISTA rules. |
| 5 | Evaluation | <p>Seedlings which have reached a stage with all essential structures that can be accurately assessed shall be removed from the test at the first and any other intermediate counts. Badly decayed seedlings should be removed in order to reduce the risk of secondary infection. Abnormal seedlings with other defects should be left on the substrate until the final count. When a seed produces more than one normal seedling, only one is counted for determining the germination percentage.</p> <p>At the end of the germination test hard seeds are counted and reported as such on the analysis card. However, where it is necessary to remove hard seededness prior to the germination test, measures are described in the current version of ISTA rules.</p> <p>When fresh seeds are to be reported at a rate of 5% or more, it must be verified that these seeds have the potential to produce a normal seedling by carrying out a tetrazolium test. If there is any doubt as to whether the seed is fresh or dead, then it must be classified as dead.</p> <p>Dead seeds are counted and reported as such on the National or the International Seed Analysis Certificate. A seed that produces any part of a seedling (e.g. the tip of the primary root) even if decayed at the time of assessment should be counted as an abnormal seedling and not as a dead seed.</p> |

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| 6 | Re-testing | <p>In the following cases the germination test shall be repeated :-</p> <ul style="list-style-type: none"> - When dormancy is suspected, any method indicated in the current version of ISTA rules is used to break dormancy. <p>When the results of a germination test are not reliable because of spread of fungus or bacteria.</p> <p>When there are a number of seedlings, which are difficult to evaluate, the retest shall be made using one or more alternative methods as prescribed in the current version of ISTA rules.</p> <p>When there is evidence of errors in test conditions, seedling evaluation or counting, a retest shall be made using the same method and the results of the retest shall be reported on the ISTA Analysis Certificate</p> <p>When the range for the 100 seed replicates exceeds the maximum tolerated range as indicated in the current version of ISTA rules.</p> <p>If the second result is not compatible with the first and the difference exceeds the tolerance indicated in current version of ISTA rules, a third test using the same method shall be made. The average of compatible results shall be reported.</p> |
| 7 | Calculation and expression of results | <p>The result of the germination test is calculated as the average of four 100 seed replicates or sub-replicates of 50 or 25 seeds are combined into 100 seed replicates. It is expressed as a percentage by number of normal seedlings. The percentage is calculated to the nearest whole number (0.5 is taken to the higher figure) the percentage of abnormal seedlings, hard, fresh and dead seed is calculated in the same way. The sum of the percentages of normal and abnormal seedlings and ungerminated seeds must be 100%</p> |
| 8 | Tolerances | <p>The germination results are reliable only if the difference between the highest and the lowest replicates is within accepted tolerances in accordance with current version of ISTA rules (Table 5B Part 1 – 3).</p> |

STANDARD OPERATING PROCEDURE 8: SEED HEALTH TESTING

PROCEDURE FOR SEED HEALTH TEST (Mycology)

Purpose: To assess the level of seed borne pathogens of the seed sample and by inference the disease infection of the seed lot.

Apparatus: (in accordance with the current version of ISTA Rules)

Apparatus and Accessories: counting boards, germination cabinet, incubators, freezer, petri dishes, blotter or filter paper,

| | Step | Procedure |
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| 1 | Preparation of working sample | Prepare working sample as described in section 7.4.1 of the current ISTA Rules It is vital to exclude any possibility of cross – contamination between seed samples. This can be achieved by swabbing/spraying equipment and gloved hands with 70% ethanol. |
| 2 | Prepare substrate | Place three 9.0 cm filter/blotter paper in each plate and soak with sterile distilled /de-ionized water Drain away excess water |
| 3 | Conduct test | Aseptically place 10 seeds, evenly spaced, on the surface of filter /blotter paper in each plate. Incubate seed for 3 days at 20±2°C in the dark. Transfer plates to freezer and maintain at - 20±2°C for 24 hours. After freezing, incubate for 6 days at 20±2°C with alternating 12 hours period of darkness and NUV light. (Note: Plates should be approximately 25 cm below the lights and should not be stacked) |
| 4 | Evaluation | After 6 days of incubation, examine seeds under a stereoscopic microscope at x30 for fungal growth and up to x80 magnification for identification of conidia (Note: Conidiophores are simple or slightly branched arising singly or in small groups from the surface of the seed). |
| 5 | Report results | Record number of infected seeds in each plate |
| 6. | Checking tolerances | Tolerances provide a means of assessing whether or not the variation in result within or between tests is sufficiently wide as to raise doubts about the accuracy of the results. Tolerance levels are indicated in a tolerance Table 5.1 of Annex to Chapter 7 of ISTA Rules for Seed Testing. |
| 7. | Other methods | Other methods for seed health test (Mycology, Bacteriology, Virology) refer to Annex of Chapter 7 of current version of ISTA Rules for seed testing |

| STANDARD OPERATING PROCEDURE 9: ISSUANCE OF NATIONAL CERTIFICATES (Test Results) | | |
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| | PROCEDURE FOR ISSUANCE OF NATIONAL CERTIFICATES (Test Results) | Purpose: To ensure an orderly release of test results certificates |
| | Step | Procedure |
| 1 | Get analysis card | Quality Control Manager or Deputy identifies an analysis card for a seed lot that requires a National certificate. Check the results on the analysis card. Ensure that the results meet the laid down standards as stipulated in the Seeds Act of the Laws of Sierra Leone. |
| 2 | Data entry | The approved results are given to the seed analyst at the reception who then enters the data on the computer or in the register (Ledger book) |
| 3 | Information check | The Quality Control Manager or Deputy counterchecks the information entered into the computer/register with that on the analysis cards. |
| 4 | Prep of Certificate | If the information is correct, a certificate is duly prepared/printed. |
| 5 | Signing of certificate | The Quality Control Manager or Deputy takes full responsibility of signing and release of the certificate. |
| 6 | Release of certificate | The client or sampler collects the signed certificate from the sample reception and signs in the Collection Book. |

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| STANDARD OPERATING PROCEDURE 10: CALIBRATION OF BALANCES |
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| | | PROCEDURE FOR CALIBRATION OF BALANCES | Purpose: To ensure accurate performance of the balances |
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| | Step | Procedure | |
| 1 | Prepare balances and Calibration weights | Ensure that the working environment and the balances are clean and that the calibration weights are kept in a dry cool place. | |
| 2 | Weighing of weights | The calibration weights are of known weight. The calibration weights are weighed twice on the balance being calibrated. The results of the weighing are recorded in the logbook for balances. | |
| 3 | Interpretation of Results | Where the difference of two weight measurements is more than 2% of the average weights of the two measurements the balance is suspended from use. The maximum tolerated range between two weight differences is 2%. | |

| STANDARD OPERATING PROCEDURE 11: QUALITY DETERMINATION OF PAPER SUBSTRATE | | | |
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| | | QUALITY DETERMINATION OF PAPER SUBSTRATE | Purpose: To determine the water holding capacity, pH and phytotoxicity |
| | Step | Procedure | |
| 1 | Check composition of paper substrate | The composition of the growing medium should provide sufficient pore space for air and water, anchorage for the root system contact with water that is required for plant growth. Refer to the current version ISTA handbook on seedling evaluation | |
| 2 | Check the water holding capacity | The particles of the growing media should have the capacity to hold sufficient water to provide continuous water to the seeds and seedlings. Water retention can be adjusted to the needs of a particular species and in such cases it should be expressed as a percentage of maximum retention. Refer to the current version of ISTA handbook on seedling evaluation | |
| 3 | Check the pH Value | The growing media must have a pH value within the range 6.0 to 7.5 when checked within the substrate. | |
| 4 | Check for the cleanliness | The growing media must be free from seeds, fungi, bacteria or toxic substances that could interfere with the germination of seeds, growth of seedlings or the evaluation of tests. Refer to the current version of ISTA handbook on seedling evaluation | |

| STANDARD OPERATING PROCEDURE 12: QUALITY DETERMINATION OF WATER | | |
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| | PROCEDURE FOR QUALITY DETERMINATION OF WATER | Purpose: To determine the water quality. |
| | Step | Procedure |
| 1 | Check composition of water | De-mineralised, De-ionised, tap and spring water can be used. |
| 2 | Check the pH Value | The pH value must be within the range 6.0 to 7.5 when checked in the substrate. |
| 3 | Check for the cleanliness | The water used to moisten the substrate must be free from seeds, fungi, bacteria or toxic substances that could interfere with the germination of seeds, growth of seedlings or the evaluation of tests. Refer to the current version of ISTA handbook on seedling evaluation |

| STANDARD OPERATING PROCEDURE 14: QUALITY DETERMINATION OF SAND SUBSTRATE | | |
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| | QUALITY DETERMINATION OF SAND SUBSTRATE | Purpose: To determine the water holding capacity, pH and phytotoxicity of sand |
| | Step | Procedure |

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| 1 | Check composition of sand substrate | The composition of the growing medium should provide sufficient pore space for air and water, anchorage for the root system contact with water that is required for plant growth. Refer to the current version ISTA Rules for Seed testing and ISTA handbook on seedling evaluation |
| 2 | Check the water holding capacity | The particles of the growing media should have the capacity to hold sufficient water to provide continuous water to the seeds and seedlings. Water retention can be adjusted to the needs of a particular species and in such cases it should be expressed as a percentage of maximum retention. Refer to the current version of ISTA handbook on seedling evaluation |
| 3 | Check the pH Value | The growing media must have a pH value within the range 6.0 to 7.5 when checked within the substrate. |
| 4 | Check for the cleanliness. | The growing media must be free from seeds, fungi, bacteria or toxic substances that could interfere with the germination of seeds, growth of seedlings or the evaluation of tests. Refer to the current version of ISTA handbook on seedling evaluation |

Appendix 9: EQUIPMENT OPERATING GUIDES

| EQUIPMENT OPERATING GUIDE 1: COMPUTER | | |
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| | | EQUIPMENT: COMPUTER |
| | | Purpose: To offer guidance to officers operating the computer |
| Step | Procedure | |
| 1. | Check cable connections | Check that all cables to and from all components are well connected. |
| 2. | Switch "ON" power | Press the power button at the main power supply to 'ON' position Switch the UPS, CPU, Monitor, and printer power buttons to 'ON' position. Wait for the computer to boot itself before commencing with your work. |
| 3. | Operating the Computer | Using the mouse, click the start button on the desktop and then click the mouse to programs menu. The programs link will give a pull down menu of all programs present on the computer. Click the program that you want to use on the programs menu for you to activate it. |
| 4. | Printing | This is done by sending a signal from the computer to the printer to print information. Whilst in an active document mode, click the File button on the menu bar, then click Print. In the dialogue box that follows, click on the appropriate options before clicking and finally click OK in order to print or click Cancel in order to cancel printing. |
| 5. | Exiting programs | Click File button or Office button (for Windows Vista) on the menu bar, then click Exit button for the computer to return to the Start up menu. |
| 6. | Switch 'OFF' power | Click Start button, then, click on the Shut Down Computer to close down the system. Switch off the printer by pressing it's power button to 'OFF' position. Then switch off power from the UPS and 'Mains' |

| EQUIPMENT OPERATING GUIDE 2: SOIL DIVIDER | | |
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| | EQUIPMENT: SOIL DIVIDER | Purpose: To give guidance to staff operating the equipment |
| Step | Procedure | |
| 1. | Check for cleanliness | Ensure that the soil divider and working table are clean. |
| 2. | Prepare the soil divider | Ensure that the divider is well balanced (use a spirit level for checking the evenness of the apparatus). |
| 3. | Pour the seed | Seed is evenly poured into the tipping pan backwards and forwards along the length of the tipping pan. The seed is then poured in approximate equal rates along the entire length of the hopper. |
| 4. | Mix the seed | Seed is thoroughly mixed by passing it through the divider, recombining the two parts and passing the whole sample one more time and two more times if necessary. |
| 5. | Reducing the sample | The sample is reduced by repeatedly passing it through the divider, removing one half on each occasion. The process is continued until the approximate or slightly more required working sample weight is obtained. |

| EQUIPMENT OPERATING GUIDE 3: DESICCATOR | | | |
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| | EQUIPMENT: DESICCATOR | | Purpose: To offer guidance to the staff operating the equipment |
| Apparatus: (see current version of ISTA RULES; Chapter 9) | | | |
| Parts and accessories: glass bowl, lid, thick perforated ceramic plate, desiccant. | | | |
| | Step | Procedure | Responsible Officer |
| 1 | Check for cleanness | Ensure that the desiccator, accessories and working table are clean. | |
| 2. | Check the equipment | Ensure that the apparatus is complete with silica gel, perforated ceramic plate and lid. | |
| 3. | Open desiccator | Use the knob on top of the lid to gently slide the lid half way open. | |
| 4. | Place moisture sample into desiccator | Place the closed sample containers on the perforated ceramic plate in the desiccator. | |

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| 5. | Close desiccator for cooling | Use the knob on top of the lid to gently slide the lid back on until firmly closed. | |
| 6 | Cool moisture Samples | Allow the samples to cool for at least 30-45 minutes. | |
| 7. | Remove moisture sample | Open the lid as described above and remove the samples one by one for weighing purposes. After removing the last sample, cover the desiccator and store it safely. | |
| <p>Note: The silica gel used as a coolant in the desiccator should always be pre-heated at 160⁰C for 30 minutes in order to restore its strength when it changes the blue colour.</p> | | | |

| EQUIPMENT OPERATING GUIDE 4: MICROSCOPE | | | |
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| | | EQUIPMENT: Microscope | Purpose: To give guidance to the staff operating the equipment |
| Parts: objective lens base, light switch, bulb, eyepieces | | | |
| | Step | Procedure | Responsible Officer |
| 1. | Check for cleanliness | Ensure that the microscope, accessories and working table are clean | |
| 2. | Switch on | Make sure that the microscope is connected to a power source, then switch on the microscope. | |
| 3. | Insert the eye pieces | Securely insert the eye pieces with the help of clamping screws and set eyecups as required. | |
| 4. | Select objective lens | Choose an objective lens suitable for the job at hand and set the working distance as required. | |
| 5 | Switch on the Illuminator | Switch on the illuminator and adjust light intensity accordingly. | |
| 6 | Observe specimen | Look through the binocular tube. Adjust the eyepiece tubes to give the correct interpupillary distance. | |

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| 7 | Set dioptic correction | Set the dioptic correction for both eye pieces by turning the diopter rings of the eyepieces Position the specimen to be investigated under the objective lens. Use the focusing drive to bring the image into focus. | |
| 8 | Switch off | Switch off the microscope and cover it to avoid dust and other foreign particles soiling the machine after use. | |

| EQUIPMENT OPERATING GUIDE 5: INDOSAW BALANCE | | | |
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| | | EQUIPMENT: INDOSAW BALANCE | Purpose: To give guidelines on how to operate the appliance |
| | Step | Procedure | Responsible Officer |
| 1. | Check electrical connections | Ensure that the cable has no breakages and is connected to the power source. Confirm that power supply matches specifications for the appliance | |
| 2. | Check for cleanliness | Keep the balance room, tables and balances clean to prevent inaccuracy. | |
| 3. | Level the balance | Ensure that the balance is placed on a stone table. | |
| 4. | Switch on the balance | Connect the appliance to the power supply and switch the balance on by pressing on ON/OFF button. | |
| 5. | Initialise | Press the button for initialising the balance, so that the display panel reads zero. | |
| 6. | Weigh | Press the Tare receptacle to select metric units Press the Tare key to display zero reading Weigh the empty sample container and zero the reading on the balance Pour the sample into the container on the balance. Weigh the sample to 1 decimal places | |

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| EQUIPMENT OPERATING GUIDE 6: GERMINATION CABINET |
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| | | EQUIPMENT: GERMINATION CABINET (INDASAW Seed Germinator) | Purpose: To give guidance to staff operating the equipment |
| APPARATUS: (see Current version of ISTA Rules; chapter 5) | | | |
| Parts and accessories: Cooling/heating system, inner glass doors, internal fan(s), times. | | | |
| | Step | Procedure | Responsible Officer |
| 1. | Check electrical connections | Ensure that the cable has no breakages and is connected to the power source. Confirm that power supply matches specifications for the appliance | |
| 2. | Check for cleanliness | Keep the germination cabinet and accessories clean. | |
| 3. | Switch incubator on | Switch on power at the mains, and then switch on power on the germination cabinet control panel. | |
| 4. | Switch on cooling system | Follow working instructions in the manual to set required operating temperature and humidity of the germination cabinet. | |
| 5. | Switch on fan | Switch on the fan. Note that the chamber circulating fan will only run if: the incubator is connected to the electrical supply the power switch is on the outer door is closed | |
| 6. | Set a single operating temperature | Follow working instructions in the manual to set required operating temperature for each crop requirement. | |
| 8. | Control Temperature and Humidity | Follow working instructions in the manual to set required operating temperature and humidity | |

| | | EQUIPMENT: NOBBE TRIER | Purpose: To give guidance to staff using the equipment for sampling seed from relatively small bags. E.g. 10,20,50kgs |
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| | Step | Procedure | |
| 1 | Check size of trier | Ensure that the trier that suits the kind of seeds you would like to sample is used (i.e. 14mm internal diameter of the tube for cereals and 10mm for small seeds). | |
| 2. | Check for cleanliness | Ensure that the nobbe trier and accessories are clean. | |
| 3. | Insert the trier | Insert the trier gently into the bag, pointing the trier upwards at an angle of 30 degrees to the horizontal, with the hole facing downwards until the hole reaches the center or the opposite side of the bag without pushing through. | |
| 4. | Draw seed sample. | Turn the trier 180 degrees to bring the hole to face upwards. Withdraw the trier at a decreasing speed so that the amount of seed obtained from the successive location increases progressively from the center or the opposite side of the bag without pushing through to the drawing side of the bag. Gently agitate the trier as you withdraw it from the bag to ensure a steady flow of the sampled seed into a suitable container. | |

Note: Sampling position should be varied from top, middle and bottom of the bags

| EQUIPMENT OPERATING GUIDE 11: SLEEVE TRIER | | | |
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| | | EQUIPMENT: SLEEVE TRIER | Purpose: To give guidance to staff using the equipment for sampling seed in open containers |
| | Step | Procedure | |
| 1 | Check size of trier | Ensure that the trier that suits the kind of seeds you would like to sample is used. | |
| 2. | Check for cleanliness | Ensure that the sleeve trier and accessories are clean. | |
| 3 | Insert the sleeve trier | Insert the trier vertically, horizontally or diagonally while it is closed. However, when used vertically the sampling stick must have partitions dividing the instrument into a number of compartments. | |
| 4 | Draw seed sample. | After the trier has been inserted into the container, open the slots and gently agitate the trier for it to fill. Thereafter close the trier delicately so as not to damage the seed before withdrawing it. Open the slot to empty the seeds into a collecting bucket. When using models with separate compartments a long sheet of paper approximately the same length of the stick is required. | |