THE REPUBLIC OF SOUTH SUDAN

# SEED LABORATORY

South Sudan Learner's Handbook.

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Module 2 SEED LAB

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# Background and rationale

For decades, the challenge of feeding the world's ever-growing population has drawn widespread attention and spurred innovation. Industrial farming systems, introduced in the 1950s, aimed to address increasing global hunger. However, despite undeniable progress in reducing undernourishment and improving nutrition, conventional agriculture still leaves almost 800 million people chronically hungry and 2 billion suffering from micronutrient deficiencies.

High-input, resource-intensive farming systems have serious drawbacks. They cause deforestation, soil degradation, biodiversity loss, and high greenhouse gas emissions, contributing to global warming and climate change. Furthermore, they increase farming costs and contribute to non-communicable diseases across all ages and socioeconomic classes. Clearly, these approaches cannot ensure sustainable food production.

Our generation needs innovative systems that simultaneously increase the productivity of healthy foods and conserve natural resources, delivering greater socioeconomic benefits with reduced environmental impact. A transformative shift towards holistic, participatory approaches is essential. Examples include agroecology, agroforestry, conservation agriculture, community seed banks, and strengthened national seed systems – approaches that incorporate indigenous and traditional knowledge.

On the other hand, critical parts of our food and seed systems are becoming increasingly capital-intensive, consolidated, and vertically integrated. This shift occurs throughout the supply chain, from agricultural inputs to food distribution. Consequently, small-scale producers and households with limited access to land and quality seeds are marginalized and often seek employment outside of agriculture. Such trends contribute to the migration of primary earners, typically men and younger household members, leaving behind the elderly, less able individuals, and contributing to the "feminization" of farming in many regions. A more sustainable farming system is needed to create a better balance, encourage greater resilience to climate change and instability, and operate within societal traditions.

A Seed Lab in South Sudan would play a crucial role in supporting agriculture, improving seed systems, enhancing resilience, and ensuring food security in the region. By focusing on seed quality, diversity, and availability, Seed Labs would contribute significantly to boosting agricultural productivity, which is vital for the food security of communities in South Sudan. Through research, testing, and distribution of high-quality seeds, Seed Labs would help farmers access improved varieties that are better adapted to local conditions, leading to higher yields and better crop resilience against climate change and pests. Ultimately, the Seed Lab's efforts would have a far-reaching impact on sustainable agriculture practices and the overall well-being of the population in South Sudan.

# Introduction

## About the course

This short course, titled "Community Seed Banks and Seed Labs," consists of two modules: community seed banks and seed labs. Participants will gain the knowledge and skills necessary to establish and manage sustainable community seed banks and effectively operate seed labs. They will also learn how to conserve diverse, locally adapted seed varieties within the South Sudanese agricultural ecosystem, perform effective seed testing, and maintain optimal seed quality.

## Target Audience

This course is ideal for motivated agricultural professionals in training who are interested in establishing or strengthening community seed banks and/or seed labs. This includes:

- Teachers, instructors, teaching assistants, lecturers, and researchers
- Plant genetic resource center (gene bank) staff
- Government extension agents
- Professionals leading efforts to establish community seed banks and/or seed labs
- Those conducting community training sessions on these topics

## About the manual

This manual consolidates information from various sources on community seed banks and seed testing to support the course's educational goals within the context of South Sudan. While some sources may use alternate terms like "gene bank," this manual will consistently use "community seed bank" in the Module 1 handbook and "seed lab" in the Module 2 handbook.

The first module contains eight topics, and the second module contains five topics, each designed to achieve specific learning outcomes. The course utilizes a participatory methodology where facilitators and learners engage actively. Lectures are paired with practical exercises that draw on participants' experiences or relevant case studies.

## Acknowledgements

This handbook was produced as part of the training of trainer's capacity building on a community seed bank under the project E4FSR funded by NUFFIC, the Netherlands. The project mobilized participants from Somaliland, Sudan, and South Sudan. The South Sudan team included participants from various institutions (University of Juba, Dr. John Garang Memorial University, Ministry of Agriculture, Environment and Forestry – Central Equatoria State, and Crop Training Center-Yei – Central Equatoria State.

We as a team are thankful to E4FSR for allowing us to take this training and develop this hand book which we hope will contribute to awareness and knowledge on community seed bank to farmers, extension workers, researchers, and other national development workers interested in crop diversity and conservation activities in South Sudan. We are thankful to the Dean of the College of Natural Resources and Environmental Studies, University of Juba, Prof. Salah Khatir Jubarah for effectively coordinating the project. We also thank the Christian Agenda for Development – Juba office, led by Executive Director Mr. Amule Thomas Haroun for providing us with internet services, and encouragement. Without his support compilation of this handbook would not have been possible .

The authors of this handbook were motivated by the concept of a community seed bank and its promise. They hope the learners and the farming communities will be inspired by the same. However, it is worthy of note that the contents or information herein, neither expresses nor reflects the views of NUFFIC or any organizations mentioned in the text. The views are those of the authors and are solely to be used for educational and training purposes.

Credits: Cover photo and layout by Godfrey Hakim Samuel Parumena.

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Module 2

# Topic 1 Seed Quality Assurance vis-à-vis Seed Quality Control.

Overview.

**This topic explains the distinction between ensuring consistent seed quality (Assurance) and the processes to produce high quality seeds (Control). Both are required for achieving and maintaining premium seed standards.**

Learning Outcomes.

By the end of this module, participants will be able to;

- Explain the meaning of seed quality control and quality assurance, and give their main principles.
- Conduct internal seed quality control.
- Pass external seed quality assessments.
- Provide quality assurance to distributors and seed buyers.

Duration.

**2hours, 25mins**

| | | |
|---|---|---|
| Introduction and Pre-test (Evaluation) | | 20 minutes |
| Plenary: 1 | Brainstorming, Question and Answer | 30 minutes |
| Plenary: 2 | Guided discussions, and presentations | 20 minutes |
| Plenary: 3 | Group discussions (Exercises) | 25 minutes |
| Plenary: 4 | Presentations | 30 minutes |
| Post-test (Evaluation) | | 15 minutes |
| Conclusion | | 5 minutes |

**Equipment or materials needed**

- Visual Aid (Slide or Poster):
  - Title: Seed lab: Seed Quality Control and Quality Assurance.
  - Concise Definition: Display of the definition of a seed quality and the principles of seed quality control.
  - Include importance of quality control in a seed lab.
- Technical Equipment:
  - Mobile projector for visual aid and potential additional media.
- Participant Resources:
  - Notebooks and writing tools for notes and activity engagement.
- Interactive Materials:
  - Large paper, markers, and affixing materials (tape/pins) for collaborative exercises (e.g., participatory discussions).

Brainstorming

In small groups of up to 3 people, reflect on the following questions.

- What is seed quality?
- What is seed quality control?

- Why is seed quality control important?
- Do you know of, or put in practice, any quality control mechanism?

These questions can be asked again at the end of the session, allowing participants to assess their learning.

## Introduction.

Seed quality control and assurance is the combined efforts and activities undertaken to ensure that the seeds that are being produced for the end users (farmers) conform to minimum quality standards. The control measures involve inspection and monitoring of seeds from production stages in the field and then during postharvest management practices to ensure quality seeds are produced and maintained in stores and supplied to the end user.

**Key terms.**

**Quality seed** refers to the "degree to which a set of inherent characteristics [distinguishing features] of a seed", "fulfills requirements."

**Quality assurance** refers to an overall management plan to guarantee the reliability of data that is needed to comply with the minimum standards.

**Quality control** refers to a series of analytical measurements used to assess the quality of seed. Good seed quality control and assurance will avoid unbiased field inspection and laboratory testing for quality control.

**Goals of quality control and Assurance**

The main goal of quality control and assurance is to ensure that clients have access to seeds which are:

- Genetically pure
- Free from seed borne diseases
- Free from weed seeds and pests
- Produced in conformance with minimum requirements in terms of physical purity, germination and moisture content.

## Principles of seed quality management systems

Effective seed quality management systems rely on the following:

1. **Customer Focus:** The management system has objective results, guided by inherent seed characteristics that satisfy customer needs. Understanding the needs and requirements of seed buyers and ensuring that seed testing procedures meet or exceed customer expectations.
2. **Leadership:** Competent inspectors or other professional personnel responsible and professional members (clear-cut roles and responsibilities regarding the quality control committee and individual members). Establishing a clear vision and direction for seed testing processes, with leadership actively promoting a culture of quality within the organization.
3. **Engagement of People:** Transparent processes (open to internal and external inspections). Involving all staff members in the seed management processes, encouraging empowerment, and providing training to ensure competence in their roles.
4. **Process Approach:** Application of rigorous scientific methods (technical fundaments of seed inspection and tests). Implementing systematic processes for seed testing to achieve consistent results, with an emphasis on identifying and addressing areas for improvement.
5. **Improvement:** Continuously seeking opportunities to enhance seed testing procedures, through monitoring performance, analyzing data, and implementing corrective actions.
6. **Evidence-based Decision Making:** Traceable measurements and repeatable tests. Using data and evidence from seed testing results to make informed decisions, improve processes, and achieve desired outcomes.
7. **Relationship Management:** Building and maintaining strong relationships with seed suppliers, customers, and other stakeholders to ensure effective communication and collaboration throughout the testing process. However, there must be Impartiality conduct of inspections(should be done by an independent body to avoid conflict of interest) \

Internal and external seed quality control

Generally speaking there are two main types or categories of seed quality control; internal seed quality control and external seed quality control.

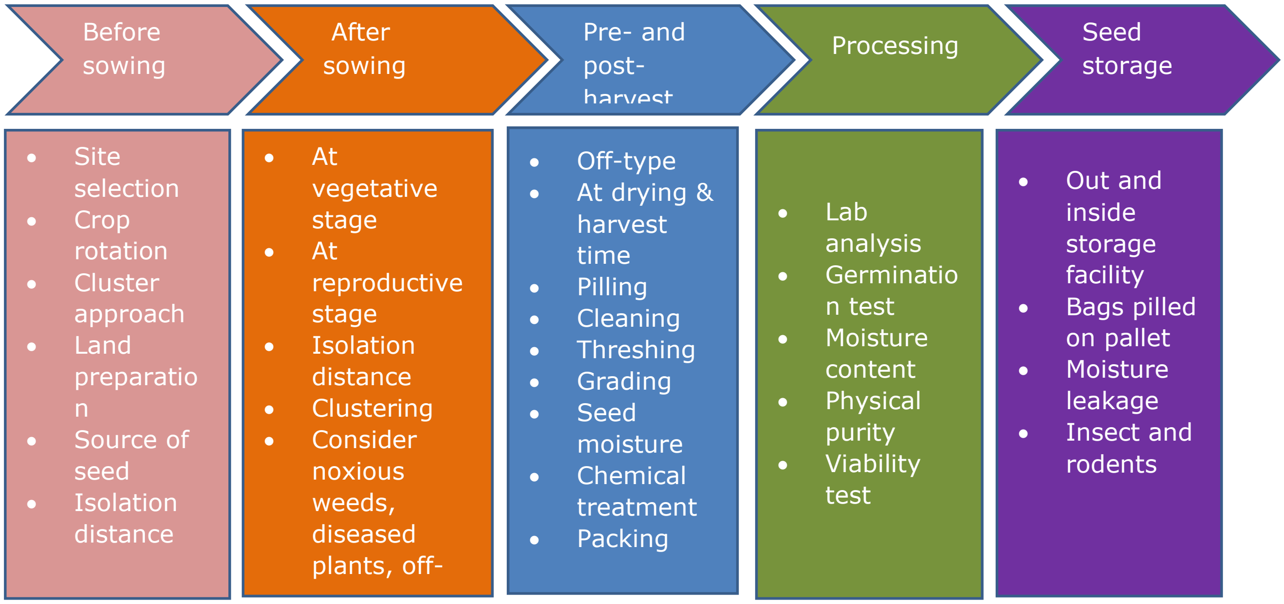
1. **Internal control** is mainly carried out by the internal seed quality control committee and professional experts of private seed producers.
2. **External control** is done by an autonomous and accredited body that should inspect every stage of production, including preparation of the seed field. Harvest period, processing, storage and transportation.

### Main activities of internal quality controls

Participants will have a good understanding of, and be able to discuss, and do the following:

- The main activities of internal quality controls.
- Improve seed quality.
- Reduce the risks of seed rejection by external inspectors.

Internal quality control bodies intervene at different points in the production cycle where they assess and inspect the production methods against the minimum standards set for different varieties of crops. The steps and points to be considered during inspection for internal quality control are summarized in the following diagram.




## Field inspection before sowing

Field inspection is a fundamental requirement both for internal and external seed quality control. In field inspection, a seed field is assessed in relation to a number of variables to check and validate its compliance with the official field standards.

**Field inspections are done to achieve the following objectives:**

1. Verify the seed source and variety
2. Gather information on the cropping history of the seed field, that is, to verify whether the seed field meets the prescribed land requirements
3. Monitor crop and cultivation conditions and isolation distance
4. Monitor freedom from impurities (other crop plants and weeds), other cultivars and off-types, and seed-borne diseases.

These field observations are compared with a set of prescribed standards which are specific to each crop.

**Site selection:** checking whether the selected plots comply with the minimum requirements for quality seed production, taking into consideration the following points:

- Suitability of land for cultivation
- Fertility status of soil
- Previous land use and history in terms of cultivation to avoid contamination by volunteer plants
- Adequate drainage
- Minimum risk and susceptibility in terms of drought, soilborne diseases, flood problems and other limiting factors.

Based on the above criteria, the inspectors confirm and validate that the selected land effectively fulfills the minimum standards for site selection, in order to ensure quality seed production and reduce risks.

**Crop rotation:** The Ethiopian seed regulation 375/2016 (article 23) dictates the minimum standards for crop rotation that should be taken into consideration for quality seed production. According to the seed proclamation:

1. Minimum standards for crop rotation vary in relation to specific crop types and types of seed classes to be produced. For example, the minimum attainable years for crop rotation to produce certified seed of food barley and bread wheat are two and one, respectively.
2. These minimum standards provide the basis for avoiding seed contamination from volunteer crops of different varieties, reducing seed-borne diseases, and avoiding weeds and pests.

The internal quality control bodies should check whether individual seed producers fulfills the minimum standards through early field visits and inspection.

**Seed quality control and assurance in clustered fields**

When members of a seed producer cooperative have decided to cluster their fields for seed production, it is important that the internal regulatory bodies pay specific attention to ensure that the correct clustering approach has been implemented, safeguarding the quality of the seeds that are being produced

**Definition Clustering:**

Growing the same variety/varieties of a given crop by grouping (clustering) adjacent plots of land from different farmers.

Clustering should be done based on the interests of members of the seed producers. In other words, individual members should want to cluster their fields on a voluntary basis. It is not advised that seed producers make it mandatory for farmers to cluster.

- The clustering approach reduces the probability of genetic and physical contamination from adjacent fields, but care should be taken that the basic/ foundation/ EGS seed is of the same lot and same batch
- The clustering approach facilitates supervision and field inspection and facilitates providing advice and coaching to seed producers.
- From this understanding it is important that the internal quality control committees train the members on the importance and advantages of clustering, and provide advice and coaching to seed producers who want to cluster or have already clustered their fields.

**Inspect source of seeds:** One of the main duties of an internal seed inspector is to check the sources and quality of the basic seeds that will be used to produce and multiply certified seed. The internal control committee should confirm that:

- Seed has been obtained from legally licensed seed producer organizations, competent in producing EGS.
- Official seed tags or labels are available and traceable.

The internal quality control committee can perform simple germination tests before distributing the seed and initiating planting, in order to avoid risks of crop failure.

**Isolation distance:** the minimum required distance between two varieties of the same crop or species in order to prevent genetic or physical contamination.

Seed producers may follow different mechanisms to comply with these requirements. Some common examples of this are:

- **Distance isolation:** ensuring a minimum distance between two adjacent plots sown with different varieties of the same crop, or with different crops
- **Spatial isolation:** planting a completely different crop variety between two adjacent plots creating a spatial/physical barrier to prevent cross contamination.
- **Temporal isolation:** planting different varieties of the same crop at different times ensuring that the flowering and pollination stages do not coincide (Only allowed in Maize).

## Field inspection at crop growth stage

The internal seed quality control committee should also inspect production fields throughout their growth stage. During this stage the key objective is to estimate the maximum tolerable off-types of different varieties of the same species, other crops, noxious weeds and disease plants and to relate those estimates against the defined standards. Field inspection should ideally take place at least at three moments during the growth and reproductive stages, for example:

- At the vegetative stage (before flowering)
- At the reproductive stage (after flowering to grain filling stage)
- At a stage near to the maturity period

For the field inspection, the inspectors should follow the internationally agreed sampling procedures (e.g. minimum number of sampling points and amount). If field inspection is conducted according to the defined standards, the internal quality control committee can provide a clear assessment, rejecting or approving a particular field of seed crops, even before the seeds are harvested. Based on the field inspection, the internal quality control committee provides recommendations to the farmer; for example, instructing her or him to rogue of off-types and other undesirable plants at the growth and reproductive stages. Once an individual seed producer has complied with the recommendations, the inspectors should re-check the field to ensure.

## Inspection at harvest and post-harvest processing stages

Internal quality control committees are required to perform inspections during harvest and post-harvest stages of the entire seed production and processing process. The section below summarizes what specific inspection activities take place at different stages

**Harvesting**

It is important to make sure that seed moisture content is checked ahead of harvesting. The inspector should check whether time of harvesting is ideal and seed moisture content is below the maximum standard limit. For instance, the inspector should inspect moisture content of maize against the maximum standard (14% at harvest time) and advise the farmers accordingly.

**Threshing**

Before initiating the threshing activity, the inspector should check the quality of the cemented or plastered threshing floor to ensure that:

- During threshing seeds are not mixed with soil or other inert matter
- The purity of the seed is maintained and it is not mixed with other varieties of the same crop.

The internal quality control inspector should provide effective advice to individual seed producers allowing them to critically consider mechanisms and strategies to avoid physical mixture during threshing and cleaning of plant material and seeds (for instance, not to thresh seed of different varieties on the same floor; and to use other threshing materials, like canvas or a threshing machine, to avoid mechanical mixture).

**Cleaning and grading**

At this stage, the internal inspectors should advise the seed producers on cleaning and grading during seed processing so that they attain the minimum quality standards. These quality standards refer to:

- The maximum percentage of other varieties or crops present in seed material
- The maximum percentage of weed seeds and other inert matter present in seed material

**Chemical treatment of seed**

Seed quality control at this stage focuses primarily on the possibility of seed-borne disease and insect attack; the internal inspector should ensure that the SPC carries out seed dressing using appropriate and certified chemicals. Post treatment, the seed bags/ packets must be labelled as "Treated with poison; Do not use for food, feed or oil".

**Packing**

The final processing stage at which internal quality control takes place is at the packing stage. Inspectors should check the quality of the bags used for packing. Ideally, the seed bag should be waterproof as to avoid moisture to infiltrate and affect the seed (most seed producers use seed bags that have internally sealed plastics). Internal quality control bodies should also provide advice to the SPC and individual seed producers about appropriate packing materials with affordable bag sizes and brand names.

**Seed storage inspection**

The main purpose of storing seeds of various crops, particularly field crops, is to store and preserve the quality of the seeds from the time of packing until the next planting season. However, management of seed in the storage is crucial as seed can easily deteriorate in inappropriate storage environments.

The longevity, viability and quality of seed kept in storage predominantly depends on:

- the moisture content of the seed upon packing
- the temperature control and relative humidity (RH) in the storage facility.

For instance, during the two months of a rainy season, high relative humidity can reduce seed viability from 90% to 70%. If the moisture content of seed is 5-14%, its storage shelf life can double by reducing its moisture content to 1% (Harrington's rule). Therefore, seed storage management by a seed producer is crucial to maintain seed viability until the next planting season.

Inspection of storage management by internal quality control bodies is also vital to evaluate the viability and healthiness of the seed and to control insects and rodents in the storage facility. the inspectors should regularly carry out the following and advise the seed producers/storage personnel accordingly:

- check the outside of the storage facility for drainage or erosion problems, signs of rodent paths and holes, and the presence of trash or weeds
- check inside the storage facility for moisture such as leaks in the roof, dampness on the floor, or water stains on the wall
- check that seed bags are kept on pallets or on tree branches placed in a wood frame on the floor, to avoid contact with a cemented floor.
- inspect the seed inside the bags or storage container for insects or moisture detection
- check the status of seed in storage areas; whether it is appropriately handled in terms of optimum temperature, relative humidity, and air moisture.

- ensure that storage personnel and visitors check in and out of storage areas, to avoid damage and seed losses in the store.

**Learning objectives**

Upon completing section 3 of this module, participants will have a clear understanding of the main functions and activities of external inspection, seed quality control and assurance.

The main activities of external inspectors for quality assurances are testing seed with a laboratory analysis, inspection of seed labelling, and seed certification. Details are provided of the specific inspection activities that take place in each mentioned step.

**Laboratory analysis**

Seed producer should ascertain that their seed are produced through legally recognized seed laboratory services. Once analyzed, these service providers can accredit quality assurance certificates.

The main purposes of laboratory analysis of seed are:

- To determine the quality of the seed based on a number of seed quality attributes
- To provide a basis for price and consumer discrimination among seed lots and seed sources
- To determine the source of seed problems, thereby facilitating any corrective measure(s).

The seed producers, usually their internal quality control committees, should contact the nearest official seed laboratory for quality analysis, which checks that a seed conforms to the applicable seed standards. It involves:

- Physical purity percentage
- Germination capacity
- Seed moisture content.

Having obtained a positive laboratory analysis report, testifying the good quality of seed, the seed producers and respective SPC have the right to obtain a quality assurance certificate.

## Inspecting seed labeling

Any registered seed seller who sells prescribed and certified seed which has been tested has the obligation to label the seed product by printing or stamping with indelible ink on the seed bag or upon a specified label attached. The labels should contain the following information:

- the name of the producer and its emblem or symbol/logo
- year of production
- the date (day, month and year) on which the prescribed seeds were tested
- type of crop and name of the variety
- seed class (pre-basic seed, basic seed or certified seed)
- other particulars specifying seed quality, for example, physical/analytical purity, moisture content and germination percentage

The external seed regulatory body will also inspect the seed labeling, particularly during transportation and distribution, making sure that any unknown seed sources are not distributed.

## Seed certification

The main purpose of seed certification is to ensure the genuineness and quality of the seed for the purchaser. It is performed in seven steps:

1. Receipt and scrutiny of application
2. Verification of the seed source/class used for raising the seed crop
3. Field inspection to verify conformity to the prescribed field standards
4. Supervision at post-harvest stages including processing and packaging
5. Supervision of seed storage to verify conformity to the prescribed standards
6. Seed sampling and laboratory analysis
7. Grant of certificate and certification tags, tagging, sealing

## Exercise 1: Seed Quality Assurance and Quality Control

**Objective**: To test the knowledge of the learner about internal quality control

The learner should be able to:

- Differentiate between quality control and quality assurance
- Use a flow diagram to generate the main activities in internal quality control
- Mention the key label content that a seed bag should contain
- Differentiate between internal and external quality control

**References and further reading**


1. American Seed Trade Association. Guide to seed quality management practices, 2020. https:// www.betterseed.org/resources/ guide-to-seed-quality-management/
2. FAO. Seeds in Emergencies: a technical handbook., Rome, 2010. http://www.fao.org/resilience/resources/resources-detail/ en/c/278935/
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Module 2

Topic **2**

# Establishment of a Seed Testing Laboratory.

**Overview.**

This topic describes the major kinds of seed testing laboratories and their scope for seed testing. Emphasis is made on kind of seed testing laboratories, the organizations involve and their roles in establishing seed testing laboratories, and defining.  The scope of laboratory analyses required in the immediate, short and long term. This topic also covers information on the decision making on the location for seed laboratory, kind of staff needed and training needs.

**Learning Outcomes.**

At the end of this topic, the learners should be able to:

- Understand the need for  seed testing laboratories
- Know the technical requirements of the specific seed testing methods
- Define the kind of seed testing laboratory needed
- Decide on the analysis required to establish a seed testing laboratory

**Duration.**

**1hour, 30mins**

| | | |
|---|---|---|
| Introduction | | 5 minutes |
| Plenary:  1 | Brainstorming, Question and Answer | 10 minutes |
| Plenary:  2 | Guided discussions, and presentations | 20 minutes |
| Plenary:  3 | Group discussions. | 15 minutes |
| Plenary:  4 | Presentations | 20 minutes |
| Post-test (Evaluation) | | 15 minutes |
| Conclusion | | 5 minutes |

**Equipment or materials needed**

- Visual Aid (Slide or Poster):
  - Title: Sed Testing Lab:
  - Concise Definition: Display of the definition
- Technical Equipment:
  - Mobile projector for visual aid and potential additional media.
- Participant Resources:
  - Notebooks and writing tools for notes and activity engagement.
- Interactive Materials:
- Large paper, markers, and affixing materials (tape/pins) for collaborative exercises (e.g., participatory setting of objectives and activities).

## Introduction:

Having a seed testing laboratory in a country or company means being autonomous in testing the quality of the seeds produced, used, processed, traded, imported or exported, or even those stored in gene banks. The decision to build and run a seed testing laboratory is usually part of a general policy or business strategy, such as developing agriculture schemes for government laboratories, or businesses for seed companies or private third parties involved in seed testing.

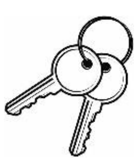
Brainstorming

What are the different types of seed testing laboratories?
Why is a seed testing laboratory important?
What is the suitable location for establishing a seed testing laboratories?
Who are the stakeholders of a seed testing laboratory?

**How many seed analysts are needed in a seed testing laboratory?**

Is it necessary for seed testing laboratory workers to be trained?
Where can you get training for seed testing laboratory workers?

Key Terms:



**"Seed Testing Laboratory":** This is a facility equipped to analyze and evaluate the quality of seeds for various purposes such as agriculture, research, or commercial production. The labs conduct tests to determine factors like germination rate, purity, viability, seed vigor, and seed moisture content.

**"Seed Analyst"**: This is a professional who works in a seed testing laboratory and specializes in evaluating seeds. Seed analysts are trained to perform various tests to assess seed quality, identify any impurities, contaminants, and provide accurate results to help seed producers and farmers make informed decisions.

**"Seed testing needs assessment"**: This is a process of evaluating the requirements, resources, and capabilities of a laboratory to determine what is necessary for its effective operation and performance. This assessment involves identifying and analyzing the equipment, facilities, staff expertise, training needs, budgetary considerations, and other factors essential for meeting the objectives and standards of the laboratory. By conducting a thorough needs assessment, laboratories can address gaps, optimize their operations, and ensure that have the necessary resources to fulfill their functions effectively and efficiently.

**"Laboratory Staffing"**: This involves the selection, training, and management of personnel working in a laboratory setting. This includes hiring qualified seed analysts, technicians, and other staff members to conduct seed testing, maintain equipment, interpret tests results, and ensure the smooth operation of the laboratory.

**"Laboratory Site Selection"**: Is the process choosing an appropriate location for establishing a seed testing laboratory. Factors such as accessibility, infrastructure, proximity to seed producers, and environmental conditions, and regulatory requirements are considered when selecting a site for setting up a seed testing laboratory.

## Importance of seed testing laboratory and needs assessment

In a nutshell seed testing laboratories are crucial to safeguard seed quality, purity, and trade.

It is therefore necessary for a nation to have seed testing laboratories for the following reasons.

1. **Quality control:** Seed testing laboratories play a crucial role in maintaining quality control standards for seeds used in agriculture, ensuring that only high-quality seeds are distributed to farmers and producers.

2. **Regulatory compliance:** Seed testing laboratories help ensure compliance with regulations and standards set by government agencies and industry bodies, safeguarding the integrity of the seed industry.

3. **Research and development:** These laboratories support research and development efforts by providing accurate seed quality data, leading to the development of new seed varieties and improved agricultural practices.

4. **Disease and pest control:** Seed testing laboratories can detect diseases, pests, and contaminants in seeds, helping prevent the transfer of pathogens and invasive species to new areas.

5. **Consumer protection:** By conducting quality tests, seed testing laboratories protect consumers from purchasing substandard or contaminated seeds that could lead to crop failure or reduced yields.

6. **Crop productivity:** Accurate seed testing results from laboratories help farmers choose the best seeds for planting, leading to higher crop productivity, better yields, and improved agricultural sustainability.

7. **International trade:** Seed testing laboratories facilitate international trade by providing certification and testing services that ensure seeds meet the phytosanitary requirements and quality standards necessary for export and import transactions.

However, for a laboratory to be able to operate and effectively and efficiently perform its functions, it has to be adequately equipped and sufficiently staffed, hence a laboratory needs assessment is mandatory. Thus laboratories have defined needs which are influenced by factors such as below:

- The crop species included and the equipment needed to analyse either unprocessed raw or cleaned seed lots ready for trade;
- The harvesting and planting season for the main crops to be tested, which will indicate peak times for the laboratory;
- The type of seed lot sampling, e g internal sampler belonging to the seed processing plant or external samplers from a network of samplers;
- The choice of standard methods (e g ISTA methods from the latest edition of the *International Rules for Seed Testing*, known as 'ISTA Rules') or the need to develop other in-house methods.
- Whether ISTA membership and ISTA accreditation are necessary if using ISTA methods; and
- The issuance of test reports, e g in-house, national regulatory or international for export needs (ISTA Certificates).

Consequently, the laboratory first needs to define a strategy based on its role as a governmental laboratory, a company laboratory or a laboratory doing private third-party testing.
The types of laboratories are considered in the following subtopics

## Defining the types of Seed laboratory needed.

There are different types of seed testing laboratories. These laboratories differ in their degrees of complexity. Seed testing laboratories can be categorized as follows:

1. **A basic seed testing laboratory:**
   This type of seed laboratory is sufficient to analyze freshly harvested seeds or seed lots during processing. In this laboratory, the methods adapted should be specific to the laboratory needs. There may be no need to follow ISTA methods or use complex equipment. Staff training may be based on in=house methods. This type of laboratory is the lowest cost option for a laboratory to start with and is strictly limited to the scope of activities defined.

2. **A standard seed testing laboratory:**
   This category analyzes the quality of seeds for local needs and inform end users and farmers on the seed quality before sowing. It also runs analysis on freshly harvested seeds or during processing. The methods used in this laboratory are based on standard methods (ISTA Rules) but not necessarily strictly followed. Staff training and, equipment should follow the requirements of the ISTA Rules. This category of laboratory can also be small; operated by three people, with a limited scope of activities, but one that meets the local needs. The investment and the operating costs are lower than the advanced and expert laboratories.

3. **An advanced seed testing laboratory:**

This category has a traceability system which is important for national trade and/or a national regulation system (e.g. seed certification). The samplers and other staff in this laboratory should be well trained, qualified and registered. Standard methods are used throughout the process, from sampling and sample preparation to testing. The equipment should be precise, accurate and regularly maintained. A quality system is recommended .This category of laboratory needs several years of experience to be run effectively and efficiently. The investments for equipment, people and the operating budget are higher than basic and standard Laboratories The staff need to be well trained and qualified in the methodology .Training can be from experienced personnel in the seed laboratory as part of an official training system for seed analysts available in the country or from another recognized source .

4. **An expert seed testing laboratory**:
   This category tests seed quality for all requirements. It provides certificates of quality for national and international trade and also responsible for the needs of national regulatory bodies. This kind of laboratory guarantees full traceability from the seed lot to the test results and ensures uniformity of results worldwide, provided it is **accredited by ISTA**. The accreditation requires a fully implemented quality system, extra equipment (calibrated, verified, controlled and maintained), qualified staff, high performance in internal and external PTs, and verification of all activities during regular internal and external audits  An expert seed testing laboratory that can issue internationally valid certificates needs extensive experience and has additional operating costs linked to equipment, people, the Quality Assurance system and the accreditation needs  This type of laboratory will cost the most to establish and maintain

## Organizations involved in Seed Testing Laboratory

**Governmental seed testing laboratory:**

Governmental laboratory objectives are usually described in seed laws, national seed regulations or breeding programmes established by the government or state regulatory organizations. For example, there is typically a need:

- To provide farmers with seed of known analytical purity (i e weed seed content) and level of germination produced by governmental organizations or delegates (subcontractors), to contribute to producing food and feed. The government laboratory tests are mostly *basic* or *standard* for instance analytical purity, other seed determination (OSD), germination, and often moisture and thousand-seed weight (TSW), but is limited to the species produced in the region. Developing a quality assurance programme or seeking accreditation may be scheduled as a longer-term goal.
- To have an official 'tool' to be part of a national seed production scheme, possibly based on a seed certification scheme such as that recommended by the Organization for Economic Co-operation and Development (OECD) The scope of activities of the laboratory should cover sampling and basic testing of all the species produced in the country.
- To have an official 'tool' to guarantee the country's independence when importing/exporting seeds. International organizations such as the International Seed Federation (ISF) and OECD recommend that ISTA International Seed Certificates (Orange or Blue) are used. The laboratory will have to be accredited by ISTA to issue ISTA Certificates. This requires:
    - *implementation of a QA programme;*
    - *calibration and regular verification of laboratory equipment;*
    - *training of staff and ensuring that trained deputies are assigned to key activities for secured continuity;*
    - *participation in ISTA Proficiency Test (PT) programmes to guarantee the uniformity of the laboratory's performance; and*
    - *full traceability from sampling to issuing test reports, by keeping records for at least 6 years*

**Seed company laboratory:**

Seed companies have their own seed testing laboratory. Such laboratory objectively support quality control of seed processing.
Some laboratories are accredited by ISO/IEC 17025:2005 EC and or ISTA to facilitate international trade, while others focus on testing the quality of freshly harvested seeds and those undergoing processing by the seed laboratories.
Newly established seed testing laboratories benefit from the experiences and expertise of existing company laboratories.

Regional, medium or small seed companies, or companies in developing areas, may plan to build a new laboratory. The laboratory can be designed to meet the company's strategic development that addresses the objectives of testing the quality of the seed produced.

Four levels of need can be identified, and the laboratory can fulfill more than one of these needs:

1. Testing the quality of freshly harvested seeds. Sampling raw seed lots may require adapting the sampling methods and tools to conform with the raw material. Micro-cleaning samples to simulate the processing in the production plants may also be necessary before testing the analytical purity and germination level.
2. Testing the quality during seed processing to identify problems, take early corrective measures, and plan further processing steps. Quick and informative are the key words; information must be given to the seed processing plant quickly to adjust the different processing stages if necessary. The main tests needed (analytical purity, germination, and moisture) may not strictly follow standard ISTA methods regarding the size of working samples.
3. Testing the quality of the seeds to be traded or distributed to end users, farmers, or seed growers. The production of seed can be part of a national seed certification scheme with field inspection and samples taken for official seed testing. Alternatively, seed can be produced by a seed company authorized to self-certify, or can be produced under a national legal framework where seed companies declare the quality. These conditions may vary in any given country, where some crops may have compulsory certification, and others do not need certification. For all cases where seed is to be sold with the quality assurance of the seed company, the laboratory will need to be equipped and the staff trained according to ISTA requirements. This may lead to the laboratory becoming accredited by ISTA.
4. Testing stocks of 'carried-over' seed stored in the warehouse before the next sales season.

**Private third-party testing**

The aim is to provide all the services and testing if allowed under national regulations. The premises, equipment and staff qualifications will depend upon the scope of activities. Private third-party laboratories could either receive samples directly from non-authorized samplers and report the quality of the sample received, or collect the sample through their own or an authorized sampler and report the quality of the entire seed lot  The objectives or requirements of ISTA methods and being ISTA accredited guarantee the quality and reliability of the services provided.

## Defining the scope of analyses needed in immediate, short and long term

It is a prerequisite to define the scope of laboratory analyses required in the immediate, short and long term. This is because:

- Provision of laboratory equipment and staff training depends on the diversity of species to be analyzed. For example, grasses such as *Poa trivialis* and *Dactylis glomerata* need a seed blower for analytical purity tests.
- Different species will have different peak times throughout the year. Variations will occur when testing 1000 samples each of two winter crops rather than the same numbers of a winter and a summer crop.
- Different species differ in the period between harvesting and the next planting season. As such the time when to obtain quality test result will vary.
- The samples to be tested annually determine the laboratory size, instruments needed, and the number of samplers.
- The type of tests requested determine the space, equipment, supplies and staff training and qualifications.
- The laboratory may work only with national/export seed lot samples or with seed lot samples taken from imported seed lots from another region.

## Which crop species will be analyzed?

The species of seeds to be analyzed is defined by the customers and stakeholders of the laboratory. A governmental laboratory must cover all regulated crop species A seed company laboratory may only need to analyse the seed of the species produced and traded by that company. A private third-party laboratory must define its business to fit market needs.

To define the crop species that needed analysis, the following steps are recommended.

1. Full inventory of the species to be analyzed is made including local as well as exotic species. Priorities are given to land races and set according to national regulations, the strategy and the *80 vs. 20 %* principle. This principle concentrates on the species that make up 80 % of the analyses, the seed production or the profits.
2. For uniformity, categorize the species according to the ISTA crop groups (i e  grasses; cereals; small legumes; pulses; other agricultural species; vegetables; spices, herbs and medicinal species; tree and shrub species; flower species).
3. Limit the number of species selected to two or three groups based on local needs. Prioritize groups that are easier to analyse. (e.g cereals, vegetables etc.
4. To establish your system, operate the laboratory and accumulate experience in working with the essential species for your customers
5. Species that are less frequently analyzed are included in future extension plans.

These steps are summarized in the decision Tree in the figure 2 below.

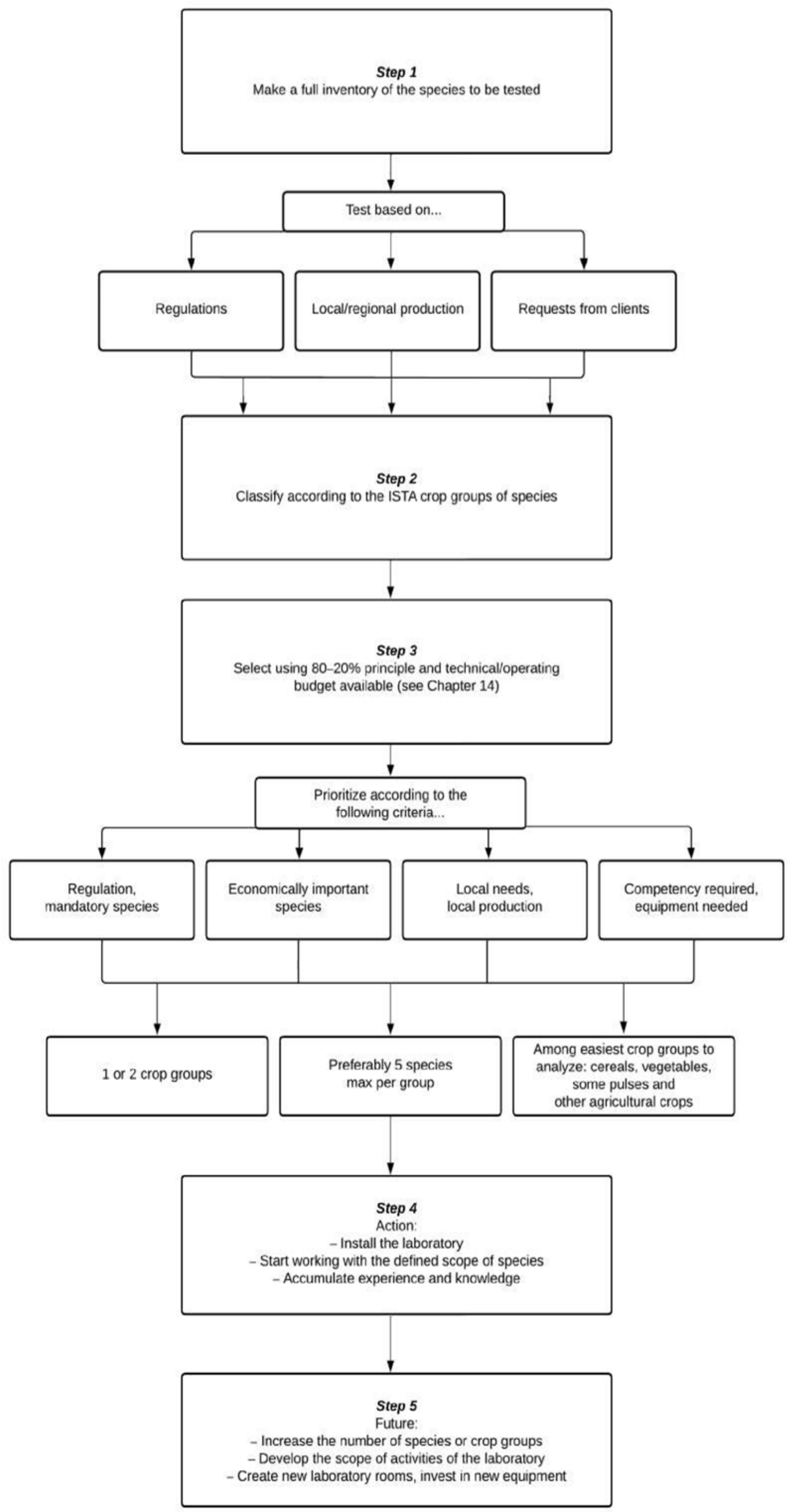



Figure 2: Decision Tree to define the Scope of Species to be analyzed by a Seed testing Laboratory.

Source: Adapted from Joint FAO & ISTA Handbook, 2023. Page 8.

## Deciding on the best location

Deciding on the best location is determined by the following criteria:

- Distance of the laboratory from the production area. Critical factors that affect the quality of the samples include climatic conditions, the distance between the collection site and laboratory, and the shipping transportation mode.
- Reliable sources of electric power, tap water and internet connections.
- Environment and climatic risks. Avoid establishment of a laboratory in places with known climate-related risks such as seasonal heat or cold cycles, flooding, fires, earthquakes and torrential rains.
- Proximity of laboratory to other scientific institutes or universities to support the training and development of new staff.
- Access for staff employees to different facilities to encourage them to work at this location.
- Availability of local resources. An available existing building within an institution may be used or a new structure may be built using available resources.

All these considerations determine building size, laboratory layout, staff needs, sample flow and budgets needed for investments and running the laboratory daily. Use a modular approach and think about an efficient workflow. Adding more specialized testing in the future is a critical part of the longer-term plan to establish a seed testing laboratory

## Laboratory Staffing

Labor force is an important component of a seed laboratory. To start a laboratory, analysts should have skills in seed testing, while managers need both skills in seed testing and business management. It is vital to employ staff who may wish to sustain their job so as to build expertise in seed testing. Staff should be encouraged to remain loyal by provision of job security, good salaries, annual bonuses, health care, a sense of team and belonging, career progression, etc.

Networking and collaboration with existing seed laboratories is essential for establishment of seed laboratory in a given area. A consultant from a seed laboratory accredited by ISTA could assist in capacity building for workers in a newly established seed laboratory.

### How many seed analysts are needed?

A laboratory doing other seed determination (OSD), analytical purity and germination testing for 2000 samples of mixed species needs four analysts. For a laboratory testing 5000 mixed species samples, seven analysts were needed, plus one administration person and a person to head the laboratory.

Testing needs can also be estimated by determining the time taken to receive, prepare, test, report, file and store samples. This approach may also help estimate how much to charge customers for a seed testing service. The fee for seed testing will need to include staff time, consumable costs, building overheads, depreciation, etc., and will be influenced by the funding. The laboratory may be supported by the state, a parent company or be entirely self-funded, needing to invoice for work at the full economic rates. The testing time varies depending on staff experience and established quality assurance requirements. Extra tests will be needed for occasional retesting, verification of equipment, stock solutions and storage conditions, and conducting internal and external Proficiency Testing (table below).

**Table 1: Estimated operations times for the different tests on large-seeded crop species, grass**

| | | |
|---|---|---|
| Sample receiving | 5–10 | 5–10 |
| Working sample preparation (mixing and dividing) | 10 | 15 |
| Percentage analytical purity testing | 40 | 60 |
| Other seed determination and seed ID (OSD) | 30 | 120 |
| Thousand-seed weight (TSW) testing | 15 | 15 |
| Germination testing:<br>• preparation of substrates<br>• planting | 15 | 25 |
| Germination assessment | 45 | 45 |
| Moisture testing | 30 | 30 |
| Worksheet checking, result calculation and reporting | 5–10 | 5–10 |
| Results authorization, issuance and invoicing | 5–10 | 5–10 |
| *Seed analyst testing time (minutes)* | *200–215* | *325–340* |
| Other time per sample (minutes) | 30 | 30 |
| *Total sample processing, testing and reporting time (minutes)* | *230–245* | *355–370* |

Additional time needed[a]

| | | |
|---|---|---|
| *Linked to analysis*[b]<br>• preparation of analyses (setting climate rooms, checking balances, preparing labels, carrying samples)<br>• maintenance of equipment<br>• cleaning of benches and equipment<br>• checking supplies, ordering, sample reception | Percentage of total time (estimated at 10%) | Percentage of total time (estimated at 10%) |
| *Staff management*[c]<br>• internal meetings<br>• organization of work<br>• training<br>• safety<br>• time for staff breaks<br>• vacations (percentage of total time)<br>• preparation to start work upon arrival and to leave work | Percentage of total time (estimated at 20%) | Percentage of total time (estimated at 20%) |

*Note(s):*

[a]The lower part of the table provides some estimates that add 10–30 percent on to the total working time per staff team needed and depends on legislation, internal management rules, staff number, etc.

[b]Significant time must be added to the time strictly dedicated to the analysis, e.g. preparation, cleaning, staff laboratory life (discussion and coordination).

[c]Additional time for staff management will vary with internal regulations or national legislation.

**(Source: Adapted from Joint FAO & ISTA Handbook, 2023. Page 14.)**

### Training needs

Short courses in seed testing and management of seed laboratories for training purposes can be availed in South Sudan public universities. Interested individuals or organizations that wish to build capacity may contact the relevant authorizes in the institutions. In-lab training for new staff other training opportunities like ISTA workshops, self-study of publications, web-based learning or Consultancies may exist.

It is also worth noting that FAO supports member countries in capacity-building activities for seed testing

The different ISTA technical handbooks are useful resources for training and provide details on the International Rules for Seed Testing (ISTA Rules). Topic 2 of this handbook provides guidance and tips on testing methods.

The South Sudan seed hub web site exists that may be accessed through www.southsudanseedhub.com also provides important resources.

**References and further reading**


FAO & ISTA. 2023. Guidelines for the establishment and management of seed testing laboratories – Joint FAO and ISTA Handbook. Rome. https://doi.org/10.4060/cc6103en

ISTA. 2024. Chapter 2: Sampling. In :International Rules for Seed Testing, Volume 2024, Number 1, January 2024, pp. 1-52(52) https://doi.org/10.15258/istarules.2023.02

Module 2

# Topic 3 Seed Testing Methods.

**Overview.**

This topic explores the different methods utilized in seed testing, from germination tests to genetic purity assays, and explains the importance of each method in determining seed viability, vigor, purity, and health.

**Learning Outcomes.**

At the end of this topic, the learners should be able to:

- Describe the different methods of seed testing
- Conduct seed testing using the various methods he/she learned.
- Observe standard operation procedures in a seed laboratory

Duration.

2hours, 25mins

| | | | |
|---|---|---|---|
| Introduction and Pre-test (Evaluation) | | | 20 minutes |
| Plenary: | 1 | Brainstorming, Question and Answer | 30 minutes |
| Plenary: | 2 | Guided discussions, and presentations | 20 minutes |
| Plenary: | 3 | Group discussions (Exercises) | 25 minutes |
| Plenary: | 4 | Presentations | 30 minutes |
| Post-test (Evaluation) | | | 15 minutes |
| Conclusion | | | 5 minutes |

Equipment or materials needed

- Visual Aid (Slide or Poster):
  - Title: Seed labs:
  - Concise Definition: Display of the definition of
- Technical Equipment:
  - Mobile projector for visual aid and potential additional media.
- Participant Resources:
  - Notebooks and writing tools for notes and activity engagement.
- Interactive Materials:
- Large paper, markers, and affixing materials (tape/pins) for collaborative exercises (e.g., participatory setting of objectives and activities).

## Introduction

Accredited seed testing laboratories use standardized seed sampling and testing methods. These methods are used globally to produce consistent, reliable and accurate results. The International Seed Testing Association rules have standards for some agricultural crop species belonging to genera of the following crop groups; 1 - Grasses, 2- Cereals, 3 - Pulses, 4 - Small legumes,

5 – Other agricultural species, 6 – Vegetables, spices, herbs, and medicinal species, 7 – Tree and Shrub species, and Flower species. When a seed lab follows the standards it will qualify for ISTA Accreditation.

**Brainstorming**

In small groups of up to 9 participants, reflect on the following questions.

- Explores the different methods utilized in seed testing
- Importance of each method

These questions can be asked again at the end of the session, allowing participants to assess their learning.

## Objective & Importance of Seed Testing

Seed testing is required to achieve the following objectives for minimising the risks of planting low quality seeds.

- To identify the quality problem and their probable cause
- To determine their quality, that is, their suitability for planting
- To determine the need for drying and processing and specific procedures that should be used
- To determine if seed meets established quality standards for labeling specifications.
- To establish quality and provide a basis for price and consumer discrimination among lots in the market.

The primary aim of the seed testing is to obtain accurate and reproducible results regarding the quality status of the seed samples submitted to the Seed Testing Laboratories

## Importance

- The importance of seed testing was realized more than 100 years ago for assured planting values. The adulteration of vegetable seeds by stone dust which was packed in some parts of the world particularly in Europe.
- Seed testing has been developed to aid agriculture to avoid some of the hazards of crop production by furnishing the needed information about different quality attributes viz., purity, moisture, germination, vigour and health.
- Quality control of seed depends on the different seed testing protocols which determine the genuineness of the cultivar.
- Testing of seed to evaluate the planting value and the authenticity of the certified lot.
- Seed testing is required to assess the seed quality attributes of the seed lots which have to be offered for sale.
- These quality attributes are seed moisture content, germination and vigour, physical and genetic purity, freedom from seed borne diseases and insect infestation. In India, seed testing is done mainly for moisture, germination and physical purity of seeds.
- Standard seed testing procedures for the evaluation of the seeds were developed by ISTA. It is obligatory on the part of the seed analyst to follow rules prescribed by 1STA (1STA, 1985) if the seed is moving to the International trade.

- The seed testing procedures which are described below are based mostly on the international rules because most of our rules (Chalam et al. 1967) are based on, 1STA, 1996. Economic yield of a crop depends on the quality of seeds which can be evaluated by seed testing (1STA, 1996).
- The testing of seed quality is carried out on seed samples drawn from seed lot to be used for cultivation. The quantity of seed sample taken for testing in laboratory is minute compared to that of seed lot it represents.

## Role of Seed Testing Laboratories

Seed testing laboratories are essential organization in seed certification and seed quality control programmes. The main objective is to serve the producer, the consumer and the seed industry by providing information on seed quality. Test results may cause rejection of poor seed multiplication or low-grade seed in a count of law.

## Analysis of seed in the laboratory:

**The Seed Testing Laboratory** is the hub of seed quality control. Seed testing services are required from time to time to gain information regarding planting value of seed lots. Seed testing is possible for all those who produce, sell and use seeds.

Seed testing is determining the standards of a seed lot viz., physical purity, moisture, germination and "other seeds" and thereby enabling the farming community to get quality seeds.

Seed testing is possible for all those who produce, sell and use seeds. Seed testing is highly specialized and technical job. With a view to maintain uniformity in quality control the seed analysis laboratory includes for distinct sections.

- Section for purity testing: Purity analysis of seed lot is considered under two factors a) Testing the cleanliness of seed lot and b) Testing the genuineness of the cultivar
- Section for moisture testing
- Section for viability, germination and
- Section for vigour testing

## Sampling in Seed Testing Laboratory

The seed samples received in the laboratory (submitted sample) are required to be reduced to obtain working samples for carrying out various tests. A number of methods are available for obtaining working samples.

**Mixing and dividing of seeds**

The main objective of mixing and dividing of seeds is to obtain the representative homogenous seed sample for analysis by reducing the submitted sample to the desired size of working sample.

**Method of mixing and dividing**

1. Mechanical dividing
2. Modified halving method
3. Hand halving method
4. Random cup method
5. Spoon method

1. Mechanical method

The reduction of sample size is carried out by the mechanical dividers suitable for all seeds except for chaffy and fuzzy seeds.

**Objective of mechanical dividing**

- To mix the seed sample and make homogenous as far as possible.
- To reduce the seed sample to the required size without any bias. The submitted sample can be thoroughly mixed by passing it through the divider to get 2 parts and passing the whole sample second time and 3rd time if necessary to make the seeds mixed and blended so as to get homogenous seed sample when the same seeds are passed through it into approximately equal parts.
- The sample is reduced to desired size by passing the seeds through the dividers repeatedly with one half remain at each occasion.

**Types of mechanical dividers**

**1.1 Boerner divider**

It consists of a hopper, a cone and series of baffles directing the seeds into 2 spouts. The baffles are of equal size and equally spaced and every alternate one leading to one spout. They are arranged in circle and are directed inward. A valve at the base of the hopper retains the seeds in the hopper. When the valve is opened, the seeds fall by gravity over the cone where it is equally distributed and approximately equal quantity of seeds will be collected in each spout. A disadvantage of this divider is that it is difficult to check for cleanliness.

**1.2 Soil divider**

It is a sample divider built on the same principles as the Boerner divider. Here the channels are arranged in a straight row. It consists of a hopper with attached channels, a frame work to hold the hopper, two receiving pans and a pouring pan. It is suitable for large seeds and chaffy seeds.

**1.3 Centrifugal or Gamet divider**

The principle involved is the centrifugal force which is used for mixing and dividing the seeds. The seeds fall on a shallow rubber spinner which on rotation by an electric motor, throw out the seeds by centrifugal force. The circle or the area where the seeds fall is equally divided into two parts by a stationary baffle so that approximately equal quantities of seed will fall in each spout.

**2. Modified halving method**

The apparatus consists of a tray into which is fitted a grid of equal sized cubical cups open at the top and every alternate one having no bottom. After preliminary mixing the seed is poured evenly over the grid. When the grid is lifted, approximately half the sample remains on the tray. The submitted sample is successively halved in this method until a working sample size is obtained.

**3. Hand halving method**

The hand halving method can be used for chaff seeds (e.g. *Echinochloa*, *Gossypium*) and for easily damaged and fragile seeds like *Arachis*, *Glycine* and *Phaseolus* The method can also be performed for certain tree and shrub species The sample is poured on a smooth, clean surface and thoroughly mixed with a spatula The following steps are then followed:

- The sample is divided into two portions
- The two subsamples are divided again into four subsamples

- The four subsamples are divided into eight subsamples
- From the eight subsamples, every second sample is selected and recombined into a working sample


**4. Random cup method**

This is the method suitable for seeds requiring working sample up to 10 grams provided that they are not extremely chaffy and do not bounce or roll (e.g.) Brassica spp. Six to eight small cups are placed at random on a tray. After a preliminary mixing the seed is poured uniformly over the tray. The seeds that fall into the cup are taken as the working sample.

**5. Spoon method**

This is suitable for samples of single small seeded species. A tray, spatula and a spoon with a straight edge are required. After preliminary mixing, the seed is poured evenly over the tray. The tray should not be shacked thereafter. With the spoon in one hand, the spatula in the other and using both small portions of seed from not less than 5 random places on the tray should be removed. Sufficient portions of seed are taken to estimate a working sample approximately but not less than the required size.

## Purity analysis

The purity analysis of a seed sample in the seed testing laboratory refers to the determination of the different components of the purity viz., pure seeds, other crop seeds, weed seeds and inert matter.

**Objective**

The objective of the purity analysis is to determine whether the submitted sample conforms to the prescribed physical quality standards with regard to physical components.

**Method**

**The working sample**

The purity analysis is done on the working sample of prescribed weight drawn from submitted sample. The analysis may be made on one working sample of the prescribed weight or on two sub-samples of at least half of this weight, each independently drawn.

**Purity separation**

The working sample after weighing is separated into its components viz., pure seed, other seed crop, weed seed and inert matter.

**Pure seed**

The seeds of kind / species stated by the sender. It includes all botanical varieties of that kind / species. Immature, undersized, shriveled, diseased or germinated seeds are also pure seeds. It also includes broken seeds, if the size is >1/2 of the original size except in Leguminosae, and Cruciferae where the seed coat entirely removed are regarded as inert matter.

**Other crop seed**

It refers to the seeds of crops other than the kind being examined.

**Weed Seed**

It includes seeds of those species normally recognized as weeds or specified under Seed Act as a noxious weed.

Inert matter It includes seed like structures, stem pieces, leaves, sand particles, stone particles, empty glumes, lemmas, pales, chaff, awns, stalks longer than florets and spikelets.

Method of purity separation. Place the sample on the purity work board after sieving / blowing operations and separate into other crop seeds and inert matter. After separation, identify each kind of weed seeds, other crop seeds as to genus and species. The names and number of each are recorded. The type of inert matter present should also be noted.

## Seed germination test

Germination is defined as the emergence and development from the seed embryo, of those essential structures, for the kind of seed in question, indicates its ability to produce a normal plant under favorable conditions.

**Principles**

Germination tests shall be conducted with a pure seed fraction. A minimum of 400 seeds are required in four replicates of 100 seeds each or 8 replicates of 50 seeds each or 16 replicates of 25 seeds each depending on the size of seed and size of containers of substrate. The test is conducted under favorable conditions of moisture, temperature, suitable substratum and light if necessary. No pre-treatment to the seed is given except for those recommended by ISTA.

Materials required Substratum The substratum serves as moisture reservoir and provides a surface or medium for which the seeds can germinate and the seedlings grow. The commonly used substrate are sand, germination paper and soil.

1. **Sand**
    - Size of sand particle Sand particles should not be too large or too small. The sand particles should pass through 0.80 mm sieve and retained by 0.05mm sieve.
    - Toxicity Sand should not have any toxic material or any pathogen. If there is presence of any pathogen found then the sand should be sterilized in an autoclave.

**Method of seed placement**

Seed in sand(S)

Seeds are planted in a uniform layer of moist sand and then covered to a depth of 1 to 2 cm with sand.

Top of sand (TS) Seeds are pressed in to the surface of the sand.

- Spacing. We must give equal spacing on all sides to facilitate normal growth of seedling and to avoid entangling of seed and spread of disease. Spacing should be 1-5 times the width or diameter of the seed.
- Water. The amount of water to be added to the sand will depend on size of the seed. For cereals, except maize, the sand can be moistened to 50% of its water holding capacity. For large seeded legumes and maize sand is moistened to 60% water holding capacity.

**2. Paper.**

Most widely used paper substrates are filter paper, blotter or towel (kraft paper). It should have capillary movement of water, at vertical direction (30 mm rise / min.). It should be free from toxic substances and free from fungi or bacteria. It should hold sufficient moisture during the period of test. The texture should be such that the roots of germinating seedlings will grow on and not into the paper.

**Methods**

<u>Top of paper (TP)</u>

Seeds are placed on one or more layers of moist filter paper or blotter paper in petriplates. These petriplates are covered with lid and placed inside the germination cabinet. This is suitable for those seeds which require light.

<u>Between paper (BP)</u>

The seeds are germinated between two layers of paper. The seeds are placed between two layers of paper and rolled in towels. The rolled towels are placed in the germinator in an upright position

**Germination apparatus**

**Germination cabinet / Germination room**

This is called chamber where room

temperature and relative humidity are controlled. We can maintain the temperature, relative humidity and light required for different crops.

**Room germinator**

It works with same principle as that of germinator. This is a modified chamber of larger one and the worker can enter into it and evaluate the seedlings. Provisions are made to maintain the temperature and relative humidity. This is used widely in practice.

**Seed counting board**

This is used for accurate counting and spacing of seeds. This consists of 2 plates. The basal one is stationary and top one is movable. Both top and basal plates are having uniform number of holes viz., 50/100, when the plates are in different position. After taking the sample, the top plate is pulled in such a way that the holes are in one line so that the fixed number of seeds falls on the substratum.

**Vacuum seed counter**

Consists of a head, pipe and wall. There are plates of 50 or 100 holes which can be fitted to the head. When vacuum is created the plate absorbs seeds and once the vacuum is released the seeds fall on the substrate.

### Impression board

Made of plastic / wood with 50 or 100 holes / pins. Here the knobs are arranged in equal length and space. By giving impression on the sand it makes uniform depth and spacing for seed

**Evaluation of germination test the germination test is evaluated as**

- Normal seedlings
- Abnormal seedlings
- Hard seeds
- Fresh and un-germinated seeds
- Dead seeds

ISTA classified the seedlings into different categories based on the development of essential structures.

## Normal seedlings

Seedlings which have the capacity for continued development into normal plant when grown in favorable conditions of soil, water, temperature and light.

**Characters of normal seedlings**

- A well-developed root system with primary root except in certain species of Gramineae which normally produce seminal root or secondary root.
- A well-developed shoot axis consisting of elongated hypocotyls in seedlings of epigeal germination.
- A well-developed epicotyl in seedlings of hypogeal germination.
- One cotyledon in monocotyledon and two in dicotyledons.
- A well-developed coleoptile in Gramineae containing a green leaf.
- A well-developed plumule in dicotyledons.

**Normal seedlings**

- Seedlings with following slight defects are also taken as normal seedlings.
- Primary root with limited damage but well-developed secondary roots in Leguminosae (Phaseolus, Pisum), Gramineae (Maize), Cucurbitaceae (Cucumis) and Malvaceae (cotton)
- Seedlings with limited damage or decay to essential structures but no damage to conducting tissue.
- Seedlings which are decayed by a pathogen with a clear evidence that the parent seed is not the source of infection.

**Abnormal seedlings**

Seedlings which do not show the capacity for continued development into normal plant when grown in favorable condition of soil, water, temperature and light.

**Types of abnormal seedlings**

<u>Damaged seedlings</u>

Seedlings with any one of the essential structures missing or badly damaged so that balanced growth is not expected. Seedlings with no cotyledons, with splits, cracks and lesions or essential structures and without primary root.

<u>Deformed seedlings</u>

Weak or unbalanced development of essential structures such as spirally twisted or stunted plumule or hypocotyls or epicotyls, swollen shoot, stunted roots etc. twisted coleoptile Twisted coleoptiles

<u>Decayed seedlings</u>

Seedlings with any one of the essential structures showing diseased or decayed symptoms as a result of primary infection from the seed which prevents the development of the seedlings. Decayed Seedlings

**Hard seeds**

Seeds which do not absorb moisture till the end of the test period and remain hard (e.g.) seed of Leguminosae and Malvaceae.

**Fresh and ungerminated seeds**

Seeds which are neither hard nor have germinated but remain firm and apparently viable at the end of the test period.

**<u>Note: Hard seeds and fresh ungerminated seeds are counted as 'Normal seedlings' after the final count evaluation</u>**

**Dead Seeds**

Seeds at the end of the test period are neither hard or nor fresh or have produced any part of a seedling. Often dead seeds collapse and milky paste comes out when pressed at the end of the test.

Retesting. If the results of a test are considered unsatisfactory it will not be reported and a second test will be made by the same method or by alternative method under the following circumstances.

1. Replicates performance is out of tolerance
2. Results being inaccurate due to wrong evaluating of seedlings or counting or errors in test conditions
3. Dormancy persistence or phytotoxicity or spread of fungi or bacteria. The average of the two tests shall be reported.

**Use of tolerances**

The result of a germination test can be relied upon only if the difference between the highest and the lowest replicates is within accepted tolerances. To decide if two test results of the same sample are compatible again the tolerance table is used.

**Reporting results**

The result of the germination test is calculated as the average of 4x100 seed replicates. It is expressed as percentage by number of normal seedlings. The percentage is calculated to the nearest whole number. The percentage of abnormal seedlings, hard, fresh and dead seeds is calculated in the same way. These should be entered on the analysis of certificate under appropriate space. If the result is 'nil' for any of these categories it shall be reported as '0'.

## Determination of moisture content

**Objective**

To determine the moisture content of seeds by methods suitable for routine use.

**Definition**

The moisture content of a seed sample is the loss in weight when it is dried. It is expressed as a percentage of the weight of the original sample. It is one of the most important factors in the maintenance of seed quality.

**Method of moisture determination**

1. Air oven method
   In this method, seed moisture is removed by drying the seed sample at a specified temperature for a specified duration.

2. Moisture meters
   Moisture meters estimate seed moisture quickly but the estimation is not as precise as by the air oven method.

## Exercise 3: Percentage germination test

Objectives: To test the knowledge about seed testing and its methods used.

The learner will be able to:

- Distinguish the different methods used in seed testing
- Define the objective of seed testing
- Identify the characteristics of a normal seed

Experiment1. Percentage germination test

Items required. Perforated tray, paper/cotton tissue, cool dry room, water/dropper, makers and labelling paper, 50-100 seeds/grains

Steps to follow

- Lay out tray on a table
- Place tissue paper over the surface covering the perforation
- Mark out 100 squares on the tissue paper
- Place one seed in each square
- Cover the seed and moisture the whole tissues and seeds
- Label and let the experiment stand for 7 days
- After 4 days, carry out the first counting and final counting after 7 days
- Calculate percentage germination

Module 2

Topic 4

# Labeling standards and their implications on seed trade.

**Overview.**

**This topic examines the global standards for seed labeling and their implications for international seed trade, and explains how proper labeling can influence trade compliance, customer trust, and traceability. Seed labeling standards are crucial in ensuring that seeds are accurately identified, allowing for proper verification and establishing trust between producers, distributors, and consumers.**

**Learning Outcomes.**

At the end of this topic, the learners should be able to:

- Design a label for seed packages in conformity with OECD or ISTA rules.
- Promote visibility and identification of South Sudanese helm seeds following international standards for labeling.
- Use the one-step-back and one-step-forward principle in labeling to aid in traceability of seeds.

**Duration.**

**2hours, 25mins**

| | | |
|---|---|---|
| Introduction and Pre-test (Evaluation) | | 20 minutes |
| Plenary: 1 | Brainstorming, Question and Answer | 30 minutes |
| Plenary: 2 | Guided discussions, and presentations | 20 minutes |
| Plenary: 3 | Group discussions (Exercises) | 25 minutes |
| Plenary: 4 | Presentations | 30 minutes |
| Post-test (Evaluation) | | 15 minutes |
| Conclusion | | 5 minutes |

**Equipment or materials needed**

- Visual Aid (Slide or Poster):
  - Title: Seed labs: Labeling standards for seeds.
  - Concise Definition: Display of the definition key terms related to labeling.
  - Include samples of seed labels.
- Technical Equipment:
  - Mobile projector for visual aid and potential additional media.

- Participant Resources:
    - Notebooks and writing tools for notes and activity engagement.
- Interactive Materials:
- Large paper, markers, and affixing materials (tape/pins) for collaborative exercises (e.g., participatory setting of objectives and activities).

## Introduction:

Labeling standards in the seed industry are essential for the effective regulation and management of international seed trade. These standards encompass a set of rules and guidelines that dictate how seeds should be labeled, including information such as seed variety, germination rate, purity, origin, and any treatments applied. In this topic, we will explore the significance of labeling standards in the international seed trade, their implications, and how they contribute to trade compliance, customer trust, and traceability.

**Brainstorming**:

- What is your understanding of the words label and labeling?
- What are the benefits of labeling seeds to a farmer and to the seed producer?
- Are there standards for labeling?
- Who sets standards for labeling globally?
- What are the implications of labeling for international seed trade?
- Labeling seed labeling influence acceptance of a seed, true or false? Discus.
- What are the traceability tools are commonly being used on products?
- Name one principle that guides establishment of traceability systems within quality management systems.

**Key terms.**

**Quality Seed:** Refers to the "degree to which a set of inherent characteristics [distinguishing features] of a seed", "fulfills requirements."

**Packaging:** Is the process of filling, weighing, and sewing bags with seeds.

**Label:** Means any tag, brand, mark, pictorial, or other descriptive matter, written, printed, stenciled, marked, embossed or impressed on, or attached to, a container or package of seed.

**Labeling:** Iincludes any written, printed or graphic matter that is present on the label, which accompanies the seed, or is displayed near the seed, for the purpose of promoting its sale or proper disposal.

**Lot:** Means a definitive quantity of seeds produced essentially under the same conditions.

**Traceability:** The ability to follow the movement of seed through specified stage(s) of testing, production, processing, storage and distribution.

| | |
|---|---|
| **Standards:** | A standard could be thought of as a formula that describes the best way of doing something. |
| **OECD:** | Organization for Economic Co-operation and Development. |
| **ISTA:** | International Seed Testing Association. |
| **ISO:** | International Organization for Standardization. |
| **UPOV:** | International Union for the Protection of New Varieties of Plants. |

## Global Standards for Seed Labeling.

The global seed industry operates within a frameworks of standards set by international organizations such as the:

- International Seed Testing Association (ISTA),
- Organization for Economic Co-operation and Development (OECD),
- International Union for the Protection of New Varieties of Plants (UPOV),
- International Organization for Standardization (ISO), and
- International Trade Center of the United Nations (ITC).

These organizations play a vital role in establishing guidelines and best practices for seed labeling to ensure transparency and facilitate trade.

One of the key aspects of seed labeling standards is the requirement to provide accurate information about the seed's genetic identity, purity, and germination capacity. For example, the ISTA sets stringent protocols for seed testing and labeling, which include seed sampling, purity analysis, germination testing, and moisture content assessment. Compliance with these standards is essential for ensuring that seeds meet the required quality criteria for commercialization and export.

## Implications for International Trade.

Adherence to seed labeling standards has significant implications for international trade in seeds. Proper labeling helps to prevent the spread of invasive species, diseases, and pests by enabling the identification of seed varieties and tracking their origin. This is particularly important in the case of genetically modified organisms (GMOs), where accurate labeling is essential for regulatory compliance and consumer safety.

Furthermore, standardized seed labeling facilitates cross-border trade by ensuring that seeds meet the specific requirements of importing countries. Different countries may have varying regulations regarding seed quality, packaging, and labeling, making compliance with international standards crucial for market access. Failure to comply with these standards can result in rejected shipments, trade disputes, and reputational damage for seed companies.

## Influence on Trade Compliance

Proper seed labeling plays a critical role in ensuring trade compliance and harmonizing regulations across different countries. By following established labeling standards, seed producers and distributors can demonstrate that their products meet the necessary quality and safety requirements. This, in turn, helps to streamline the customs clearance process, reduce trade barriers, and foster a more transparent and efficient international seed trade.

Moreover, transparent and accurate seed labeling contributes to better traceability along the supply chain, enabling stakeholders to identify the source of seeds, monitor their movement, and respond promptly to any quality issues or contamination incidents. Traceability is essential for maintaining the integrity of the seed trade and safeguarding against fraud, counterfeiting, and mislabeling.

**Building Customer Trust and Confidence**

In addition to facilitating trade compliance and traceability, proper seed labeling plays a crucial role in building customer trust and confidence in seed products. Consumers, including farmers, rely on seed labels to make informed purchasing decisions based on factors such as seed variety, quality, and performance characteristics.

Accurate labeling allows farmers to select seeds that are best suited to their specific needs and growing conditions, thereby enhancing crop productivity and profitability. By providing clear and reliable information on seed labels, seed companies can establish a reputation for transparency, integrity, and commitment to quality, earning the trust and loyalty of their customers.

## Information found on Seed labels.

Any registered seed seller who sells prescribed and certified seed which have been tested has the obligation to label the seed product by printing or stamping with indelible ink on the seed bag or upon a specified label attached. The labels should contain the following information:

- The name of the producer and its emblem or symbol/logo
- Year and or month of production
- The date (day, month and year) on which the prescribed seeds were tested
- Type of crop and name of the variety
- Seed class (pre-basic seed, foundation seed, basic seed or certified seed)
- Other particulars specifying seed quality, for example, physical/analytical purity, moisture content and germination percent.

## Labeling as the main component a traceability systems

A traceability system is the totality of data and operations that is capable of maintaining the desired information about a product and its components through all or part of its production and utilization chain (ISO 2007). A traceability system records and follows the trail as products and materials come from suppliers and are processed and distributed as end products (ISO 2005). Therefore, the basis of all traceability systems is the ability to identify things that move along the supply chain.

The basic characteristics of traceability systems are as follows:

- Identification of units / batches of all ingredients and products;
- Registration of information on when and where units / batches are moved or transformed; and
- A system linking these data and transferring all relevant traceability information with the product to the next stage or processing step.

These characteristics, i.e. identification, information and the links between supply chain participants are common, irrespective of process or product involved. However, the traceability systems may differ in the amount of information recorder, how far (back or forward) the system tracks the information and the degree of precision with which the system can pinpoint the movement of a particular product. In practice, traceability systems are record keeping systems that show the path of a particular product from suppliers through intermediate steps to consumers

As well as identifying the product, traceability systems may identify other information (e.g. country of origin, species and best by date) that is associated with the product. Traceability systems range from paper-based systems to use of bar coding and Radio Frequency Identification Devices (RFID).

Technologies on automatic identification and data capture allow data to be captured at minimal operating cost.

**Types of traceability**

Implementing a traceability system within a supply chain requires all parties involved to link the physical flow of products with the flow of information about them. Adopting uniform industry requirements for traceability processes ensures agreement about identification of the traceable items between parties. This supports transparency and continuity of information across the supply chain.

**External traceability**

This requires all traceable items to be uniquely identified, and information to be shared between all affected distribution channel participants. The identification of products for the purpose of traceability may include assignment of a:

- Unique product identification number; and
- Batch/lot number.

To maintain external traceability, traceable item identification numbers must be communicated to distribution channel participants on product labels and related paper or electronic business documents. This links the physical products with the information requirements necessary for traceability. External traceability allows tracing back (supplier traceability) and tracking forward (client traceability).

**Internal traceability**

Internal traceability means processes must be maintained within an enterprise to link identities of raw materials to those of the finished goods. When one material is combined with others, and processed, reconfigured, or repacked, the new product must have its own Unique Product Identifier. The linkage must be maintained between this new product and its original material inputs (such as seeds, fungicides, packaging materials, labels and other inputs) to maintain traceability. A label showing the Lot Number of the traceable input item should remain on the packaging until that entire traceable item is depleted.

This principle applies even when the traceable item is part of a larger packaging hierarchy (such as cases, pallets, or shipment containers).

**Effectiveness of traceability systems**

In all cases, traceability depends on the correct collection and recording of relevant data, coordinated within the context of a seed quality management system. A traceability system is effective when seeds can be completely traced across the seed systems say within a country. The information should be readily accessible in order to know what, how much and from where product/s need to be recalled in case of poor seed quality issues.

Each traceability partner should be able to identify the direct source and direct recipient of traceable items as they pertain to their process. This requires application of the **one-step-forward–one-step-back principle** and, further, that distribution channel participants collect, record, store, and share minimum pieces of information for traceability, as described below:

- Any item that needs to be traced forward or backward should be identified with a globally unique identifier.
- All seed chain participants should implement both internal and external traceability practices. Implementation of internal traceability should ensure that the necessary linkages between material inputs and finished product outputs are maintained.

**Traceability within the framework of seed quality management systems**

Traceability is but one component in a bigger scheme to achieve efficient supply management, product differentiation or quality management. Indeed, tracking seed by lot does not achieve seed quality unless there is also an effective quality control system, which includes good practices like good agricultural practices (GAP), good postharvest practices (GPHP), Reliable seed testing methods (STM), that produce consistent, accurate results, and so on. In a fiercely competitive global economy, all key markets demand product traceability, driven by issues such as biosecurity, homogeneity, seed quality and variety/ brand / market protection. Therefore, it is important to consider implementing traceability system, within a Seed Quality Management System.

## Establishing a quality management system.

The framework in table 1 below is a design of a proposed systematic workflow for a seed testing laboratory incorporating the PDCA (Plan, Do, Check, Act) approach. It is an example of a framework for a quality management system proposed along with traceability tools or relevant documents at each stage of the PDCA cycle.

**Table 2: Framework for a systematic quality seed management workflow**

| Stage | Process | Activities | Relevant Documents |
|---|---|---|---|
| Plan | Farm inspection (F) | Inspect and monitor farm fields, to ensure production of quality seeds. Check lots for crop type, variety, production management, phytosanitation, noxious weeds, soil health. | Field Visit Report / Farm Inspection Form |
| | Reception of Seed Samples (1) | Record details like seed lot number, source, type, and quantity received. | Sample Registration Form |
| | Interim Storage (1A) | Store labeled seed samples in designated areas ensuring proper inventory management. | |
| Do | Testing (2) | Conduct various tests like germination, purity, moisture content, and viability as per standards. | Testing Request Form |
| | Labeling (3) | Design label for final product, and include on the label the product name, type, description, source, crop production year/month, lot number, Batch number, date of packaging, Expiry date, Net weight, Handling advice. | Label including a Barcode/ QR code |
| | Seed Treatment(2A) | Clean impurities, treat with bactericides, or fungicides | Seed Treatment Record |
| | Interim Storage (4) | Store tested and treated or the poor quality seeds in designated areas ensuring proper inventory management. | Storage Inventory |

| | | | |
|---|---|---|---|
| Check | Reporting Results(2B) | Compile test results, verify accuracy, and generate comprehensive reports for each seed lot. | Test Result Report |
| | Distribution (5) | Distribute and track outgoing packages, verify accuracy with distribution records, and ensure proper shipping procedures are followed. | Distribution Record<br><br>Invoice, receipts and delivery notes, contracts. |
| Act | Packaging (2AC3D) | Package and label seed packages(C) with necessary information. | Packaging Log |
| | Feedback and Improvement (6) | Collect feedback from customers, analyze suggestions for process improvement, and implement necessary changes. | Feedback Form |

By following this systematic workflow with the PDCA approach, the seed testing laboratory can ensure efficient operations, accurate reporting, and quality control throughout the testing, packaging, storage, and distribution processes, that complies with national or international standards.

## Developing traceability procedures within a Quality Management System

Step 1: Create an operations diagram.

- Identify the main activities carried out by the company
- Organize the activities into a flow chart
- List inputs and outputs for each activity
- Analyse the flow of items to identify their key points:
- ✓ Operations carried out
- ✓ All changes of state or packaging
- ✓ Transport, movements, warehousing or removal from inventory
- ✓ Assemblies (components brought in at a certain point of the process) and mixes

It is important to identify how continuity of information will be guaranteed throughout the process steps.

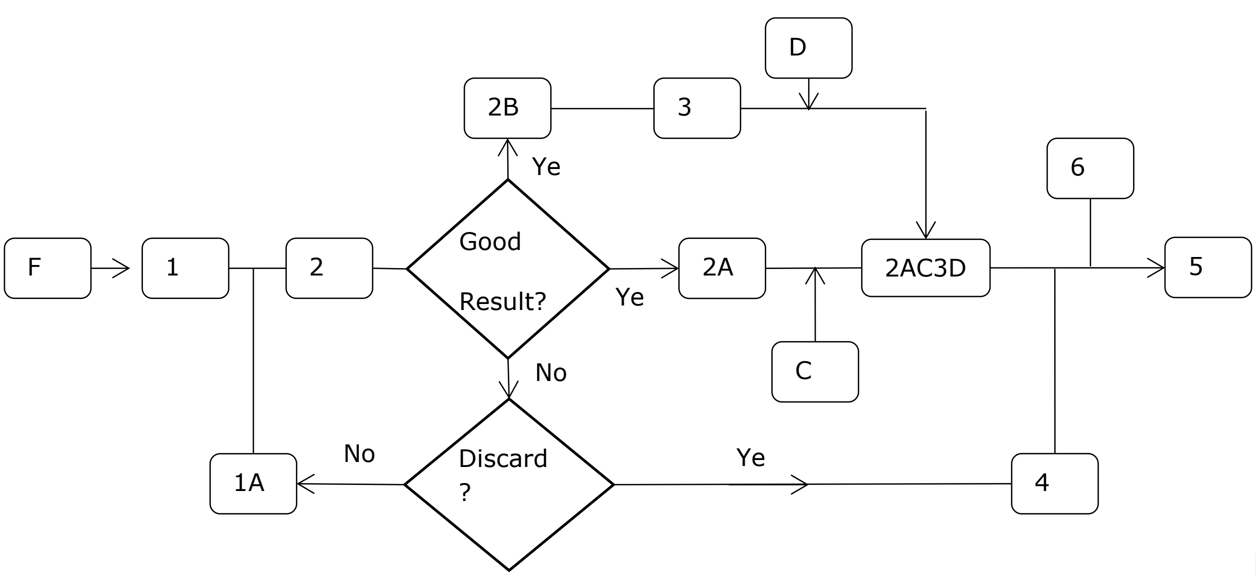


**Figure 3: Example of operations flow at a seed laboratory**

Step 2: Write-up the instructions to be followed as procedures.

For each activity in the operations diagram:

- Identify the type of activity by name and number.
- Briefly describe the activity carried out.
- Identify / assign the person responsible for the activity, the data to be captured and the traceability data documentation to be kept.
- Explain how to capture traceability data.
- Indicate where data must be saved.

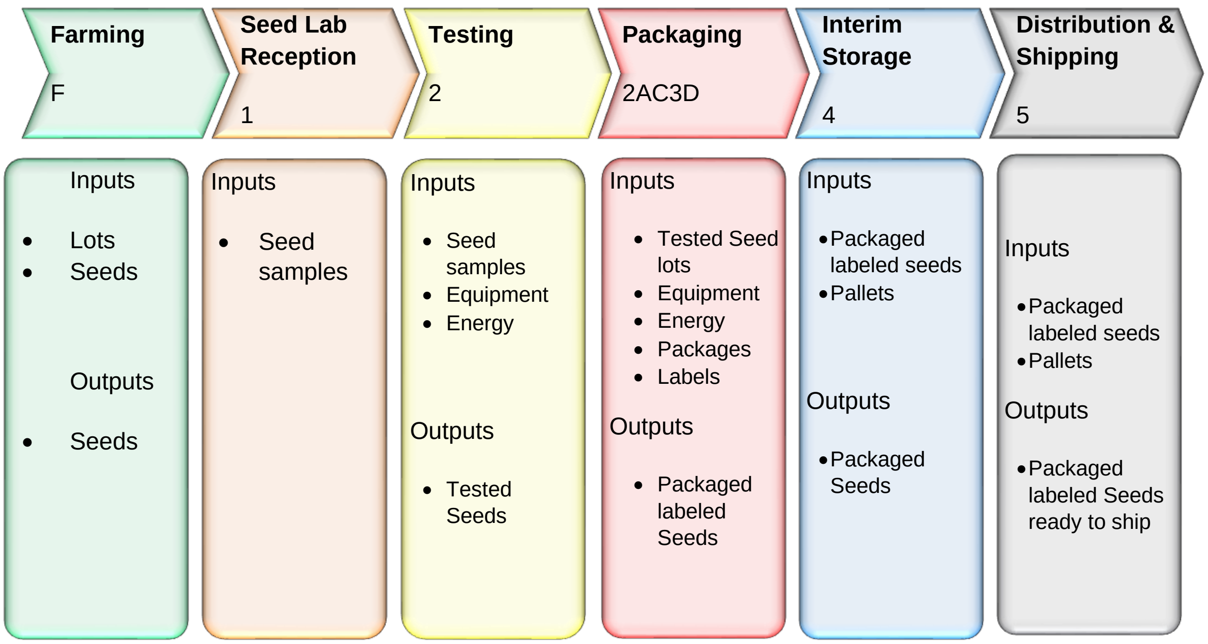



**Figure 4: Example of a process flow when developing traceability system**

## Exercise 4: Labels as a tool in a traceability system in a seed lab.

### Objective

To test the knowledge about establishing a traceability system

Answer the following questions and instructions:

1. Mention three data that can be used to trace a seed from farm where it was produced through a seed lab and to another farm where it may be planted.
2. What information is necessary to include on a seed label, on a seed package intended for export?
3. Using a computer and a Microsoft office word or publisher application design a document for capturing necessary information used for the following purposes or as a;
    - i. Seed label
    - ii. Seed Sample registration form
    - iii. Seed sample tag.
    - iv. Seed test request form
    - v. Seed distribution records form
    - vi. Sales receipt
4. List at least five qualities of a seed that may be tested in a seed lab, reflected on a label.
5. Mention the characteristics of seeds that may cause seeds to be rejected and discarded.
6. What are the minor seed quality issues that may be easily corrected to allow seeds to be approved for further treatment and subsequent packaging?
7. As a graduate of the short course in seed laboratory, list detailed technical activities that would be done before, during, and after germination testing.

## Conclusion

In conclusion, labeling standards are fundamental to the international seed trade, shaping how seeds are identified, traded, and used by farmers worldwide. These standards not only ensure compliance with regulations and promote trade harmonization but also foster customer trust, support traceability, and uphold the integrity of the seed industry.

In general, traceability systems favor large-scale producers and vertically integrated enterprises. The amount of information which must be stored and available for immediate review is considerable. If the traceability system is being introduced as a means of showing that certain standards are being met, then it is necessary to be in a position to demonstrate how those standards are being implemented. Undoubtedly, these represent additional costs to most market operators and possibly prohibitive ones for exporters and producers in developing countries. It is easier to manage traceability systems within single enterprises where the information is available in a single format to all participants in the production process, from seed to farm and consumer.

By adhering to global seed labeling standards, seed laboratories can enhance their competitiveness in the international market, mitigate risks associated with non-compliance, and contribute to a more sustainable and secure seed supply chain. As the seed industry continues to evolve, the importance of standardized labeling practices in facilitating seed trade, promoting transparency, and meeting the needs of consumers will only grow in significance.

**References and further reading.**

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Module 2

Topic 5

# Quality Management Systems and ISO/ISTA Accreditations.

Overview.

**This topic explains the significance of adhering to Quality Management Systems (QMS) in seed labs and the benefits of ISO and ISTA accreditations, and how these standards and certifications enhance credibility, consistency, and global acceptance of seed testing results.**

Learning Outcomes.

At the end of this topic, the learners should be able to:

- Understand the significance of adhering to seed quality management systems
- Appreciate the benefits of ISO/ISTA accreditation
- Establish a quality management system in a seed lab
- Prepare a seed lab for ISO and ISTA Accreditation

Duration.

**2hours, 25mins**

| | | |
|---|---|---|
| Introduction and Pre-test (Evaluation) | | 20 minutes |
| Plenary: 1 | Brainstorming, Question and Answer | 30 minutes |
| Plenary: 2 | Guided discussions, and presentations | 20 minutes |
| Plenary: 3 | Group discussions (Exercises) | 25 minutes |
| Plenary: 4 | Presentations | 30 minutes |
| Post-test (Evaluation) | | 15 minutes |
| Conclusion | | 5 minutes |

Equipment or materials needed

- Visual Aid (Slide or Poster):
    - Title: QMS and ISO/ISTA accreditation.
    - Concise Definition: Display of the key terms.
    - Include framework for the functions and services offered by a community seed bank.
- Technical Equipment:
    - Mobile projector for visual aid and potential additional media.
- Participant Resources:
    - Notebooks and writing tools for notes and activity engagement.
- Interactive Materials:
- Large paper, markers, and affixing materials (tape/pins) for collaborative exercises (e.g., participatory setting of objectives and activities).

Content

## Introduction

Ensuring quality standards and obtaining ISO/ISTA accreditations are crucial aspects of running a seed laboratory efficiently and effectively. Quality Management Systems (QMS) play a fundamental role in maintaining high standards of operation within seed labs. The adherence to QMS in seed labs is essential for ensuring the consistency, accuracy, and reliability of seed testing results. To expand on this topic, this article will delve into the significance of adhering to QMS in seed labs, the benefits of obtaining ISO and ISTA accreditations, and how these standards contribute to enhancing credibility, consistency, and global acceptance of seed testing results.

**Brainstorming**

1. What does ISTA Accreditation mean?
2. What is the meaning of quality in the context of Agricultural Seeds?
3. What are the main aspects of quality management systems audited by ISO Accreditation bodies?
4. What are the principles that guide quality management systems in a seed lab?
5. What practices are implemented in a seed lab with a functional quality management system?
6. Is ISTA Accreditation beneficial to the Seed Laboratory, Seed Seller and Seed Buyer?
7. Describe the steps for ISTA Accreditation.
8. As you prepare a seed laboratory for ISTA Accreditation what aspects would you consider being in place? Explain why?
9. What are the standards set for the seed testing laboratories globally?
10. In the 2022 international survey conducted by country to enumerate ISO accredited organizations, South Sudan had none. While else after the 3 years of accreditation, some organizations fail to be re-accredited.
    a. Why have local organizations failed to be accredited in South Sudan?
    b. What could be the reasons for the re-accreditation failure elsewhere?

Key terms

| | |
|---|---|
| **ISO:** | Is an abbreviation for International Organization for Standardization. |
| **ISTA:** | Is an abbreviation for International Seed Testing Association. |
| **Quality:** | This is the "degree to which a set of inherent characteristics [distinguishing features] of an object", which in turn is defined as anything perceivable or conceivable, such as a product, service, process, person, organization, system or resource, "fulfills requirements." |
| **Standards:** | A standard could be thought of as a formula that describes the best way of doing something. |
| **Accreditation:** | The formal recognition by an independent body, generally known as an accreditation body, that a certification body operates according to international standards. |
| **Certification:** | The provision by an independent body of written assurance (a certificate) that the product, service, or systems in question meets specific requirements. Certification is also known as third party conformity assessment. |
| **Conformity assessment. (Audit)** | The process that demonstrates whether a product, service, process, claim, system or person meets the relevant requirements. Such requirements are stated in standards, regulations, contracts, programmes, or other normative documents. |
| **Testing.** | An activity that helps to determine one or more characteristics of an object or product. |
| **Inspection.** | This is the regular checking of an object or product to make sure that it meets specified criteria. |
| **Mutual/ Multilateral Recognition Agreement (MRA)** | This is an arrangement that increases confidence in conformity assessment between countries as it formally recognizes the results of each other's testing, inspection, certification or accreditation. |

## Accreditation

Prior to issuance of a certificate of accreditation, for quality management systems, the organization is audited in accordance with standards spelt out in sections 4 – 10 of the ISO 9001:2015 standard. The aspects covered in the standard looks at the context of the organizations, Leadership, planning, support, operation, performance evaluation, and continual improvement. ISO does not accredit the organizations. Accreditation is done by third party accreditation bodies. The accreditation bodies are under the umbrella of the IAF (International Accreditation Forum) and ILAC (International Laboratory Accreditation Cooperation). The bodies are structured at global and national levels. These bodies are either government owned or in agreement with governments to audit or assess organization's conformity with set national or international standards. They include, African Accreditation Cooperation (AFRAC), Southern Africa Development Community Accreditation (SADCA), Asia-Pacific Laboratory Accreditation Cooperation (APLAC), UKAS and European Cooperation for Accreditation.

Within the ISO standards there are over 20,000 sector-specific standards for example ISO/IEC 17025 which provides for requirements in testing and calibration laboratories. ISTA at the other hand has specific rules and regulations set for seed laboratories and they also provide accreditation for the seed labs. ISO standards and ISTA accreditation are renewed after every three years.

## ISO standards

ISO 9001 is a globally recognized standard for quality management. It helps small or big organizations to improve their performance, meet customer expectations, and demonstrate their commitment to quality. Its requirements define how to establish, implement, maintain, and continually improve quality management system (QMS) of the institution. Implementing ISO 9001 means your organization has put in place effective processes and trained staff to deliver flawless products or services time after time.

The ISO 9000 family has seven (7) quality management principles and benefits as described below.

Benefits of ISO 9001

The business benefits of ISO 9001 include:

- **Customer confidence:** The standard ensures that organizations have robust quality control processes in place, leading to increased customer trust and satisfaction.
- **Effective complaint resolution:** ISO 9001 offers guidelines for resolving customer complaints effectively, contributing to timely and satisfactory problem-solving.
- **Process improvement:** The standard helps identify and eliminate inefficiencies, reduce waste, streamline operations, and promote informed decision-making, resulting in cost savings and better outcomes.
- **Ongoing optimization:** regular audits and reviews encouraged by ISO 9001 enable organizations to continually refine their quality management systems, stay competitive, and achieve log-term success.

## Principles of Quality Management Systems.

In the context of seed testing, the principles of quality management systems are essential to ensure accurate and reliable results. Some key principles include:

1. **Customer Focus:** Understanding the needs and requirements of seed buyers and ensuring that seed testing procedures meet or exceed customer expectations.
2. **Leadership:** Establishing a clear vision and direction for seed testing processes, with leadership actively promoting a culture of quality within the organization.
3. **Engagement of People:** Involving all staff members in the seed testing process, encouraging empowerment, and providing training to ensure competence in their roles.
4. **Process Approach:** Implementing systematic processes for seed testing to achieve consistent results, with an emphasis on identifying and addressing areas for improvement.
5. **Improvement:** Continuously seeking opportunities to enhance seed testing procedures, through monitoring performance, analyzing data, and implementing corrective actions.
6. **Evidence-based Decision Making:** Using data and evidence from seed testing results to make informed decisions, improve processes, and achieve desired outcomes.
7. **Relationship Management:** Building and maintaining strong relationships with seed suppliers, customers, and other stakeholders to ensure effective communication and collaboration throughout the testing process.

By adhering to these principles of quality management systems in seed testing, organizations can enhance the reliability and accuracy of their testing procedures, ultimately leading to improved seed quality and customer satisfaction.

**Quality Management Practices**

Quality management practices in a seed lab are essential to ensure accurate and reliable results. Here are some key practices typically implemented in a seed lab:

1. **Quality Control Checks:** Regular quality control checks are performed to verify the accuracy and precision of testing procedures. This includes checking equipment calibration, verifying testing protocols, and monitoring environmental conditions.
2. **Documented Procedures:** All testing procedures and protocols are documented in detail to ensure consistency and repeatability. This documentation includes sample preparation methods, testing methodologies, equipment calibration procedures, and data analysis protocols.
3. **Staff Training:** Personnel working in the seed lab undergo thorough training on testing procedures, operation of instruments, safety protocols, and quality management practices. Training is ongoing to ensure staff competency and to keep them updated on best practices.
4. **Sample Tracking:** A robust sample tracking system is employed to ensure traceability and prevent mix-ups. Each sample received is assigned a unique identifier that is tracked throughout the testing process.
5. **Quality Assurance:** Quality assurance protocols are implemented to monitor overall lab performance and identify areas for improvement. This may include regular audits, proficiency testing, and participation in external quality assessment programs.
6. **Instrument Maintenance:** Regular maintenance and calibration of lab equipment are crucial to ensure accurate test results. Scheduled maintenance checks are conducted, and corrective actions are taken if any issues are identified.
7. **Data Management:** A secure data management system is in place to store and analyze test results. Data integrity checks are performed to verify the accuracy and completeness of test data.

By implementing these quality management practices, a seed lab can ensure the reliability and accuracy of its testing processes, ultimately providing customers with trusted results for seed quality assessment.

A management system is what the organization does to manage its processes, or activities in order that its products and services meet the organization's objectives such as;

- Satisfy the clients' quality requirements
- Complying with regulations
- Meeting environmental objectives
- Complying with standards

To be efficient and effective, the organization can manage its way of doing things by systemizing its activities to ensure;

- Nothing important is left out
- Everyone is clear about who is responsible for doing what, when, how, why and where.

## The steps for ISO certification

| | | |
|---|---|---|
| **STEP** | 1 | **Quality Management System (QMS).**<br><br>**Candidate organization is required to document and establish a quality management system, which complies with the ISO 9001standard.** |
| **STEP** | 2 | Implement the QMS.<br><br>Quality planning, control, and assurance measures, methods for monitoring, and measure their performance. Follow guidelines for documentation, internal audit and corrective actions. Implement for at least 3 – 6 months before audit . |
| **STEP** | 3 | ISO Audit. (in two stages)<br><br>Undergo a successful, documentation review, and the on-site audit three months later before certification decision. An experienced independent audit body also known as conformity assessment body will evaluate the organization’s compliance with the ISO 9001 standard. |
| **STEP** | 4 | Certification.<br><br>Once the organization is certified, it is authorized to issue ISO 9001 mark on the products they process. |

**Table 3: Articles of the ISO/IEC 17025:2005 Standard: Quality Management System.**

| ISO/IEC 17025:2005 Clause | Description | Documents/Procedures Needed for Seed Testing Labs |
|---|---|---|
| **4. Management Requirements** | | |
| **4.1 Organization** | Legal entity status and organizational structure | Legal entity registration, Organizational chart, Roles/responsibilities, Quality manual |
| **4.2 Management System** | Establishing and maintaining a management system | Quality manual, Document control, Record control, Internal audit, Corrective/preventive action procedures |
| **4.3 Document Control** | Controlling documents related to activities | Document control procedure, Master list of documents, Document change process |
| **4.4 Review of Requests...** | Ensuring capability and resources to meet requirements | Review procedure, Record of reviews |
| **4.5 Subcontracting** | Ensuring competence and compliance when subcontracting | Subcontracting procedure, Approved subcontractor list |
| **4.6 Purchasing** | Ensuring purchased services/supplies meet requirements | Purchasing procedure, Approved supplier list, Purchase order templates |
| **4.7 Service to Customer** | Ensuring effective communication and addressing feedback | Customer service procedure, Feedback mechanism, Satisfaction monitoring |
| **4.8 Complaints** | Handling and resolving complaints | Complaint handling procedure, Complaint log |
| **4.9 Control of Nonconforming Work** | Identifying and controlling nonconforming work | Nonconforming work control procedure, Nonconformity log |
| **4.10 Improvement** | Continual improvement of the management system | Management review procedure, Preventive action procedure, Improvement plan |
| **4.11 Corrective Action** | Implementing actions to eliminate nonconformities | Corrective action procedure, Corrective action log |
| **4.12 Preventive Action** | Identifying/implementing actions to prevent potential nonconformities | Preventive action procedure, Preventive action log |
| **4.13 Control of Records** | Controlling/maintaining records | Record control procedure, Retention policy, Storage/archiving system |
| **4.14 Internal Audits** | Conducting internal audits to verify effectiveness | Internal audit procedure, Audit schedule, Audit reports |
| **4.15 Management Reviews** | Conducting reviews of system suitability and effectiveness | Management review procedure, Review agenda/minutes |
| **5. Technical Requirements** | | |

| | | |
|---|---|---|
| **5.1 General** | Ensuring staff competence and result validity | Staff competence/training records, Proficiency testing, Standard operating procedures (SOPs) |
| **5.2 Personnel** | Ensuring competence and qualifications for specific tasks | Job descriptions, Personnel qualifications/training records, Competence evaluation procedure |
| **5.3 Accommodation and Environmental Conditions** | Ensuring suitable conditions | Environmental monitoring procedures, Control/monitoring records, Facility maintenance plan |
| **5.4 Test and Calibration Methods...** | Using appropriate methods, including validation | Standard test methods/procedures, Method validation, Uncertainty estimation, Data control |
| **5.5 Equipment** | Calibration, maintenance, and handling of equipment | Equipment inventory, Calibration and maintenance schedules, Calibration procedures, Handling and storage procedures |
| **5.6 Measurement Traceability** | Ensuring traceability of results to national/international standards | Traceability procedures, Reference material inventory, Calibration certificates and records |
| **5.7 Sampling** | Ensuring representative nature and proper handling of samples | Sampling procedures, Sample handling and storage procedures, Sample identification and traceability |
| **5.8 Handling of Test and Calibration Items** | Proper handling, storage, and identification of items | Procedure for handling test and calibration items, Sample/item identification and tracking system, Storage/preservation procedures |
| **5.9 Assuring Quality of Results** | Ensuring quality through control procedures and data monitoring | Quality control procedures, Proficiency testing program, Data monitoring and analysis procedures |
| **5.10 Reporting Results** | Ensuring accuracy, clarity, and objectivity of reports | Report templates, Report review and approval procedures, Report distribution and archiving procedures |

## Significance of adhering to quality management systems in seed labs.

Quality Management Systems are essential frameworks that help seed labs establish and maintain processes to ensure quality in their operations. In the context of seed testing, adherence to QMS helps seed labs can;

1. **Meet the required standards** for testing procedures, data accuracy, result interpretation, and reporting.
2. **Standardize their processes,** minimize errors, and ensure the integrity of their testing activities.
3. **Fosters a culture** of continuous improvement.
4. **Identify areas for enhancement** and implement corrective actions to address any deviations from established standards, through regular audits, reviews, and evaluations.

This proactive approach not only ensures the reliability of testing results but also contributes to the overall efficiency and effectiveness of seed lab operations.

Furthermore, QMS compliance is often a prerequisite for obtaining ISO and ISTA accreditations. By aligning with QMS principles, seed labs can demonstrate their commitment to quality, competence, and reliability, which are essential attributes in the field of seed testing. Overall, adhering to QMS in seed labs is essential for upholding quality standards, ensuring regulatory compliance, and enhancing the overall credibility of seed testing activities.

## Case Study

**Establishment and operationalization of University of Juba seed lab.**

At the University of Juba, School of Natural Resources and Environmental sciences a mini Seed lab was established. To operationalize the seed lab, the school administration assigned, an administrator, a lab technician and two other junior staff to manage the affairs of the Seed Lab. She started the assignment by contracting Company X to supply assorted laboratory equipment, printer, computer software, stationary, and packaging materials funded by the university.

The administrator of the seed lab then applied to the South Sudan Bureau of Statistics and also to the National Bureau of Standards to have the seed bank be registered and licensed to operate as a business. The application was honored, the laboratory equipment that included weighing scales, and moisture meter were calibrated and the seed lab was issued a certificate of compliance.

Abe is a farmer who owns 6-acres farmland located at Panyume boma, Panyume Payam Morobo County of Central Equatoria state. In 2023 September, Abe produced his second batch of ground-nuts, maize, and beans on a crop rotation basis in lots of 2-acres each which were labeled lot 1, 2 and 3. The harvest of that season was 3.6 tons, 1.8 tons, and 3 tons respectively. Abe delivered 50% of each seed lots harvested to the University of Juba seed laboratory for testing which would be packaged and sold as seeds in 1kg pack at 4.0 SSP, 6.0 SSP and 8.0 SSP for ground-nuts, maize and beans respectively.

Jada ordered for 100 kg of ground-nuts, 150kg of maize and 50kg of beans of locally adapted varieties from the University of Juba Seed lab. He had planned to plant the seeds in his farm at Rajaf payam in Juba county of Central Equatoria state. He requested that his order should be supplied in April 2024.

**Source**: A fictional article written by Godfrey Hakim Samuel

Using the framework in Table 3 above and the case study above, follow the basic four-step methodology that may be used for establishing and evaluating a system:

1. **Set in place a project:** Put together a team with an administrator, technicians, and other support staff with clear roles, working methodologies, equipment, schedule, budget and reporting.
2. **Define the context and assess the needs:** Implement the proposed system of traceability should be adapted to the organization, the sector, the supplier profile, customer requirements (contractual requirements) and regulatory requirements.
3. Bring together the internal and the external requirements: Define the goals, research solutions and resources.
4. **Assess internal capacities:** Review the data that is recorded and already in place for production management, customer relations, marketing, and accounting.

## Exercise 5: Traceability within a Quality Management system in a seed lab.

**Objective**:

To establish a QMS and a traceability action plan for a seed laboratory that receives seeds from farmers.

The learner assignment is the following:

- Based on the information in provided in the case study above, evaluate the internal and external needs of the University of Juba seed lab. Identify the data that needs to be traced and define the parameters of traceability.
- Design the relevant document control forms proposed in the framework and record the respective data accordingly that need to be kept by the seed lab.
- Compare with the specifications of the external requirements.
- Articulate the benefits to the company and the internal clients.
- Prepare a traceability action plan and response strategy.
- Using a "Plan-Do-Check-Act" cycle, test a process on site or on "pilot" basis and improve/adjust the methodology. Discus with your team (workforce) on the new requirement/task obligation. Extend to other parts. Assess the robustness of the system and periodically review the system with changes in context, clientele, suppliers, processes, products, and/or regulations.

## The five steps for ISTA accreditation

STEP ❶ ISTA Membership.

Only member laboratories and sampling Entities may become accredited.

STEP ❷ ISTA Proficiency Test.

Prior to accreditation, member laboratories must demonstrate their competence to seed testing in accordance with the ISTA rules by participating in the Proficiency Test programme.

STEP ❸ Quality Management System.

Candidate laboratories and sampling Entities are required to establish a quality management system, which complies with the ISTA accreditation standard.

STEP ❹ ISTA Audit.

Part of the accreditation is an on-site assessment. An experienced audit team member will evaluate the laboratory's compliance with accreditation standard.

STEP ❺ Accreditation.

Once the laboratory is accredited, it is authorized to issue ISTA Certificates for methods and species covered by its scope of accreditation.

IMPORTANT NOTE

- Accredited laboratories are continuously monitored through the unique ISTA Proficiency Test Programme to maintain their high quality standard.
- It is mandatory for ISTA Accredited laboratories to participate in all Proficiency Tests, relevant to their scope of Accreditation.

- All non-accredited laboratories may participate in Proficiency Tests voluntarily to benchmark themselves against ISTA Accredited laboratories and prepare for ISTA Accreditation.
- Proficiency Tests are conducted thrice a year in April, August and December.
- Adding Tests to the scope of Accreditation is possible at any time when evidence for competence is provided.
- Re-accreditation audits are performed every 3 years.

## Benefits of ISTA accreditation.

Obtaining ISTA (International Seed Testing Association) accreditations offers numerous benefits for seed labs seeking to establish themselves as reputable and reliable testing facilities. These accreditations serve as international benchmarks for quality assurance and provide external validation of a seed lab's competence and adherence to industry standards. There are benefits accrued to the seed seller and also to the seed buyer as described below.

**Benefits for the seed laboratory;**

1. Formal recognition for the technical competence to test seed and produce reliable results.
2. Increase employee motivation and technical expertise.
3. Participation in the Proficiency Testing Programme.
4. Public exposure via the ISTA website and other marketing materials.

**Benefits for the seed seller;**

1. Increased credibility and reduction of costs due to higher acceptance of seed lots.
2. Minimized risk of shipping seeds with faulty test results.
3. In some countries/distinct economies, the export of seeds is only permitted if the seed lot is accompanied by an ISTA certificate.
4. Seed producers/traders themselves can apply for accreditation for their laboratories.

**Benefits for the seed buyer;**

1. Confidence that results on the test report corresponds to the quality of the seed lot.
2. Assurance that the seeds have been tested by internationally accepted methods, particularly important for the international trade of seeds.
3. In some countries/distinct economies, the import of seeds is only permitted if the seed lot is accompanied by an ISTA certificate.

**Standards for seed testing laboratories**

The standards for seed testing laboratories are typically outlined by international organizations such as the International Seed Testing Association (ISTA) and national regulatory bodies. Some common standards for seed testing laboratories include:

1. **ISTA Rules for Seed Testing:** These rules provide guidelines for seed sampling, testing methods, and seed health testing procedures. They cover a wide range of seed types and are widely recognized in the seed testing industry.
2. **ISO/IEC 17025:** This standard specifies the general requirements for the competence of testing and calibration laboratories. It encompasses quality management systems, technical

requirements, and the competence of staff. This standard is set by the International Organization for Standardization (ISO). ISO also provides a general standard for quality management systems; ISO 9001.

3. **ISTA Accreditation**: Seed testing laboratories can seek accreditation from ISTA to demonstrate their compliance with international standards. Accredited laboratories are recognized for their technical competence and reliability in seed testing.
4. **National Regulations:** Different countries may have specific regulations or standards for seed testing laboratories to ensure the quality and accuracy of seed testing procedures.

**Aspects covered in the ISTA Rules**

The ISTA (International Seed Testing Association) rules for seed testing provide guidelines and standards for conducting seed testing procedures. Some key aspects covered in the ISTA rules include:

1. **Seed Sampling**: Guidelines for proper seed sampling techniques to ensure representative samples are collected for testing.
2. **Seed Testing Methods:** Detailed procedures for testing seed quality attributes such as purity, germination, moisture content, and seed health.
3. **Seed Health Testing:** Standards for assessing seed health, including testing for seed-borne pathogens and diseases.
4. **Reporting:** Requirements for reporting test results accurately and consistently to allow for comparison and verification.
5. **Seed Identification:** Guidelines for seed identification to ensure the correct identification of seed lots.
6. **Equipment and Environment:** Standards for equipment calibration, testing conditions, and laboratory environment to maintain the quality and accuracy of seed testing.
7. **Quality Management:** Recommendations for quality management systems to ensure the reliability and consistency of seed testing procedures.

By following the ISTA rules for seed testing, seed testing laboratories can ensure the quality, accuracy, and reliability of their test results, which is essential for seed certification and trade purposes.

## Conclusion

In conclusion, adherence to Quality Management Systems in seed labs is essential for maintaining high standards of operation, ensuring data integrity, and driving continuous improvement. Obtaining ISO and ISTA accreditations further elevates the credibility, consistency, and global acceptance of seed testing results, positioning accredited seed labs as leaders in the field of seed testing. Having in mind an understanding of the internal capacities of the organization and the external requirements for the operations, clarifies all that is import for to meet quality standards that can be monitored with a good traceability system in place. Finally by embracing QMS principles and pursuing accreditation, seed labs can uphold quality standards, meet customer expectations, and contribute to the advancement of the seed industry as a whole.

References and Further Reading


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