Seed Lab for Quality Assurance A Manual





Dr. Ibrahim Osman Ismail
Ms. Nimo Abdirahman Yusuf
Faculty of Agriculture & Environmental Science

UNIVERSITY OF BURAO
FACULTY OF AGRICULTURE AND ENVIRONMENTAL SCIENCE.
كلية الزراعة والعلوم البيئية

SEED TESTING LAB

Guided and edited by:

1. **Ronnie Vernooy** of the Alliance of Biodiversity International and CIAT; and
2. **Arnab Gupta** of the Wageningen Centre for Development Innovation of Wageningen University and Research, the Netherlands.

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The contents of this manual are the direct outcome of a specialized course meticulously delivered and organized by WCDI. This seed lab guiding manual, specially designed for instructors, plays a vital role in supporting and enhancing the Somaliland seed quality for improved agriculture productivity.

Sincere gratitude is extended to WCDI for their valuable contribution to the strengthening of the seed laboratory establishment for the improvement of seed quality practices in Somaliland.

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Email: ismail@uob-edu.net

Phone:00252634436112

Dr. Ibrahim Osman Ismail

Expert in Climate Smart Agriculture

Dean of Faculty of Agriculture and Environmental Science

FORWARD

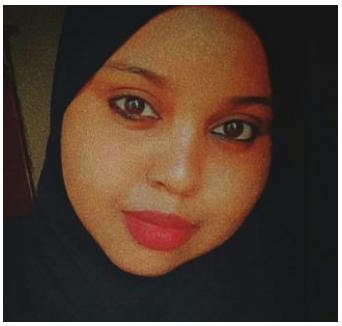
Seed, a crucial input in agriculture, significantly influences plant stand and crop productivity. The quality of the seed is paramount for optimal results in the field. Laboratory testing using uniform procedures is key to ensuring seed quality. The International Seed Testing Association (ISTA) provides standardized procedures encompassing seed sampling, moisture estimation, physical purity tests, germination, vigor, and seed health.

Adopting these uniform procedures is essential for obtaining accurate and reproducible results. Capacity building on seed testing, following ISTA norms, empowers technocrats involved in seed testing to refine their skills. This ensures that procedures are carried out effectively, further enhancing the overall quality of seeds.

Therefore, this manual serves as a valuable tool for advancing seed testing practices by international standards.

Email: nimoabdirahman24@gmail.com

Phone:00252654957380



Mss. Nimo Abdirahman Yusuf

Seed Laboratory Manager

Faculty of Agriculture and Environmental Science, UOB

PREFACE

Seed stands as the pivotal link in the food value chain, acting as the foundation for both food and nutrition security in our ever-growing population. Ensuring the timely and precise supply of quality seed, achieved through improved varieties, advanced production technologies, and rigorous seed quality enhancement and testing, is imperative. Measuring seed quality involves multifaceted parameters, and establishing and reinforcing seed quality testing laboratories into hubs for seed quality assurance are vital for invigorating national seed production programs.

In this context, strengthening seed testing laboratories and training initiatives in Somaliland for seed quality assurance and control is immensely beneficial to stakeholders invested in seed production and testing.

The invaluable contributions of WCDI Facilitators and experts, encompassing specialization training, equipment support, and compiling this manual on seed quality assurance and control, are deeply appreciated. This manual is anticipated to serve as a valuable resource for individuals engaged in seed quality testing within academia, agricultural institutions, and private seed industries, fostering advancements in agricultural production.

ACKNOWLEDGMENT

We express heartfelt gratitude for the exceptional contribution and unwavering support from the Facilitators and experts, namely

1. **Ronnie Vernooy** of the Alliance of Biodiversity International and CIAT; and
2. **Arnab Gupta** of the Wageningen Centre for Development Innovation of Wageningen University and Research, the Netherlands.

Their instrumental role in conducting the specialization course on seed laboratory and their invaluable guidance in crafting this Seed Lab Manual is deeply appreciated. Their expertise has been a cornerstone in shaping this manual into a comprehensive and reliable resource.

1.0. Introduction

Seed laboratories play a significant role in ensuring the quality and viability of seeds, crucial for agricultural productivity. Support for Food Security: By meticulously testing and certifying seeds, seed labs contribute to a reliable and robust seed supply, a cornerstone for food security by enhancing crop yield and quality. Contribution to Healthy Food and Biodiversity: Seed labs aid in cultivating healthier crops, which directly influences the nutritional quality of food. Additionally, by preserving and testing diverse seed varieties, they contribute to maintaining biodiversity and safeguarding the genetic resources essential for sustainable agriculture.

1.1. Historical events of seed testing in Somalia

The Afgoye Research Center, founded in 1976, plays a significant role in Somalia's agricultural history. This center dedicated its efforts to seed improvement and multiplication, with a specialized laboratory section designed for rigorous seed testing, including quality, germination, and vigor assessments. The first seed guide for seed testing was developed in 1979. Tragically, in 1991, the research center in Afgoye faced a setback with the collapse of the former Somalia government. This upheaval disrupted agricultural research, development activities, and improvement of quality seed, multiplication, and distribution.

In a hopeful turn of events, the seed laboratory at the University of Burao was established in 2022. This revival comes from the technical and financial support provided by the Wageningen Center for Development Innovation (WCDI) in the Netherlands. The establishment of this laboratory signifies a created commitment to advancing seed testing and research in Somaliland, contributing to the recovery of agricultural innovation and development in Somaliland.

1.2. Importance of seed testing

i. **Seed Testing Development:**
Seed testing has evolved as a crucial support system for agriculture, mitigating hazards in crop production. It provides vital information on various quality attributes such as purity, seed viability, storage needs, planting value, dormancy moisture, germination, vigor, and health, aiding farmers in making informed decisions.

ii. **Quality Control**
The foundation of seed quality control rests on adhering to diverse seed testing protocols. Rigorous testing ensures that seeds meet the specified standards, contributing to the overall quality and success of crop production.

iii. **Evaluation of Seed Testing**
Testing seeds serves as a comprehensive evaluation process, determining both the planting value and the authenticity of certified seed lots. This evaluation is instrumental in maintaining the integrity of the agricultural supply chain.

iv. **Seed Quality Assessment**
Seed testing is indispensable for assessing the quality attributes of seed lots. By analyzing factors such as purity, germination rates, and overall health, farmers can make informed choices that directly impact the success of their crops.

v. Standard Seed Testing Procedures (ISTA)

The establishment of the International Seed Testing Association (ISTA) is driven by the need for standardized procedures. These standards are not only obligatory but essential for the uniform evaluation of seed quality worldwide. Adherence to ISTA rules is critical for ensuring the economic yield of crops, underlining the direct correlation between seed quality, as dictated by ISTA guidelines, and agricultural success.

1.3. Objective of the Seed Lab Manual:

The objective of the Seed Laboratory Manual is to establish standardized testing procedures, fostering consistency in seed quality assessment across various laboratories. The manual aims to provide a comprehensive framework for accurate seed testing, supporting the reliability and comparability of results.

1.4. Components of Seed Laboratory Manual:

i. **Testing Protocols:** Clearly defined procedures for germination tests, purity analysis, moisture content determination, and other essential seed evaluations.
ii. **Quality Control Measures:** Guidelines for maintaining equipment calibration, ensuring precision, and monitoring environmental conditions to uphold the integrity of seed testing.

1.5. Strategies for Running Seed Laboratory Manual

i. **Training and Certification:** Emphasize comprehensive training programs for laboratory personnel, ensuring proficiency in executing seed testing procedures.
ii. **Regular Updates:** Continuously update protocols and methodologies to incorporate advancements in seed testing technologies, keeping guidelines current and relevant.
iii. **Collaboration:** Foster collaboration between seed labs, agricultural institutions, and the industry to share knowledge, best practices, and technological advancements.

1.6. The Role of the University of Burao in Sustaining Seed Laboratory

The role of the University of Burao in managing a sustained seed laboratory is multifaceted and crucial for ensuring the success and effectiveness of the seed testing facility.

i. **Academic Excellence:**

The University of Burao serves as a hub for academic expertise, providing a pool of knowledgeable FAES staff and researchers. Leveraging this intellectual capital, the University can contribute to the continuous improvement of seed testing methodologies and research in seed technology.

ii. **Training Hub:**

The University of Burao plays a significant role in training and educating personnel involved in seed testing.
Offering specialized courses and workshops in seed science and technology ensures a skilled workforce, vital for the sustained operation of the seed laboratory.

iii. **Research and Development**

By engaging in research activities related to seed quality, genetics, and agricultural advancements, the University can provide valuable insights and innovations.
This research-driven approach can enhance the capabilities and efficiency of the seed laboratory over time.

iv. **Collaboration and Networking**

The University of Burao can foster collaborations with agricultural institutions, governmental bodies, and industry stakeholders.
Building a network of partnerships ensures a continuous exchange of knowledge, resources, and best practices, contributing to the long-term sustainability of the seed laboratory.

v. **Quality Assurance**

The University of Burao can establish a robust quality assurance framework for seed testing procedures.
Regular audits, adherence to international standards, and continuous improvement initiatives will ensure the reliability and credibility of the seed laboratory's results.

vi. **Community Engagement:**

Involving the local community in seed-related initiatives can enhance awareness and support for sustainable agriculture. The University of Burao can play a role in outreach programs, educating farmers and stakeholders about the importance of quality seeds and the services offered by the seed laboratory.

2.0. Seed Sampling andSubmitting Protocols

Seed testing accuracy fundamentally relies on representative sampling. Small submitted samples aretested to predict the field performance of large seed lots. Meticulous sampling is vital as quality is seldom uniform within a seed lot and tests are sensitive to sampling errors. Key steps in seed sampling include:

1. Defining the Seed Lot

The seed lot must be physically identifiable and distinct based on uniform origin, variety, markings,container, etc. Seed lot size and heterogeneity determine subsequent sampling protocols.

In the context of seed certification and testing, both the International Seed Testing Association (ISTA)and the Association of Official Seed Analysts (AOSA) provide definitions and standards for a "seed lot."A seed lot is generally defined as a quantity of seed that is uniform in its characteristics, meaning it is identified by a unique set of descriptors, such as:

- Origin (where the seed was grown)
- Variety (the specific type of plant)
- Year of production
- Specific field or production area designation
- Processing history
- Any treatments applied

According to ISTA, a seed lot should be "uniform in composition and so far as can be judged by theinformation available, free from any pests, diseases or other organisms which may affect its sowingquality" (ISTA, 2021).

However, A seed lot would represent any quantity of agricultural seeds up to a maximum of 20,000 kilograms for seeds of the size of rice or larger (except maize seed, seed potato, sweet potato, yams,taro, and chow-chow for which the maximum size of the lot may be 40,000 kilograms) and 10,000 kilograms for seeds smaller than rice subject to a tolerance limit of 5.0%. The quantities above the above maximum limits shall be subdivided and separate lot identification shall be given. See thetable in Annexe 2 for the maximum seed lot sizes

2. Collecting Primary Samples

Multiple primary samples are drawn evenly across the entire seed lot using triers or manually. Sample number, size, and distribution depend on lot volume and heterogeneity. Minimum numbers of primarysamples have been defined for three

different situations: -

- containers between 15 and 100 kg
- containers smaller than 15 kg
- containers larger than 100 kg (or streams of seed entering containers).

The primary sample is a sample from one single sampling action. Like either the quantity that came outafter one time the trier was inserted into the bag or the bin.

Sampling intensity: By ISTA standards, the sampling intensity—meaning the number of samples collected from a seed lot for testing—depends on the size of the seed lot and the type of seed. The ISTA Rules specify maximum lot sizes for each species. For most agricultural and vegetable seeds that are smaller than wheat, including many grass species, the maximum lot size is typically 10,000 kilograms. For larger seeds, the maximum lot sizes can be larger, ranging from 20,000 to 30,000 kilograms. However, the lot sizes for different types of crops, like trees and flowers,can vary significantly .

a) Sampling seed lots in containers between 15 and 100 kg

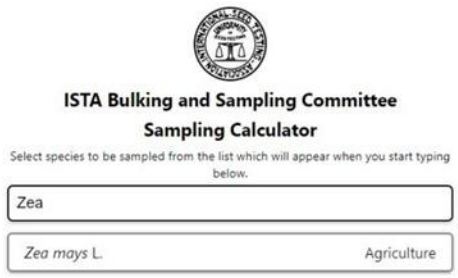
Lot Size	Minimum Number of Primary Samples to Be Taken
1 - 4 containers	Three (3) samples from each container
5 - 8 containers	Two (2) samples from each container
9 – 15 containers	One (1) sample from each container
16 - 30 containers	Fifteen (15) samples from the seed lot
31 - 59 containers	Twenty (20) samples from the seed lot
60 or more containers	Thirty (30) samples from the seed lot

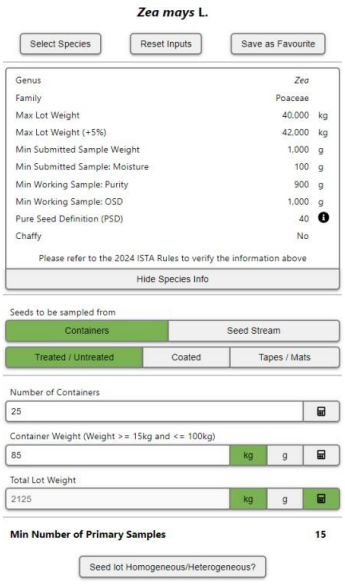
Containers are combined into sampling units of 100 kg. The sampling scheme for containers between 15kg and 100kg is followed by taking the samplingunits as containers Sampling seed lots in containers greater than 100 kg and from the seed stream

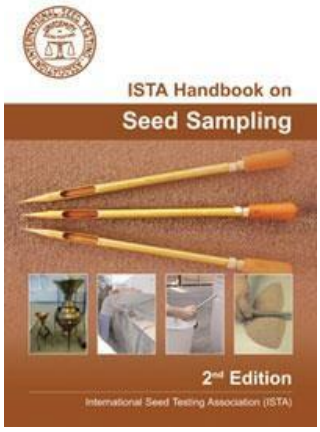
Lot Size	Minimum Number of Primary Samples to be Taken
up to 500 kg	At least five (5) samples
501 - 3,000 kg	One (1) sample for each 300 kg, but not less than five
3,001 - 20,000 kg	One (1) sample for each 500 kg, but not less than 10
20,001 kg and above	One (1) sample for each 700 kg but not less than 40

Sampling seed lots in containers more than 100 kg, in bulk

The sampling must represent the entire lot, and the process should be carried out only when the seedis ready to be shipped, after any treatments or rebagging. This ensures that the sample reflects the seed lot as it will be received by the importer. It's important to note that any treatment of the seeds after testing will invalidate the certificate since the seeds no longer represent the tested sample.For specific sampling procedures, including the minimum number of primary samples required forheterogeneity testing, ISTA offers tools such as the ISTA Sampling Calculator (https://sampling- calculator.seedtest.org/). This tool helps in calculating the number of samples based on various variables such as seed type, container size, and packaging.



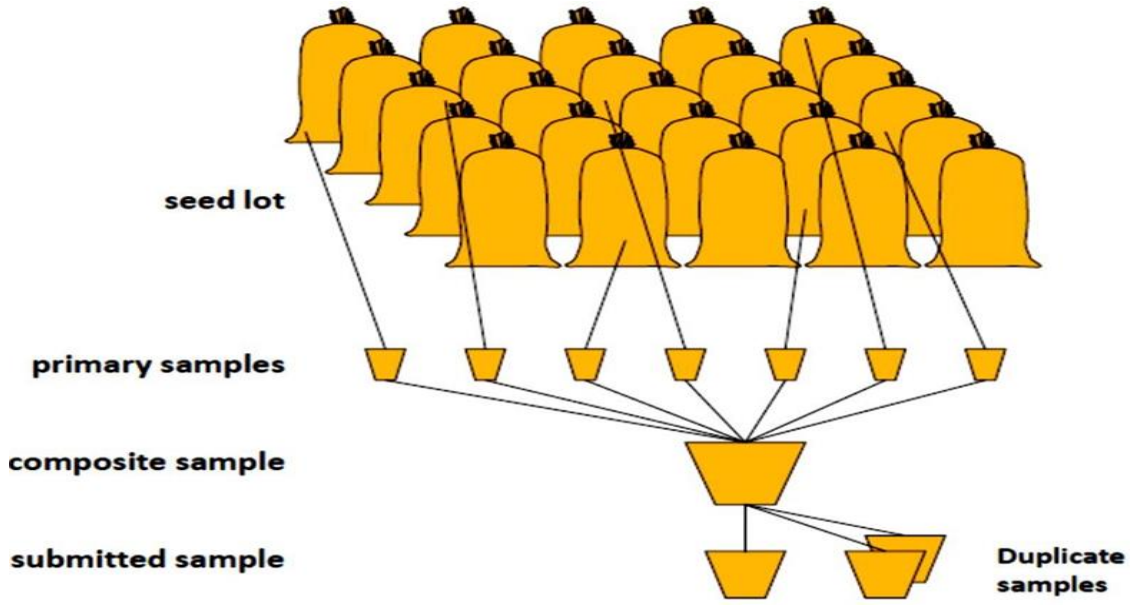




Screenshots of the ISTA sampling calculator and the ISTA Handbook on seed sampling

1. Preparing Composite Sample

All primary samples are combined and thoroughly mixed to obtain a homogeneous composite samplerepresenting the seed lot.



Obtaining Submitted Sample

The submitted sample of specified size for different tests is derived from the composite sample through methods like repeatedly halving/quartering or withdrawing random portions.

Every crop, based on the seed size, has a standard submitted sample size.

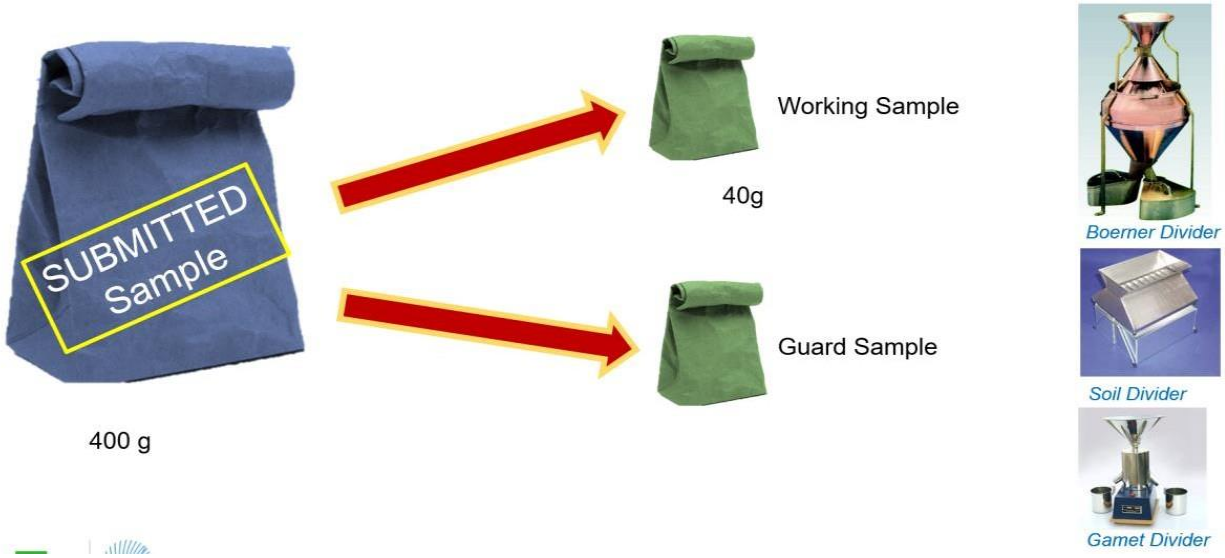
- **1000 grams** for maize, cotton, groundnut, soybean, and species of other genera with seeds of asimilar size.
- **500 grams** for sorghum, wheat, paddy, and species of other genera with seeds of similar size.
- **250 grams** for Beta and species of other genera with seeds of similar size.
- **100 grams** for bajra, jute, and species of all other genera.
- **250 tubers/planting stakes/roots/corns** for seed potato, sweet potato, and other vegetativelypropagating crops

Packaging, Labelling, and Submission Submitted samples are securely packed to avoid damage or contamination in transit and accurately labeled with details like variety, lot number, test requirements, sender, etc. before prompt submission to the testing laboratory. When seeds are to be sent to the lab for seed moisture content test also, they are packed in metal tins, aluminum foil pouches, or any other moisture vapor-proof packets.

Working Sample Preparation

The laboratory prepares uniform working samples from the submitted samples for conducting the various tests. Following standardized sampling and sample reduction protocols minimizes errors and enhances test result reliability. The sample size requirements prescribed by ISTA for various crops and tests serve as international benchmarks.

Drawing Working sample from Submitted sample



Preparing a working sample in a seed testing lab involves three key steps:

Receiving and recording:

The submitted seed sample arrives at the lab and is documented with details likespecies, weight, and test requirements.

Mixing and dividing:

The entire sample is thoroughly mixed to ensure uniformity.

Mechanical dividers (like Boerner dividers) or manual methods (like spreading and splitting)are used to reduce the sample size to the required amount for specific tests. This process might be repeated to achieve the desired working sample size.

Sub-sampling (optional)

For some tests, specific sub-samples may be needed (e.g., counting for germination tests). These are carefully drawn from the working sample following specific protocols to maintain representativeness.

Key features:

Maintaining representativeness: Each step aims to ensure the working sample accuratelyreflects the entire seed lot.

Standardized procedures: Labs follow specific ISTA or national/regional standards for mixing, dividing, and sub-sampling to obtain reliable results.

Equipment used: Mechanical dividers like soil type/ Riffle dividers or Boerner types are common for efficient and unbiased sample reduction. Alternatively, hand-halving can also be used. (see fig)

Topic 1: Seed Quality Assurance vs Seed Quality Control

1. Objective:

The objective of this module is to differentiate between Seed Quality Assurance (SQA) and Seed Quality Control (SQC), understanding their unique roles in ensuring high-quality seeds for optimal crop production.

Duration:1 hour and 20 minutes

Contents for Seed Quality Assurance (SQA)

- **Introduction to Seed Quality Assurance:** Defining SQA and its significance in sustainable agriculture.
- **Regulatory Framework**: Exploring the legal aspects and regulations governing seed quality assurance.
- **Quality Management Systems**: Understanding the systems and protocols in place to ensure seed quality at various stages.

Contents for Seed Quality Control (SQC)

- **Introduction to Seed Quality Control:** Defining SQC and its role in maintaining seed standards.
- **Quality Testing Methods**: Exploring various testing techniques for assessing seed quality parameters.
- **Sampling Procedures:** Understanding how representative samples are collected for quality control purposes.

Process and Steps

Seed Quality Assurance

- **Planning:** Develop a comprehensive plan outlining quality objectives and strategies.
- **Implementation:** Executing quality management systems, including adherence to regulatory standards.
- **Monitoring:** Continuous surveillance to identify deviations and potential risks.
- **Documentation:** Maintaining detailed records of processes and quality control measures.

Seed Quality Control:

- **Sampling:** Collecting representative samples from seed lots for testing.
- **Testing:** Employing various methods to assess factors like germination rate, purity, and vigor.
- **Analysis:** Applying statistical tools to interpret test results and compare them against established standards.

Photo: Seed Testing germination, Credit: Nimo Abdirahman, University of Burao Seed Lab.

Topic 2: Seed testing international organizations

Objective:

The objective of the Seed Testing International Organizations topic is to familiarize participants with global entities involved in seed testing, emphasizing their roles and significance in ensuring seed quality and international trade standards.

Duration: 1 hour and 30 minutes

Content

The session will cover an overview of prominent international organizations engaged in seed testing, including their missions, functions, and collaborative efforts. Participants will gain insights into the regulatory frameworks shaping seed quality on a global scale.

Process and Steps

- Introduction to seed testing and its importance in global agriculture.
- Overview of key international organizations such as ISTA (International Seed Testing Association) and OECD (Organization for Economic Co-operation and Development).
- Exploration of the roles played by these organizations in establishing and maintaining seed quality standards.
- Discussion on international collaborations and agreements influencing seed trade.
- Case studies showcasing the impact of seed testing organizations on agriculture and food security

Materials Required

- Presentation slides highlighting key information about seed testing international organizations.
- Handouts summarizing key points for participants.
- Access to online resources for real-time updates on the activities of these organizations.

Evaluation

Participants will be assessed through
1. Participation in discussions.

2. Understanding demonstrated through responses to case studies.
3. Completion of a short quiz assessing knowledge acquired during the session.

Photo: Seed Testing Germination Credit: Nimo Abdirahman Yusuf, University of Burao, Seed Testing Lab

Topic 3: Seed Testing Methods

Objective:

The objective of seed testing methods is to assess seed quality, ensuring viability, vigor, purity, and overall health.

Duration: 2 hours theory and 4 hours practical

Contents:

- **Introduction to Seed Quality:** Understanding the importance of seed quality for successful crop production.
- **Germination Test:** Measures the potential for seed growth by observing and recording germination rates under controlled conditions.
- **Genetic Purity Assay:** Confirms seed conformity by assessing the genetic makeup to maintain the desired characteristics.
- **Moisture Content Analysis:** Determines seed moisture levels, crucial for storage and preventing issues like mold or decay.
- **Seed Health Assessment:** Overview of methods for identifying diseases, pathogens, and abnormalities in seeds.

Process and Steps

- **Germination Test**: Seeds are placed in a controlled environment, and the percentage of germinated seeds is recorded over a specified period. (Theory + Practical)
- **Moisture Content Analysis**: Measures the amount of water present in seeds using specialized equipment. (Theory + Practical)
- **Seed Health Assessment**: This involves visual inspection, microscopic analysis, and laboratory tests to identify potential diseases or pathogens. (Theory)
- Tolerances to determine the test results fall under acceptable variability statistically
- Seed Lab Documentation and results handling

Training Materials Required

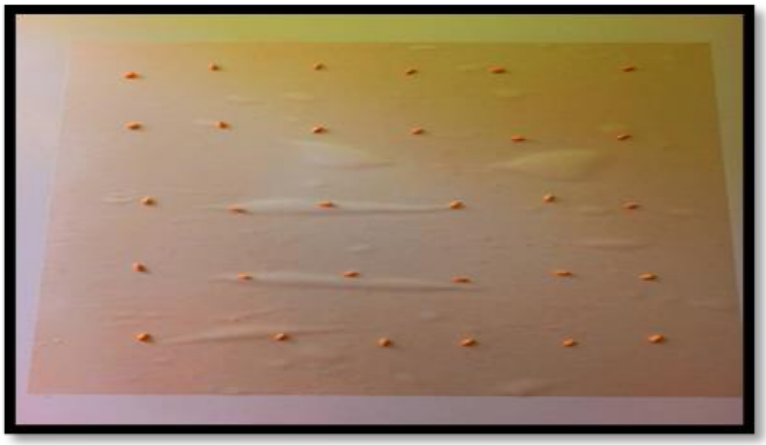
- Seed samples,
- Specialized testing equipment (germination chambers, meters, **purity work board, magnifiers, weighing balance, etc.**)
- Detailed protocols, and
- Reference materials on seed pathology.
- Links to documents are there in **Annex 2**

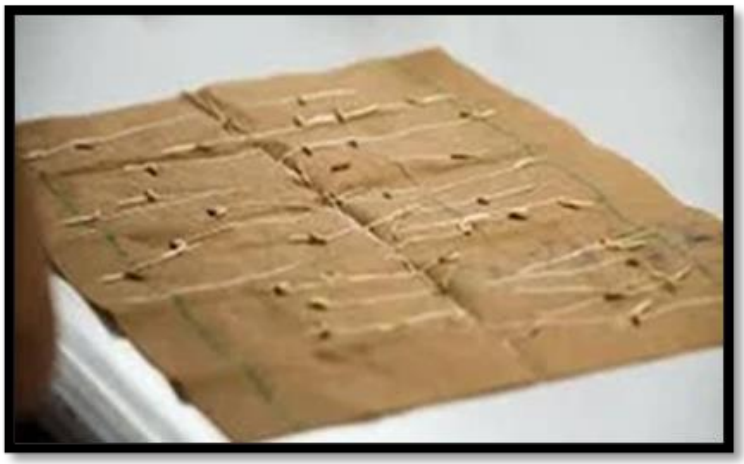
Training Evaluation

- Assessment should focus on understanding testing protocols, equipment operation, and accurate result interpretation.
- A full demonstration of the seed testing procedures is to be done with the student's hands-on exercises on different crop seeds to make them understand the difference between the testing procedures for different seeds.

- Successful training ensures proficiency in conducting various seed tests and applying knowledge to assess seed quality effectively.

Seed Moisture Test Instrument **Physical Purity of seed**





Seed Germination Test on Top of Paper

Topic 4: Labeling Standards and Implications in International Seed Trade

Objective

The objective is to understand and comply with labeling standards in the international seed trade, ensuring accurate information, traceability, and adherence to regulatory requirements.

Duration: 2 hours and 30 minutes

Content:

- International seed trade regulations
- Labeling requirements,
- Information on seed varieties,
- Origin quality, and Packaging details.

NB: Emphasis should be placed on compliance with global standards like ISTA (International Seed Testing Association) guidelines.

Process and Steps:

- Introduction to International Seed Trade Regulations: Overview of key regulations governing seed trade.
- **Labeling Standards**: Detailed exploration of labeling requirements, including mandatory information and recommended best practices. Different labels for different classes of seeds in different countries.
- **Information on Seed Varieties:** Understanding the importance of accurate variety information on labels.
- **Quality and Origin Specifications:** Ensuring labels reflect seed quality parameters and accurate origin details.
- **Packaging Details:** Guidelines on proper packaging information to meet international standards.

Training Materials Required:

Regulatory documents, sample labels, case studies, and access to relevant online resources.

Practical exercises using seed samples and labeling scenarios are valuable for hands-on learning.

Training Evaluation:

Evaluation should assess participants' comprehension of international seed trade regulations, their ability to create compliant labels, and their understanding of the implications of adherence. Successful training ensures.

Topic 5: Quality Management Systems and ISO/ISTA Accreditations

Objective

The objective is to provide participants with a comprehensive understanding of Quality Management Systems (QMS) and ISO/ISTA accreditations in the context of seed industry standards, fostering proficiency in maintaining and achieving accreditation.

Duration:2 hours

Contents

- **Introduction to Quality Management Systems (QMS):** Understanding the principles and significance of QMS in seed industry practices.
- **ISO: IEC 17025:2005 EC and ISTA Accreditations:** Exploring the International Organization for Standardization (ISO) and International Seed Testing Association (ISTA) accreditations and their relevance. **(see Annex 2)**
- **Implementation of QMS:** Steps and strategies for integrating effective QMS practices within seed-related processes.
- **ISO/ISTA Requirements:** Detailed examination of the requirements for obtaining and maintaining ISO and ISTA accreditations.
- **Case Studies:** Real-world examples highlighting the successful implementation of QMS and achieving ISO/ISTA accreditations in the seed industry.

Training Materials Required:

- Essential materials include ISO 17025: 2005 EC and ISTA accreditation guidelines,
- Case study documents,
- Presentation slides and handouts summarizing key points.
- Additionally, access to relevant ISO and ISTA documents is crucial for comprehensive training.

Training Evaluation

- Evaluation will focus on participants' comprehension of QMS principles, ISO/ISTA requirements, and their ability to apply this knowledge.
- Assessment methods may include a post-training quiz, a practical exercise, or a discussion session to gauge participants' understanding and readiness to implement QMS in the seed industry.
- Successful evaluation indicates participants are equipped to navigate quality management and accreditation processes effectively.

Annex 1: Seed Quality Assurance vs Seed Quality Control

Introduction (15 minutes):

a) Briefly explain the importance of seed quality in agriculture and the impact on crop yield.
b) Introduce Seed Quality Assurance (SQA) and Seed Quality Control (SQC) as two essential components of seed production.

Presentation (20 minutes):

A. Present key concepts and processes and steps of Seed Quality Assurance and Seed Quality Control using the handouts.

B. Highlight the difference between SQA and SQC, emphasizing their unique roles in ensuring seed quality.

C. Discuss how SQA focuses on proactive measures throughout the entire seed production process, while SQC involves reactive measures to detect and correct issues.

Group Discussion (25 minutes)

a) Divide participants into small groups.
b) b. Provide scenarios or case studies related to seed production.
c) Ask each group to identify aspects that align with Seed Quality Assurance and Seed Quality Control.
d) Encourage groups to discuss how SQA and SQC can work together to enhance overall seed quality.

Practical Activity (20 minutes):

a) provide participants with sample seeds for inspection.
b) Ask them to perform a basic quality control check on the seeds, identifying potential issues such as size, color, and abnormalities
c) Discuss how the identified issues could be addressed through Seed Quality Assurance practices.

Summary and Reflection (15 minutes)

a) Gather the groups together and discuss their findings.
b) Summarize the key points of the training, emphasizing the collaborative nature of SQA and SQC.
c) Allow participants to share insights and ask any remaining questions.

This practical exercise engages participants through discussion, hands-on activities, and reflection, facilitating a deeper understanding of Seed Quality Assurance and Seed Quality Control in the context of seed production.

Annexe2: Seed Testing Methods Practical

Objective: To engage participants in a collaborative learning experience to perform seed testing methods and collectively analyze seed quality.

Materials Needed:

1. Seeds of a specific crop (e.g., wheat, maize, or soybeans)
2. Germination trays or Petri dishes, germination paper
3. Filter paper
4. Distilled water
5. Thermometers
6. Weighing scales
7. Hand lenses or microscopes
8. Seed purity testing equipment (optional)
9. Seed moisture meters (optional)

Group Formation(15 Minutes)

Divide participants into small groups (3-5 members per group). Each group will be responsible for conducting the seed testing methods collectively

Task Allocation:

- Assign specific tasks to each group member, such as germination testing, purity analysis, moisture content determination, and seed counting.
- Encourage collaboration and communication among group members.

1. **Germination Test (40 Minutes)**
    - Group members set up germination trays or paper, petri dishes with seeds and monitor the germination process over a designated period.
    - Record daily observations and calculate the percentage of germination.

2. **Purity Analysis (40 Minutes)**
    - Group members visually inspect and separate impurities from the seed sample using hand lenses or microscopes.
    - Collaboratively weigh the pure seed and impurities, then calculate the percentage purity.

3. **Moisture Content Determination (30 Minutes)**

- Group members collectively weigh a representative seed sample and dry it using the appropriate method.
- Calculate the percentage moisture content collaboratively.

4. **Seed Count (40 Minutes)**
    - Group members use a seed counter or manually count a known weight of seeds.
    - Calculate the average number of seeds per unit weight collaboratively.
5. **Data Compilation and Analysis (40 Minutes)**
    - Each group compiles their data for germination, purity, moisture content, and seed count.
    - Discuss and analyze the results as a group, comparing them with established seed testing standards.
6. **Group Presentation (1 hour)**
    - Each group prepares a brief presentation summarizing their findings and insights.
    - Highlight any challenges faced during the practical and propose solutions.
7. **Discussion and Reflection (20 Minutes)**
    - Facilitate a group discussion on the overall process, the importance of each seed testing method, and the implications for agriculture.
    - Reflect on the collaborative experience and share key learnings.

Note: This group-based practical exercise encourages teamwork, communication, and shared responsibility in conducting seed testing methods. It promotes a holistic understanding of seed quality assessment and allows participants to collectively analyze and interpret the results.

Annex 3: A Standard germination testing procedures (ISTA)

B.P.: Between paperT.P.: Top of paper S.: Sand

20-30 means alternating temperature while 20,30 25, 30 means constant temperatures of that particular temperature. A **dash "-"** implies alternating temperature while a **comma ","** implies thatthat species can be germinated in a constant temperature of both those temperature regimes

Crop (Botanical Name)	Substrate	Temperature (°C)	First Count (days)	Final Count (days)	Additional Treatments
Cereals and Millets					
Barnyard millet (Echinochloacalona)	T.P., B.P.	20-30	4	7	Pre-drying at 40°C
Little millet (Panicum sumatrense)	T.P., B.P.	20-30	3	7	-
Maize (Zea mays)	B.P., S.	20-30	4	7	-
Paddy (Oryza sativa)	T.P., B.P., S	20-30	5	14	Pre-dry (40°C), GA_3
Pearl Millet (Pennisetum americanum); (P. typhoides)	B.P.	25-30	3	7	-
Finger millet (Elucine coracana)	T.P., B.P.	20-30	5	8	Pre-dry (40°C), GA_3
Sorghum (Sorghum bicolor)	B.P., S	20-30	4	10	Pre-dry (40°C), GA_3
Jowar (Sorghum vulgare)	T.P., B.P.	20-30	4	10	-do-
Pulses					
Black gram (Vigna mungo)	B.P., S	20-30	5	8	*Hot water treatment (80°C) for1-2 minutes

Chickling Vetch (Khesari) (Lathyrus sativus)	B.P., S	20-30, 25	5	8	*Hot water treatment (80°C), for1-2 minutes
Chick pea (Cicer arietinum)	B.P., S.	20	5	14	*Hot water treatment (80°C), for1 minute

Cowpea (Vigna unguiculata)	B.P., S	20-30	5	8	*Hot water treatment (80°C), for 1-2 minutes
Green gram (Vigna radiata)	B.P.,S	20-30	3	7	*Hot water treatment (80°C) for 1-2 minutes
Horse gram (Dolichos biflorus)	B.P, S	20-30	5	10	*Hot water treatment (80°C), for 1 minute
Indian bean (Lablab Purpureus)	B.P, S	25	3	7	Do
Lentil (Lens esculenta), (L.culinaris)	B.P, S	20	4	10	*Hot water treatment (80°C), for 1 minute
Mothbean (Vigna aconitifolia)	B.P, S	20, 30	5	10	*Hot water treatment (80°C), for 1 minute
Pigeon pea (Cajanus cajan)	B.P, S	20-30	4	10	* Hot water treatment (80°C), for 1 minute
Faba bean (Vicia faba)	B.P, S	25, 30	5	8	Pre-chilling Scarification with sandpaper Conc. H_2SO_4 Treatment for 60 and 120 seconds
Rice bean (Vigna umbellata)	B.P.	20-30	5	8	Scarification with sandpaper Conc. H_2SO_4 Treatment for 60 and 120 seconds
Oilseeds					
Castor (Ricinus communis)	B.P., S	20-30	7	14	Predry (40°C)
Groundnut (Arachis hypogaea)	B.P.	20-30	5	10	-
Linseed (Linum usitatissimum)	T.P., B.P.	20-30	3	7	KNO_3
Mustard and rape (Brassica campestris, B. Juncea)	T.P.	20-30	4	7	Predry (40°C)

Safflower (Carthamus tinctorius)	B.P., S	20-30	3	6	Predry (40°C)
Seasame (Sesamum indicum)	T.P.	20-30	4	10	Predry (40°C)
Sunflower (Helianthus annus)	B.P., S	20-30	7	14	-
Fibre Crops					
Cotton (Gossypium species)	B.P., S	20-30	5	10	-
Jute (Corchorus capsularis), (Corchorus olitorius)	T.P; B.P	30	4	8	Light
Forage Crops					
Birdwood grass (Cenchrus setigerus)	T.P.; B.P	30	3	6	Low moisture
Cluster bean (Cyamopsis tetragonoloba)	B.P.	25	5	14	*Hot water treatment (80°C) for 1-2 minutes
Methi/ fenugreek	T.P.	25-30	4	8	Pre-dry (40°C)
Forage sorghum (Sorghum sudanense)	B.P.	20-30	3	7	*Hot water treatment (80°C) for 1-2 minutes
Marvel grass (Dichanthium annulatum)	B.P.	20-30	4	14	Pre-dry(40°C)
Setaria grass (Setaria anceps)	B.P.,S.	20-30	4	14	Pre-dry (40°C)
Stylo (Stylosathes spp.)	T.P	20-30	4	12	KNO_3
Medicinal Plants					
Isabgol (Plantago sps.)	B.P., S.	20-30	4	8	*Hot water treatment (80°C) for 5-10 minutes

Vegetable and Root Crops					
Amaranth (chauli) (Amaranthus tricolor)	T.P.	30	4	8	GA_3

Ash gourd (Petha) (Benincasa cerifera)	B.P.	20-30	5	14	*Low moisture
Asparagus (Asparagus-officinalis)	T.P.,B.P.,S.	20-30	7	21	*Low moisture
Bitter gourd (Momordicacharantia)	B.P.,S.	25-30	3	7	GA_3
Bottle gourd (Lagenariasiceraria)	B.P.,S.	20-30	5	14	*Low moisture
Brinjal (Solanum melongena)	T.P.	30	4	8	GA_3
Cabbage (B. Oleracea var. capitata)	B.P.	20-30	5	14	GA_3
Capsicum (Capsicum annum)	T.P.,B.P.	20-30	7	21	*Low moisture
Carrot (Daucus carota)	T.P.,B.P	20-30	4	10	GA_3
Cauliflower (B.oleracea var.botrytis)	B.P.	25	3	7	-
Celery (Apium graveolens)	T.P.	20,25	4	8	* Low moisture

Chinese cabbage (B.pekinensis)	25-30	4	8	* Low moisture	
Cucumber (Cucumis sativus)	B.P.,S.	20-30	7	14	GA_3
Knolkhol (B. oleracea var. gongylodes)	T.P.	20,25	3	7	-
Okra (Abelmoschus esculentus)	B.P., S.	25,30	5	10	GA_3
Pointed gourd (Trichosanthes dioica)	B.P., S.	20,30	4	8	* Low moisture
Pumpkin (Cucurbita moschata)	B.P., S.	25,30	5	10	* Low moisture
Radish (Raphanus sativus)	B.P., S.	25,30	5	10	* Low moisture
Rat tail Radish (Raphanus caudatus)	B.P., S.	25,30	4	8	* Low moisture
Ridge gourd (Luffa cylindrica) and Snake gourd (Trichosanthes anguina)	T.P.	20-30	5	14	
Snap melon (Cucumis melo var Momordica)	T.P.	20-30	3	7	
Sponge gourd (Luffa cylindrical)	B.P., S.	20-30	5	14	
Summer squash (Cucurbitapepo)					
Tomato (Lycopersicum esculentum) Turnip (Brassica rapa) Water melon (Citrullus lanatus)	B.P., S.	20-30	4	8	

Winter squash (Cucurbitamaxima)					

Annex 4: Grow-Out Test

Grow-Out Test for Cultivar Purity

I. Object

The primary objective of the Grow-Out Test (GOT) is to ascertain the genetic purity of a given seed lot of a released cultivar. This test aims to evaluate the extent to which the submitted sample conforms to the prescribed standards, ensuring the integrity and reliability of the seed supply system.

II. Sampling

The samples for the grow-out test are to be drawn simultaneously with samples for other quality tests, following standard procedures. The size of the submitted sample varies according to the crop type:

- 1,000 gm: Maize, cotton, groundnut, soybean, and species of similar seed size.
- 500 gm: Sorghum, wheat, paddy, and species of similar seed size.
- 250 gm: Beta and species of similar seed size.
- 100 gm: Bajra, jute, and species of all other genera.
- 250 tubers/planting stakes/roots/corns: Seed potato, sweet potato, and other vegetatively propagating crops.

III. Procedure

The procedure involves raising the desired population under standard agronomic and cultural practices, ensuring uniformity between the unknown sample and its control. The test relies on the hereditary characteristics of plants, with cultivar differences being more distinct under favorable growth conditions. The examination entails mutual comparison between the samples to be tested and the standard sample, with standard samples sown at suitable intervals. Crop-specific specifications, including plot size and row length, are detailed in the provided table.

S. No.	Crop	Row Length (meters)	Plant to Plant Distance (cm)	Space Between Rows (cm)	Space Between Plots (cm)	No. of Replications
1	Wheat, barley, oats	6	2	25	50	2
2	Pea, cowpea	6	10	45	90	2
3	Chickpea, green gram, black gram	6	10	30	60	2
4	Maize	10	25	60	90	2
5	Hybrid cotton	5	10	45	45	2
6	Paddy / Rice	6	15	20	45	2
	Paddy (b)	6	25	30	60	2
7	Pearlmillet	6	10	60	90	2
8	Sorghum	6	10	45	60	2

I. Observations

All plants are meticulously studied for distinguishing characters described for the cultivar, both in the test crop and the control. Observations are made throughout the growing period, with deviations from the standard sample recorded at suitable development stages. Plants exhibiting characteristics of other cultivars are identified and recorded accordingly.

II. Calculation, Interpretation, and Reporting of Results

The percentage of off-types is calculated to the first decimal place. Results are interpreted using tolerance tables provided, allowing for the application of tolerance when assessing conformity to prescribed standards

	Field bean	*Vicia faba*	500	1000
	French bean	*Phaseolus vulgaris*	700	1000
	Green gram	*Vigna radiata*	120	1000
	Lentil	*Lens culinaris*	60	600
	Lablab bean	*Lablab purpureus*	500	1000
	Lima bean	*Phaseolus lunatus*	1000	1000
	Pea	*Pisum sativum*	900	1000
	Pigeon pea	*Cajanus cajan*	300	1000
	Soybean	*Glycine max*	500	1000
OILS & FATS	Castor	*Ricinus communis*	500	1000
	Groundnut	*Arachis hypogaea*	1000	1000
	Safflower	*Carthamus tinctorius*	90	900
	Sesame	*Sesamum indicum*	7	70
	Sunflower	*Helianthus annuus*	200	1000
	Rape & Mustard	*Brassica rapa & Brassica juncea*	4	40
	Linseed	*Linum usitatissimum*	15	150
SUGAR & STARCHES	Buckwheat	*Fagopyrum esculentum*	60	600
	Sugar beet	*Beta vulgaris subsp. vulgaris*	50	500
	Berseem	*Trifolium alexandrinum*	6	60
	Blue panic	*Panicum antidotale*	2	20

FORAGE CROPS	Buffelo grass	*Cenchrus ciliaris*	2	20
	Canary grass	*Phalaris aquatica*	4	40
	Carpet grass	*Axonopus affinis*	1	10
	Clovers	*Trifolium spp.*	0.5-25	5 to 250
	Dallies grass	*Paspalum dilatatum*	5	50
	Guinea grass	*Megathyrsus maximus*	2	20
	Lucerne	*Medicago sativa*	5	50
	Lupines	*Lupinus spp.*	450	1000
	Napier grass	*Pennisetum purpureum*	5	50
	Orchard grass	*Dactylis glomerata*	3	30
	Tall fescue	*Festuca arundinacea*	5	50
	Vetches	*Vicia spp.*	120-1000	1000
	Weeping love grass	*Eragrostis curvula*	1	10
GREEN MANURES	Cluster beans	*Cyamopsis tetragonoloba*	80	800
	Sunnhemp	*Crotalaria juncea*	70	700
BEVERAGES	Chicory	*Cichorium intybus*	5	50
	Tobacco	*Nicotiana tabacum*	0.5	5
LEGUME VEGETABLES				

	Broad bean	*Vicia faba*	1000	1000

Annexe5: Working samples minimum weight required forPhysical Purity and Genetic Purity

Category	Crop	Botanical Name	Minimum Working Sample Wt. (gm) - Physical Purity	Minimum Working Sample Wt. (gm) - Genetic Purity/ Grow Out Test
CEREALS	Barnyard millet	*Echinochloa crus-galli*	8	80
	Common millet	*Panicum miliaceum*	15	150
	Italian millet	*Setaria italica*	9	90
	Barley	*Hordeum vulgare*	120	1000
	Maize	*Zea mays*	900	1000
	Paddy/ Rice	*Oryza sativa*	40	400
	Pearl millet	*Pennisetum glaucum*	15	150
	Oats	*Avena sativa*	120	1000
	Sorghum	*Sorghum bicolor*	90	900
	Wheat	*Triticum aestivum*	900	1000
	Black gram	*Vigna mungo*	700	1000

PULSES	Chick pea	*Cicer arietinum*	1000	1000
	Cowpea	*Vigna unguiculata*	400	1000

	Field bean	*Vicia faba*	500	1000
	French bean	*Phaseolus vulgaris*	700	1000
	Green gram	*Vigna radiata*	120	1000
	Lentil	*Lens culinaris*	60	600
	Lablab bean	*Lablab purpureus*	500	1000
	Lima bean	*Phaseolus lunatus*	1000	1000
	Pea	*Pisum sativum*	900	1000
	Pigeon pea	*Cajanus cajan*	300	1000
	Soybean	*Glycine max*	500	1000
OILS & FATS	Castor	*Ricinus communis*	500	1000
	Groundnut	*Arachis hypogaea*	1000	1000
	Safflower	*Carthamus tinctorius*	90	900
	Sesame	*Sesamum indicum*	7	70
	Sunflower	*Helianthus annuus*	200	1000
	Rape & Mustard	*Brassica rapa & Brassica juncea*	4	40
	Linseed	*Linum usitatissimum*	15	150
SUGAR &	Buckwheat	*Fagopyrum esculentum*	60	600

STARCHES	Sugar beet	*Beta vulgaris subsp. vulgaris*	50	500
FORAGE CROPS	Berseem	*Trifolium alexandrinum*	6	60
	Blue panic	*Panicum antidotale*	2	20
	Buffelo grass	*Cenchrus ciliaris*	2	20
	Canary grass	*Phalaris aquatica*	4	40
	Carpet grass	*Axonopus affinis*	1	10
	Clovers	*Trifolium spp.*	0.5-25	5 to 250
	Dallies grass	*Paspalum dilatatum*	5	50
	Guinea grass	*Megathyrsus maximus*	2	20
	Lucerne	*Medicago sativa*	5	50
	Lupines	*Lupinus spp.*	450	1000
	Napier grass	*Pennisetum purpureum*	5	50
	Orchard grass	*Dactylis glomerata*	3	30
	Tall fescue	*Festuca arundinacea*	5	50
	Vetches	*Vicia spp.*	120-1000	1000
	Weeping love grass	*Eragrostis curvula*	1	10
GREEN	Cluster beans	*Cyamopsis tetragonoloba*	80	800

MANURES	Sunnhemp	*Crotalaria juncea*	70	700
BEVERAGES	Chicory	*Cichorium intybus*	5	50
	Tobacco	*Nicotiana tabacum*	0.5	5
LEGUME VEGETABLES	Broad bean	*Vicia faba*	1000	1000

Annex 6:Maximum lot sizes

Crop Name	*Botanical Name*	Maximum LotSize (tons); 1 ton =1000 kg
Chow-chow	*Sechium edule*	**40 tons**
Garlic	*Allium sativum*	
Lesser yam	*Dioscorea esculenta*	
Maize	*Zea mays*	
Multiplier onion	*Allium cepa var. aggregatum*	
Seed potato	*Solanum tuberosum*	
Sweet Potato	*Ipomoea batatas*	
Ashgourd (Petha)	*Benincasa hispida*	**20 tons**
Asparagus	*Asparagus officinalis*	
Barley	*Hordeum vulgare*	
Birdwood grass	*Cenchrus setigerus*	
Bitter gourd	*Momordica charantia*	
Black gram (Urdbean)	*Vigna mungo*	
Bottle gourd	*Lagenaria siceraria*	
Castor	*Ricinus communis*	
Chikling vetch (Khesari)	*Lathyrus sativus*	
Cluster bean (Guar)	*Cyamopsis tetragonoloba*	
Cotton	*Gossypium spp.*	
Cowpea (Asparagus bean)	*Vigna unguiculata*	
Garden beet	*Beta vulgaris*	
Gram (Bengal gram)	*Cicer arietinum*	
Green gram (Mung bean)	*Vigna radiata*	
Groundnut	*Arachis hypogaea*	
Horse gram (Kulthi)	*Macrotyloma uniflorum*	
Indian bean (Sem)	*Lablab purpureus*	
Indian squash (Tinda)	*Praecitrullus fistulosus*	
Moth bean (Kidney bean)	*Vigna aconitifolia*	
Oats	*Avena sativa*	
Okra (Bhindi)	*Abelmoschus esculentus*	
Paddy	*Oryza sativa*	
Pea	*Pisum sativum*	

Pigeon pea (Arhar)	*Cajanus cajan*	
Rajmash (French bean)	*Phaseolus vulgaris*	
Ridge gourd	*Luffa acutangula*	
Snake gourd	*Trichosanthes cucumerina*	
Soybean	*Glycine max*	
Spinach beet	*Beta vulgaris subsp. cicla*	
Sponse gourd	*Luffa aegyptiaca*	
Sugar beet	*Beta vulgaris subsp. vulgaris*	
Summer squash	*Cucurbita pepo var. cylindrica*	
Sunflower	*Helianthus annuus*	
Teosinte	*Zea mays subsp. mexicana*	
Triticale	*× Triticosecale*	
Watermelon	*Citrullus lanatus*	
Wheat	*Triticum aestivum*	
Winter squash	*Cucurbita maxima*	
Alfa alfa (Lucerne)	*Medicago sativa*	**10 tons**
Amaranth	*Amaranthus spp.*	
Barnyard millet (Sawan)	*Echinochloa frumentaceae*	
Berseem (Egyptian clover)	*Trifolium alexandrinum*	
Brinjal (eggplant)	*Solanum melongena*	
Broccoli	*Brassica oleracea var. italica*	
Buffel grass	*Cenchrus ciliaris*	
Cabbage	*Brassica oleracea var. capitata*	
Carrot	*Daucus carota subsp. sativus*	
Cauliflower	*Brassica oleracea var. botrytis*	
Celeriac	*Apium graveolens var. rapaceum*	
Celery	*Apium graveolens*	
Chinese cabbage	*Brassica rapa subsp. pekinensis and Brassica rapa subsp. chinensis*	
Common millet (Cheema)	*Panicum miliaceum*	
Cucumber	*Cucumis sativus*	
Dharaf grass	*Cenchrus ciliaris*	
Dinanath grass	*Pennisetum pedicellatum*	
Fenugreek (methi)	*Trigonella foenum-graecum*	
Finger millet (Ragi)	*Eleusine coracana*	
Guinea grass	*Panicum maximum*	
Hot pepper (chilli)	*Capsicum annuum*	
Italian millet (Kangni)	*Setaria italica*	
Jute	*Corchorus spp.*	
Knol-kohl	*Brassica oleracea var.gongylodes*	
Kodo millet (Kodo)	*Paspalum scrobiculatum*	
Lentil	*Lens culinaris*	
Lettuce	*Lactuca sativa*	

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