

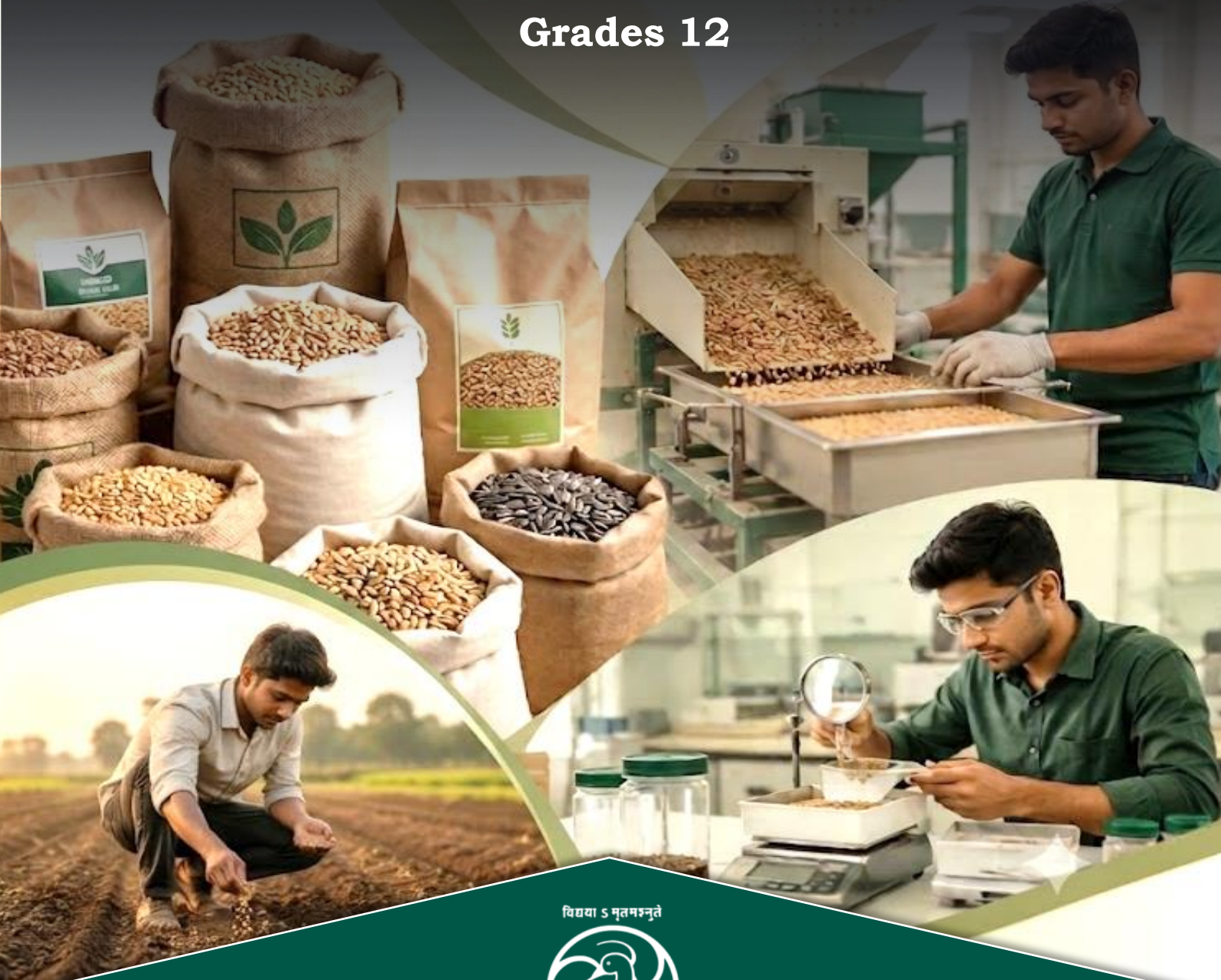
Draft Study Material

# Quality Seed Grower

(Qualification Pack: Ref. Id. AGR/ Q7101)

Sector: **Agriculture**

Grades 12



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NCERT

**PSS CENTRAL INSTITUTE OF VOCATIONAL EDUCATION**

(a constituent unit of NCERT, under MoE, Government of India)

**Shyamla Hills, Bhopal- 462 002, M.P., India**

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## Preface

Vocational Education is a dynamic and evolving field, and ensuring that every student has access to quality learning materials is of paramount importance. The journey of the PSS Central Institute of Vocational Education (PSSCIVE) toward producing comprehensive and inclusive study material is rigorous and time-consuming, requiring thorough research, expert consultation, and publication by the National Council of Educational Research and Training (NCERT). However, the absence of finalized study material should not impede the educational progress of our students. In response to this necessity, we present the draft study material, a provisional yet comprehensive guide, designed to bridge the gap between teaching and learning, until the official version of the study material is made available by the NCERT. The draft study material provides a structured and accessible set of materials for teachers and students to utilize in the interim period. The content is aligned with the prescribed curriculum to ensure that students remain on track with their learning objectives. The contents of the modules are curated to provide continuity in education and maintain the momentum of teaching-learning in vocational education. It encompasses essential concepts and skills aligned with the curriculum and educational standards. We extend our gratitude to the academicians, vocational educators, subject matter experts, industry experts, academic consultants, and all other people who contributed their expertise and insights to the creation of the draft study material. Teachers are encouraged to use the draft modules of the study material as a guide and supplement their teaching with additional resources and activities that cater to their students' unique learning styles and needs. Collaboration and feedback are vital; therefore, we welcome suggestions for improvement, especially by the teachers, in improving upon the content of the study material. This material is copyrighted and should not be printed without the permission of the NCERT-PSSCIVE.

Deepak Paliwal  
(Joint Director)  
PSSCIVE, Bhopal

Date: 09 February 2026

## Study Material Development Committee

### MEMBERS

Dr. Dharendra Khare, Dean Faculty of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh

Dr. Rajiv Kumar Pathak, Professor, Department of Agriculture and Animal Husbandry, PSSCIVE, Shyamla Hills, Bhopal, Madhya Pradesh

Aman Kumar, Assistant Professor, Department of Agriculture and Animal Husbandry, PSSCIVE, Bhopal, Madhya Pradesh

Anurag Kamathekar, Lab Assistant, Department of Agriculture & Animal Husbandry, PSSCIVE, Bhopal

### Member-Coordinator

Dr. Anoop Kumar Rathore, Assistant Professor, Department of Agriculture and Animal Husbandry, PSSCIVE, Bhopal, Madhya Pradesh

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# Module 1

## Harvesting, Processing & Certification at Seed Level

### Module Overview

The production of high-quality seed is essential for ensuring better crop performance, higher productivity, and agricultural sustainability. This unit provides learners with a comprehensive understanding of the key operations carried out after a seed crop reaches maturity. It covers the principles and practices of seed harvesting and post-harvest management, emphasizing the importance of timely harvesting and proper handling to maintain seed quality. The unit further explains various seed processing techniques used to improve physical purity, germination, and storability. In addition, learners will gain knowledge about seed certification procedures at the seed level, including standards, inspections, and quality assurance measures that ensure the availability of genetically pure and healthy seed to farmers. Through these sessions, students will develop the knowledge and skills required for effective seed management from harvest to certification.

This module introduces students to the essential activities carried out after seed crop production, focusing on harvesting, processing, and certification procedures. It emphasizes the importance of proper post-harvest management in maintaining seed quality and viability. In Session 1, students will learn about the techniques of harvesting seed crops and the post-harvest practices required to minimize losses and preserve seed quality. Session 2 covers seed processing operations such as cleaning, grading, drying, and packaging. Session 3 focuses on seed certification procedures, standards, and regulations that ensure the genetic purity and quality of seeds. The module highlights the significance of these processes in delivering quality-assured seeds to farmers.

### Learning Outcomes

After completing this module, you will be able to:

- Explain the methods of harvesting seed crops and the importance of post-harvest management in maintaining seed quality.
- Describe the various seed processing operations and their role in improving seed quality and marketability.
- Identify the procedures, standards, and importance of seed certification in ensuring the quality and authenticity of seeds.

## Module Structure

Session 1: Harvesting of Seed Crop and Post-Harvest Management

Session 2: Processing of Seed

Session 3: Certification at Seed Level

### Session 1: Harvesting of Seed Crop and Post-Harvest Management

#### Harvestable Maturity of Seed Crops

Harvestable maturity refers to the stage at which a seed crop is ready for harvesting while ensuring maximum seed quality, viability, vigour, and storage potential. It is a critical stage in seed production because the quality of seed largely depends on the time of harvest. Harvesting the crop before maturity results in immature seeds with poor germination and low vigour, whereas delayed harvesting may lead to shattering, lodging, weather damage, pest infestation, and deterioration of seed quality. The development of a seed begins after fertilization and continues through various stages until it reaches physiological maturity. Physiological maturity is the stage at which the seed attains maximum dry matter accumulation and maximum vigour. However, at this stage, the moisture content of the seed is still high. Therefore, harvesting is usually carried out slightly later when the crop exhibits visible signs of maturity and the moisture content decreases to a safer level. This stage is known as harvestable maturity.

Timely harvesting at harvestable maturity is essential for obtaining high-quality seed with maximum germination and vigour. Proper harvesting also reduces field losses and helps maintain genetic and physical purity of the seed lot.

#### Harvestable Maturity of Different Seed Crops

Crop	Harvestable Maturity Stage	Maturity Indicators
Rice	30–35 days after flowering	80–85% grains turn straw yellow and become hard
Wheat	Full maturity stage	Crop turns golden yellow and grains become hard
Maize	30–35 days after flowering	Husk turns straw yellow and kernels become hard
Sorghum	Physiological maturity	Earheads turn brown and grains attain characteristic colour

Pearl Millet	35–40 days after flowering	Earheads become brown and grains harden
Finger Millet	Full maturity	Earheads dry and seeds become hard
Pigeon Pea	75–80% pod maturity	Pods turn brown and dry
Chickpea	Full maturity	Plants become yellow and pods dry completely
Green Gram	80–85% pod maturity	Pods turn black or dark brown
Black Gram	80–85% pod maturity	Pods become black and dry
Cowpea	Pod maturity stage	Pods turn straw coloured and dry
Pea	About 70% pod maturity	Pods become yellowish brown and dry
Soybean	Physiological maturity	Leaves shed and pods turn brown
Groundnut	70–80% pod maturity	Inner shell shows dark markings and kernels fully develop
Mustard	70–80% siliqua maturity	Siliquae turn yellowish brown
Sunflower	Physiological maturity	Back of flower head turns yellow to brown
Sesame	70–80% capsule maturity	Lower capsules turn yellow and begin drying
Castor	75–80% capsule maturity	Capsules become brown and dry
Cotton	60–70% boll opening	Bolls burst open showing fluffy lint
Tomato	Fully ripe fruit stage	Fruits attain characteristic red colour
Brinjal	Fully mature fruit stage	Fruits become dull and seeds harden
Chilli	Fully ripe fruit stage	Fruits turn deep red and seeds become hard

Onion	Seed maturity stage	Umbels turn brown and black seeds become visible
Cabbage	Pod maturity stage	Seed pods turn yellowish brown
Cauliflower	Pod maturity stage	Pods become brown and dry
Carrot	Umbel maturity stage	Primary umbels turn brown and seeds fully develop
Radish	Pod maturity stage	Pods turn yellowish brown and dry
Coriander	Full maturity stage	Fruits become light brown and dry
Fenugreek	Pod maturity stage	Pods turn yellow and dry completely

### Harvesting Methods of Seed Crops

Harvesting is one of the most important operations in seed production because it directly influences seed quality, viability, vigour, and storage life. Harvesting refers to the removal of mature seed-bearing plant parts from the field at the proper stage of maturity. Seeds harvested at the correct time possess maximum germination capacity and storage potential. Delayed or premature harvesting may result in loss of seed quality, shattering, mechanical injury, pest infestation, and weather damage. The method of harvesting varies depending on the crop, plant type, maturity pattern, and scale of seed production. The primary objective of harvesting is to obtain maximum seed yield with minimum loss and damage while preserving genetic and physical purity.

### Methods of Harvesting Seed Crops

- 1. Manual Harvesting:** Manual harvesting is the traditional method in which crops are harvested by hand using sickles, knives, or by pulling the plants. This method is commonly adopted for small-scale seed production and crops that require careful handling. In cereals such as rice and wheat, plants are cut close to the ground using sickles. In pulse crops, mature plants are uprooted or cut and allowed to dry before threshing. Vegetable seed crops such as tomato, brinjal, chilli, and okra are harvested manually by picking mature fruits at regular intervals. Manual harvesting causes less mechanical damage and allows selective harvesting of mature plants or fruits. However, it is labour-intensive, time-consuming, and expensive.
- 2. Mechanical Harvesting:** Mechanical harvesting involves the use of machines such as reapers, combines, harvesters, and threshers. It is commonly adopted in large-scale seed production because it saves labour, time, and production costs. Combine harvesters perform harvesting, threshing, and cleaning simultaneously in crops such as wheat, rice,

soybean, and sorghum. Mechanical harvesting increases efficiency and enables timely completion of harvest operations, especially during peak seasons. However, improper machine adjustment may cause mechanical injury to seeds, reducing germination and seed vigour. Therefore, machinery should be properly calibrated when used for seed crops.



Fig. 1.1: Manual Harvesting



Fig. 1.2: Mechanical Harvesting

### Precautions During Harvesting

1. Harvest the seed crop only at the proper stage of harvestable maturity.
2. Avoid harvesting immature or overmature crops, as they produce poor-quality seeds.
3. Harvest during dry weather and avoid harvesting immediately after rain, dew, or irrigation.
4. Prevent mixing of different varieties and seed lots during harvesting.
5. Use clean harvesting tools and equipment to avoid contamination.
6. Handle harvested plants carefully to minimize seed shattering and mechanical injury.
7. Remove diseased, damaged, and off-type plants before harvesting.
8. Label harvested seed lots properly to maintain identity and traceability.
9. Avoid prolonged exposure of harvested produce to direct sunlight in the field.
10. Transport harvested material carefully to the threshing floor to prevent losses.

### Threshing of Seed

Threshing is the process of separating seeds or grains from the harvested plant material such as ears, panicles, pods, capsules, cobs, or fruits. It is the first operation performed after harvesting and drying of the crop. The method of threshing varies according to the type of crop and the nature of the seed-bearing structure. In cereal crops such as rice, wheat, sorghum, and pearl millet, threshing is carried out by beating, trampling, or using mechanical threshers. In

pulse crops such as chickpea, pigeon pea, green gram, and black gram, dried plants are beaten with sticks or passed through threshing machines to separate seeds from pods. In crops such as maize, seeds are separated from cobs through shelling, while in vegetable crops like tomato and cucumber, seeds are extracted from mature fruits.

Threshing should be carried out carefully to avoid mechanical injury to seeds. Damaged seeds show reduced germination, poor vigour, and lower storage life. Therefore, threshing equipment should be properly adjusted and operated to minimize seed damage.



Fig. 1.3: Threshing

### Precautions During Threshing

1. Thresh the crop only after proper drying of harvested material.
2. Clean the threshing floor and threshing equipment before use.
3. Thresh different seed lots separately to prevent varietal mixtures.
4. Adjust threshing machines properly to avoid seed breakage and cracking.
5. Avoid excessive beating or mechanical force during threshing.
6. Maintain optimum seed moisture content during threshing to reduce mechanical injury.
7. Remove stones, soil particles, and plant debris before threshing.
8. Do not allow seeds to remain mixed with straw and chaff for long periods.
9. Collect threshed seeds immediately and protect them from moisture.
10. Regularly inspect threshing equipment for wear and damage.

## Cleaning of Seed

Cleaning is the process of removing unwanted materials from the threshed seed lot. These unwanted materials may include dust, soil particles, broken seeds, straw pieces, weed seeds, chaff, stones, immature seeds, and seeds of other crops. Cleaning improves the physical purity and appearance of the seed lot and enhances its market value.

The cleaning process is based on differences in seed size, shape, weight, texture, and aerodynamic properties. Initially, coarse impurities are removed manually or through sieving. Further cleaning is carried out using specialized seed-cleaning machines. Several types of equipment are used for seed cleaning. Air-screen cleaners remove impurities based on differences in size and weight. Gravity separators separate seeds according to density. Spiral separators separate seeds based on shape, while indented cylinder separators remove contaminants based on seed length. Proper cleaning ensures that only healthy, well-developed, and true-to-type seeds remain in the seed lot. It also improves germination percentage and facilitates efficient storage and handling.

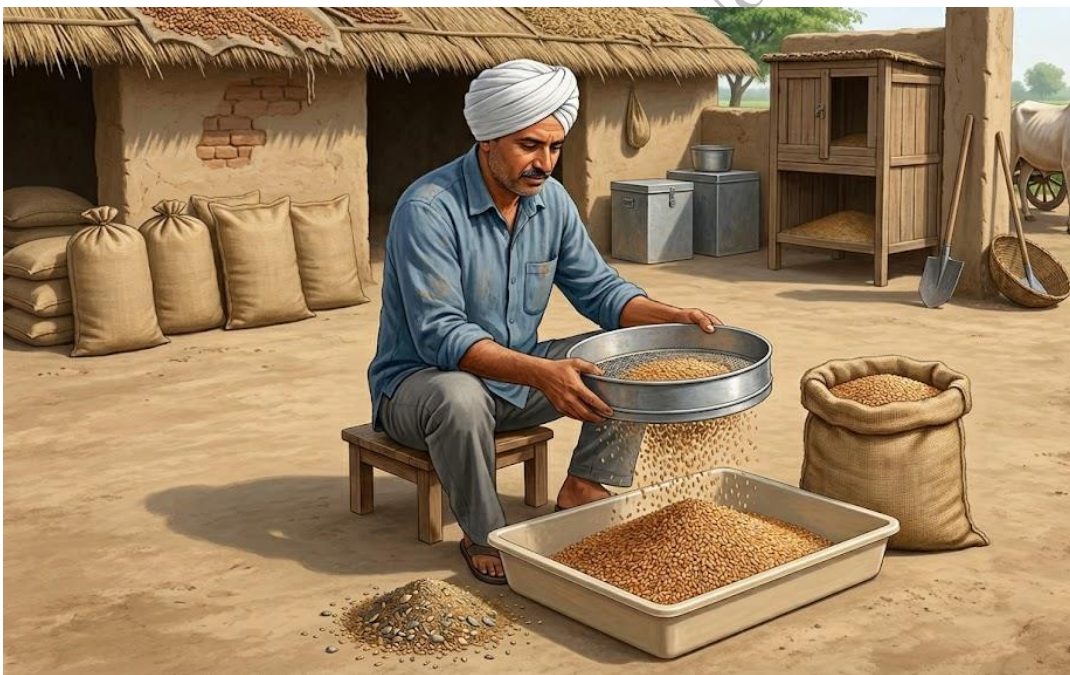


Fig. 1.4: Cleaning

### Importance of Seed Cleaning

- Improves physical purity of seed.
- Removes inert matter and weed seeds.
- Enhances germination and seed vigour.
- Improves seed appearance and market value.
- Facilitates grading and certification.

- Reduces storage losses caused by impurities.

### **Precautions During Cleaning**

1. Clean seeds immediately after threshing.
2. Remove all inert matter, weed seeds, damaged seeds, and foreign materials.
3. Ensure that seed-cleaning machines are thoroughly cleaned before use.
4. Avoid mixing different varieties and seed lots during cleaning operations.
5. Use suitable sieves and cleaning equipment according to seed size and shape.
6. Handle seeds gently to prevent mechanical damage.
7. Remove diseased and shrivelled seeds to improve seed quality.
8. Clean equipment periodically during operation to maintain efficiency.
9. Ensure complete removal of dust and chaff from the seed lot.
10. Store cleaned seeds in clean containers before drying.

### **Drying of Seed**

Drying is the process of reducing seed moisture content to a safe level suitable for storage. Freshly harvested seeds generally contain high moisture content, which promotes fungal growth, insect infestation, heating, and rapid deterioration. Therefore, drying is an essential operation for maintaining seed viability and storage life.

The safe moisture content varies among crops. Generally, cereal seeds are dried to about 12 percent moisture, while pulses and oilseeds are dried to lower moisture levels. For long-term storage, seed moisture content is usually reduced further depending on storage conditions.

Drying may be carried out naturally or artificially. Natural drying involves spreading seeds in thin layers under sunlight or shade. Seeds are stirred periodically to ensure uniform drying. Shade drying is preferred for vegetable seeds and seeds sensitive to high temperatures because direct sunlight may reduce seed viability. Artificial drying is carried out using mechanical seed dryers. Heated air is circulated through the seed mass to remove excess moisture. Mechanical drying provides uniform drying and is particularly useful during unfavorable weather conditions. However, excessively high temperatures should be avoided because they may damage seed embryos and reduce germination.

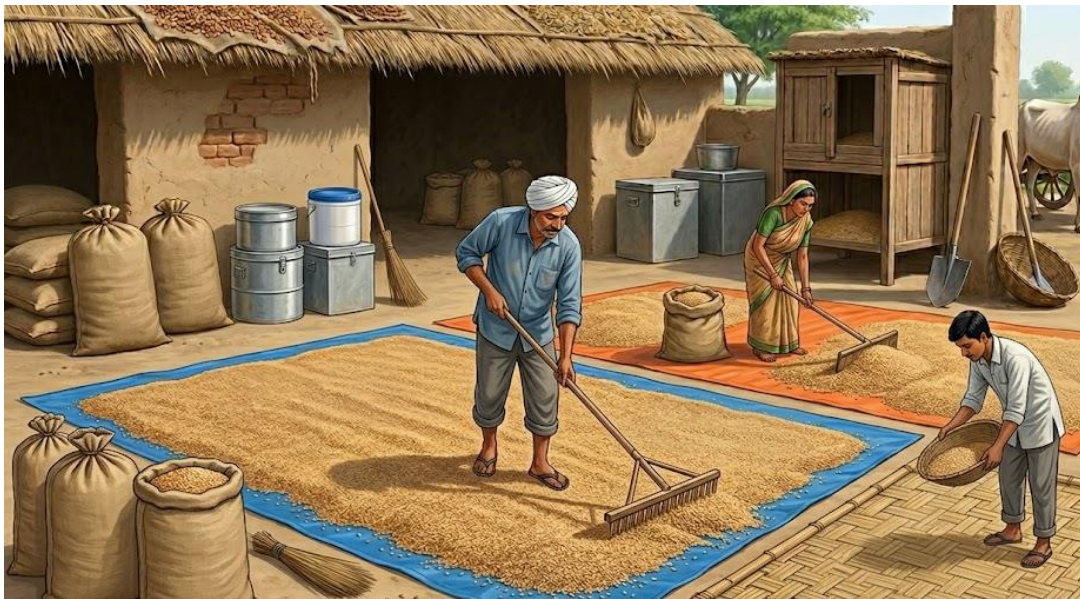


Fig. 1.5: Drying

### Precautions During Drying

1. Dry seeds immediately after cleaning to prevent deterioration.
2. Spread seeds in thin and uniform layers for efficient drying.
3. Stir seeds frequently to ensure uniform moisture removal.
4. Protect seeds from rain, dew, and excessive humidity during drying.
5. Avoid drying seeds directly on bare ground to prevent contamination.
6. Use clean tarpaulins, mats, or drying floors.
7. Avoid excessive drying temperatures that may damage the embryo and reduce germination.
8. Prefer shade drying for sensitive vegetable and flower seeds.
9. Monitor moisture content regularly and stop drying when the recommended level is reached.
10. Store seeds only after they have attained safe moisture content suitable for storage

### Activities

**Activity 1-** Determination of seed crop maturity of different crops for harvesting

#### Materials Required:

Practical notebook, pencil, pen, seed crop samples, observation sheet, etc.

#### Procedure:

- Visit a field and observe different seed crops approaching maturity.
- Identify and write the name of the crop selected for observation.

- Observe and record the physical signs of seed crop maturity such as change in color, drying of leaves, pods, or ears.
- Note the maturity indicators specific to different crops (cereals, pulses, and vegetables).
- Record the optimum stage of maturity for harvesting seed crops.
- Write the importance of harvesting seeds at the proper maturity stage for maintaining seed quality.
- Compare the maturity characteristics of different seed crops and record your observations.

**Activity 2-** Demonstrate precautions to be taken during harvesting, threshing, cleaning, and drying

**Materials Required:**

Practical notebook, pencil, pen, seed samples, harvesting and threshing tools, observation sheet, etc.

**Procedure:**

- Observe the methods used for harvesting seed crops and record the precautions followed.
- Note the precautions taken during threshing to avoid mechanical damage and seed mixing.
- Observe and write the methods used for cleaning seeds and removing impurities.
- Record the precautions followed during seed cleaning to maintain seed purity and quality.
- Observe the drying methods used and write the precautions taken to prevent damage due to excess moisture or overheating.
- Note the importance of proper harvesting, threshing, cleaning, and drying in maintaining seed viability and quality.
- Record your observations in the practical notebook.

**Check Your Progress**

**Fill in the Blanks**

1. \_\_\_\_\_ maturity is the stage at which a seed crop is ready for harvesting.
2. Seeds attain maximum dry matter accumulation at \_\_\_\_\_ maturity.
3. In rice, harvestable maturity occurs about \_\_\_\_\_ days after flowering.
4. Manual harvesting of crops is commonly done using \_\_\_\_\_.

5. \_\_\_\_\_ is the process of separating seeds from harvested plant material.

### Multiple Choice Questions

1. Which crop is harvested when 80–85% of grains turn straw yellow?
  - a. Maize
  - b. Rice
  - c. Groundnut
  - d. Cotton
2. Which crop is harvested at about 70% pod maturity?
  - a. Pea
  - b. Soybean
  - c. Black gram
  - d. Mustard
3. Which harvesting method is labour-intensive?
  - a. Mechanical harvesting
  - b. Combine harvesting
  - c. Manual harvesting
  - d. Machine shelling
4. Which machine is commonly used for large-scale harvesting?
  - a. Sprayer
  - b. Combine harvester
  - c. Seed drill
  - d. Cultivator
5. Which operation is performed immediately after harvesting and drying?
  - a. Storage
  - b. Grading
  - c. Threshing
  - d. Certification
6. Air-screen cleaners separate impurities mainly based on:
  - a. Colour
  - b. Taste
  - c. Moisture
  - d. Size and weight
7. Which drying method is preferred for vegetable seeds?
  - a. Hot air drying
  - b. Shade drying
  - c. Oven drying
  - d. Fire drying

**Match the Following**

<b>Column A</b>	<b>Column B</b>
A. Rice	1. Back of flower head turns yellow to brown
B. Sunflower	2. 30–35 days after flowering
C. Cleaning	3. Removal of unwanted materials
D. Gravity separator	4. Separation based on density

**Descriptive Questions**

1. What is harvestable maturity?
2. Write any four precautions to be followed during harvesting.
3. Explain the process of threshing of seed crops.
4. Describe the precautions to be followed during seed drying.

## Session 2: Processing of Seed

### Seed Lot

A **seed lot** is a specified quantity of seed that is physically identifiable and has been produced, processed, and stored under uniform conditions. It represents a single unit of seed that is considered homogeneous with respect to variety, origin, quality, processing history, and storage conditions.

According to seed technology, a seed lot is a quantity of seed that is handled as one unit and from which a representative seed sample can be drawn for testing and certification purposes. All seeds within a seed lot are expected to possess similar genetic, physical, physiological, and health characteristics.

### Characteristics of a Seed Lot

1. It belongs to a single variety or hybrid.
2. It is produced from the same source seed.
3. It is harvested from a specific field or group of fields under similar conditions.
4. It is processed and stored as one identifiable unit.
5. It is assigned a unique lot number for identification and traceability.
6. It should be reasonably uniform in quality throughout the lot.

### Importance of Seed Lot

- Facilitates seed testing and certification.
- Helps maintain identity and traceability of seed.
- Ensures uniformity in seed quality.
- Enables proper storage and inventory management.
- Assists in quality control during marketing and distribution.

### Example

If 5 tonnes of certified wheat seed produced from the same field, processed together, and stored in 100 bags are assigned a single identification number, the entire quantity constitutes **one seed lot**.

### Pre-conditioning of Seed

Pre-conditioning of seed is an important operation in seed technology and seed processing. It refers to the preliminary treatment given to seeds or seed-bearing structures before seed extraction, cleaning, drying, testing, or storage. The purpose of pre-conditioning is to prepare the seed material for further processing without causing damage to seed viability and vigour. In many crops, seeds are enclosed within fruits, pods, capsules, cones, or other protective structures,

making direct extraction difficult. Similarly, some seeds possess hard seed coats or high moisture content that may interfere with processing and testing operations. In such situations, pre-conditioning becomes essential. Seed quality is determined not only by field production practices but also by proper post-harvest handling. If seeds are extracted or processed without suitable pre-conditioning, mechanical injury, contamination, poor germination, and loss of vigour may occur. Therefore, pre-conditioning serves as a preparatory step that facilitates efficient seed handling and helps maintain the quality of the final seed lot.

Pre-conditioning is the process of subjecting seeds or seed-bearing plant parts to specific physical, mechanical, chemical, or environmental treatments before seed extraction, processing, testing, or storage in order to improve handling efficiency and maintain seed quality. In seed testing, pre-conditioning may also refer to treatments given to seeds before germination testing to facilitate water absorption and ensure uniform germination.

### **Objectives of Pre-conditioning**

The major objectives of pre-conditioning are:

- To facilitate easy extraction of seeds from fruits, pods, capsules, cones, and seed heads.
- To reduce seed moisture content before processing and storage.
- To soften hard fruit tissues and protective coverings.
- To improve the efficiency of seed cleaning and grading operations.
- To minimize mechanical injury during seed extraction.
- To obtain uniform seed samples for testing.
- To improve water absorption during germination testing.
- To maintain seed viability and vigour during processing.
- To enhance overall seed quality and marketability.

### **Methods of Pre-conditioning**

Several methods of pre-conditioning are used depending upon the crop species, seed structure, and processing requirements.

**1-Drying:** Drying is the most widely used method of pre-conditioning. Harvested pods, capsules, fruits, seed heads, umbels, or cones are dried either under sunlight or in shade to reduce moisture content. As moisture is lost, the surrounding tissues become brittle and often split open naturally, making seed extraction easier. In crops such as mustard, sesame, onion, coriander, sunflower, and many pulse crops, drying facilitates the opening of seed-bearing structures and improves threshing efficiency. Drying also reduces the chances

of fungal growth and seed deterioration during processing. The drying process should be carefully controlled because excessive drying may damage seed viability, while insufficient drying may encourage mould development.

- 2- Fermentation:** Fermentation is commonly employed in fleshy-fruited vegetable crops such as tomato. The seeds in these crops are surrounded by a gelatinous material that interferes with extraction and cleaning. During fermentation, crushed fruit pulp is allowed to remain in containers for a short period. Microbial activity breaks down the gelatinous layer, allowing seeds to separate easily from the pulp. Fermentation not only facilitates extraction but also helps eliminate certain seed-borne pathogens. However, the process must be carefully monitored because prolonged fermentation may adversely affect seed quality and germination.
- 3- Soaking:** Soaking involves immersing fruits, pods, or seeds in water for a specified period. Water absorption softens hard tissues and facilitates seed extraction. This method is particularly useful in crops where dry structures become difficult to break without damaging the seed. Soaking is also used as a pre-conditioning treatment before germination testing. Gradual hydration prevents seed injury and promotes uniform water uptake during germination.
- 4- Scarification:** Scarification is the process of weakening or breaking hard seed coats to facilitate water absorption and germination. Some seeds possess impermeable seed coats that prevent water and oxygen from entering the embryo. Mechanical scarification involves scratching or abrading the seed coat, while chemical scarification may involve treatment with acids. Scarification is commonly used in leguminous crops and many tree species where hardseededness is a major cause of delayed germination.
- 5- Moistening:** Moistening is frequently practiced in seed testing laboratories. Extremely dry seeds may crack or suffer injury when exposed suddenly to large amounts of water. Therefore, seeds are first exposed to a humid environment where they absorb moisture gradually. This treatment ensures uniform hydration and reduces the possibility of imbibitional injury. Moistening is particularly useful for delicate seeds and seeds intended for laboratory germination tests.
- 6- Chemical Treatment:** Certain chemical substances are used as pre-conditioning agents for seed extraction, dormancy breaking, or germination enhancement. For example, hydrochloric acid is commonly used during tomato seed extraction to dissolve the gelatinous material surrounding the seeds. Chemical treatments must be applied carefully because excessive concentrations or prolonged exposure may damage seed tissues and reduce viability.

### Precautions During Pre-conditioning

Several precautions must be observed while carrying out pre-conditioning treatments:

- Use only recommended methods suitable for the crop species.
- Avoid excessive drying temperatures that may reduce seed viability.
- Monitor fermentation carefully to prevent seed damage.
- Use clean water and containers during soaking operations.
- Avoid prolonged soaking that may initiate premature germination.
- Follow recommended concentrations when applying chemicals.
- Ensure uniform treatment of the entire seed lot.
- Protect treated seeds from contamination and moisture.
- Handle seeds carefully to prevent mechanical injury.
- Dry seeds adequately after treatment before storage.

### Grading of Seed

Grading is one of the most important operations in seed processing. After harvesting, threshing, cleaning, and drying, the seed lot contains seeds of different sizes, shapes, weights, and quality. Some seeds may be immature, shrivelled, damaged, diseased, or mechanically injured. Such seeds reduce the overall quality of the seed lot and adversely affect germination and field performance. Therefore, grading is carried out to separate high-quality seeds from inferior seeds and other undesirable materials.

Seed grading is the process of separating seeds into different categories based on physical characteristics such as size, shape, weight, density, and surface texture in order to obtain a uniform and high-quality seed lot.

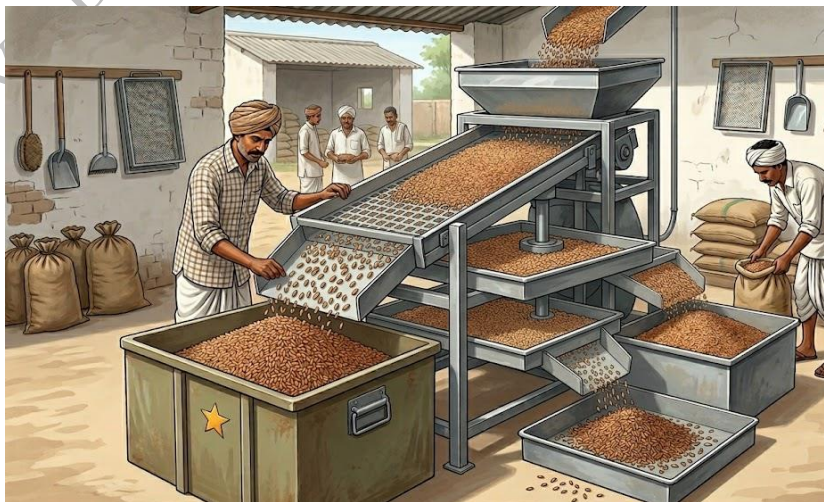


Fig. 1.6: Grading

### Objectives of Seed Grading

The major objectives of seed grading are:

- To remove undersized, shrivelled, broken, and damaged seeds.
- To improve the physical purity of the seed lot.
- To obtain uniform seed size and weight.
- To enhance seed germination and vigour.
- To improve seed appearance and market value.
- To facilitate precision sowing and mechanical planting.
- To increase field emergence and crop establishment.
- To meet seed certification standards.

### Principles of Seed Grading

Seed grading is based on the physical properties of seeds. Different seeds vary in size, shape, density, weight, thickness, surface texture, and colour. These differences are utilized to separate desirable seeds from undesirable materials. The major principles used in seed grading include:

- **Size:** Seeds differ in length, width, and thickness. Grading based on size helps remove small, immature, and broken seeds. Sieves with specific openings are commonly used for this purpose.
- **Shape:** Seeds of different crops possess characteristic shapes. Shape-based grading helps separate weed seeds and other contaminants from the seed lot.
- **Weight and Density:** Well-filled seeds are generally heavier and denser than shrivelled or damaged seeds. Gravity separators are used to separate seeds according to density differences.
- **Surface Texture:** Some seeds differ in surface roughness or smoothness. Specialized equipment may be used to separate seeds based on these characteristics.
- **Length:** Differences in seed length can be utilized for grading. Indented cylinder separators are commonly used for separating seeds based on length.

### Methods of Seed Grading

Several methods are used in seed grading depending on the crop and nature of the seed lot.

**1-Hand Grading:** Hand grading is the simplest method in which undesirable seeds and foreign materials are removed manually. It is generally adopted for small seed lots and high-value vegetable seeds. Although hand grading is effective, it is labour-intensive and time-consuming.

**2-Sieve Grading:** Sieve grading is one of the most common methods used in seed processing. Sieves with different sizes of openings are used to separate seeds according to their dimensions. Large impurities are retained on the upper sieve, while undersized seeds and dust pass through the lower sieve. The desired seeds remain between the sieves and are collected separately. This method is widely used for cereals, pulses, oilseeds, and vegetable seeds.

**3-Air-Screen Grading:** Air-screen machines combine air flow and screens to separate seeds based on size and weight. Light impurities such as chaff and dust are removed by air currents, while screens separate seeds according to size. Air-screen cleaners are among the most commonly used machines in seed processing plants.

**4-Gravity Separation:** Gravity separation is based on differences in seed density. Heavy, healthy seeds are separated from light, shrivelled, and damaged seeds using gravity separators. The machine utilizes a vibrating deck and controlled air flow to separate seeds according to specific gravity.

**5-Indented Cylinder Separation:** Indented cylinder separators are used to separate seeds based on length. The inner surface of the cylinder contains small indentations that pick up seeds of a particular length and separate them from longer or shorter contaminants. This method is commonly used in cereal and vegetable seed processing.

**6-Spiral Separation:** Spiral separators separate seeds based on shape. Round seeds roll differently from flat or elongated seeds, allowing effective separation. This method is useful for removing certain weed seeds and contaminants from the seed lot.

### **Seed Grading Equipment**

The choice of equipment depends on crop species, seed size, and processing requirements. Various machines are used for grading seeds in commercial seed processing plants:

- Air-screen cleaner
- Gravity separator
- Indented cylinder separator
- Spiral separator
- Specific gravity separator
- Magnetic separator
- Vibratory grader
- Precision seed grader

### Activities

**Activity-** Visit nearby seed processing plant to observe seed processing and packaging

**Materials Required:**

Practical notebook, pencil, pen, observation sheet, camera/mobile phone (optional), etc.

**Procedure:**

- Visit a nearby seed processing plant and observe the different operations carried out.
- Identify and write the names of the sections involved in seed processing and packaging.
- Observe and record the steps involved in seed cleaning, grading, treatment, and packaging.
- Note the machines and equipment used for seed processing and their functions.
- Write the types of packaging materials and containers used for storing and transporting seeds.
- Record the precautions followed during seed processing and packaging to maintain seed quality.
- Collect information about labeling, storage, and distribution of processed seeds.

### Check Your Progress

**Fill in the Blanks**

1. A \_\_\_\_\_ is assigned a unique lot number for identification and traceability.
2. The process of reducing seed moisture content to a safe level for storage is called \_\_\_\_\_.
3. \_\_\_\_\_ is commonly used for seed extraction in tomato.
4. \_\_\_\_\_ helps seeds absorb water more easily.
5. \_\_\_\_\_ based on seed density is done using a gravity separator.
6. In rice, harvestable maturity occurs when about \_\_\_\_\_% grains turn straw yellow.

**B. Multiple Choice Questions**

1. Which operation is performed immediately after harvesting and drying to separate seeds from plant parts?

- a. Grading
  - b. Storage
  - c. Threshing
  - d. Certification
2. Which method is used to separate seeds based on length?
- a. Gravity separator
  - b. Spiral separator
  - c. Indented cylinder separator
  - d. Air-screen cleaner
3. Which crop is harvested when pods become black and dry?
- a. Pea
  - b. Black gram
  - c. Chickpea
  - d. Mustard
4. Which pre-conditioning method is used to break hard seed coats?
- a. Drying
  - b. Soaking
  - c. Scarification
  - d. Fermentation
5. Which machine removes impurities based on size and weight?
- a. Air-screen cleaner
  - b. Spiral separator
  - c. Magnetic separator
  - d. Vibratory grader
6. Which harvesting method is suitable for large-scale seed production?
- a. Manual harvesting
  - b. Uprooting
  - c. Hand picking
  - d. Mechanical harvesting
7. In onion, harvestable maturity is indicated when:
- a. Leaves shed
  - b. Pods turn brown
  - c. Fruits turn red
  - d. Umbels turn brown
8. Which of the following is an objective of seed grading?
- a. Remove damaged seeds
  - b. Increase weed population
  - c. Increase moisture content

d. Delay germination

**C. Match the Following**

Column A	Column B
A. Seed Lot	1. Separates seeds based on density
B. Fermentation	2. Tomato seed extraction
C. Gravity Separator	3. Unique identifiable quantity of seed
D. Air-screen Cleaner	4. Removes impurities using air and screens
E. Scarification	5. Breaks hard seed coat

**D. Descriptive Questions**

1. Define a seed lot and explain its importance.
2. What is pre-conditioning of seed? State its objectives.
3. Describe the precautions to be followed during seed drying.
4. Explain the importance of seed cleaning in seed processing.
5. Write a short note on mechanical harvesting of seed crops.

### Session 3: Certification at Seed Level

#### Preparation of Sample for Seed Testing

Seed testing is an important component of seed quality control. It provides information about the physical purity, germination capacity, moisture content, vigour, and health status of a seed lot. Since a seed lot may consist of thousands or even millions of seeds, it is not practical to test every seed. Therefore, a small quantity of seed known as a sample is taken from the seed lot and used for testing.

Preparation of sample for seed testing is the process of obtaining a representative portion of a seed lot through systematic sampling and sample reduction techniques for conducting various laboratory tests.

#### Importance of Sample Preparation

Proper sample preparation is essential because seed testing results are valid only when the sample accurately represents the entire seed lot. A representative sample ensures reliable evaluation of seed quality parameters and helps seed producers, processors, and farmers make informed decisions regarding seed use and marketing. Accurate sample preparation facilitates seed certification, quality control, storage management, and compliance with seed laws and standards. It also prevents errors in testing that may arise from biased or non-representative samples.

#### Objectives of Sample Preparation

The main objectives of preparing a sample for seed testing are:

- To obtain a representative portion of the seed lot.
- To ensure accuracy and reliability of test results.
- To reduce the quantity of seed to a manageable size for laboratory analysis.
- To maintain the identity and purity of the seed lot.
- To provide uniform samples for different seed quality tests.
- To avoid contamination and mechanical injury during sampling.

#### Types of Seed Samples

Several types of samples are prepared during the sampling process.

- **Primary Sample:** A primary sample is a small quantity of seed taken from a single point in a seed lot during sampling. Several primary samples are collected from different portions of the seed lot to ensure proper representation.
- **Composite Sample:** The composite sample is formed by combining all the primary samples collected from the seed lot. It represents the entire seed lot more accurately than an individual primary sample.

- **Submitted Sample:** A submitted sample is the quantity of seed sent to the seed testing laboratory from the composite sample. It should be large enough to conduct all required tests.
- **Working Sample:** A working sample is the final sample obtained from the submitted sample for conducting a specific laboratory test such as purity analysis, germination testing, moisture determination, or seed health testing.

### Procedure for Preparation of Sample

- **Collection of Primary Samples:** The first step in sample preparation is the collection of primary samples from different parts of the seed lot. Samples are taken from bags, containers, or bulk seed lots using suitable sampling equipment such as triers, probes, or hand sampling methods. The number of primary samples depends on the size of the seed lot. Samples should be collected randomly from various locations to ensure that all portions of the seed lot are represented.
- **Preparation of Composite Sample:** After collecting the primary samples, they are thoroughly mixed to form a composite sample. Proper mixing is important to distribute seeds uniformly and eliminate any sampling bias. The composite sample should accurately represent the entire seed lot and contain seeds from all portions of the lot.
- **Preparation of Submitted Sample:** The composite sample is reduced to obtain the submitted sample required for laboratory testing. The size of the submitted sample depends on the crop species and the type of tests to be performed. Care must be taken to ensure that the reduction process does not affect the representativeness of the sample.
- **Preparation of Working Sample:** The submitted sample is further reduced in the laboratory to obtain working samples for individual tests. Separate working samples may be prepared for purity testing, germination testing, moisture testing, vigour testing, and seed health analysis. The working sample should contain a sufficient number of seeds to provide accurate and reliable results.

### Methods of Sample Reduction

To obtain representative working samples, several sample reduction methods are used.

#### A-Mechanical Divider Method

Mechanical dividers are commonly used in seed testing laboratories. These devices divide the seed sample into two equal portions repeatedly until the required sample size is obtained.

The most common mechanical dividers are:

**1-Boerner Divider-** The Boerner divider consists of a hopper and a series of channels that divide the seed sample equally into two portions. It provides highly accurate and representative sample reduction.

**2-Soil Divider-** The soil divider functions on a similar principle and is suitable for larger seeds and rough seed lots.

**3-Centrifugal Divider-** This divider uses centrifugal force to distribute seeds uniformly into separate containers and is useful for small-seeded crops.

**B-Random Cup Method** In this method, several small cups are placed randomly on a tray. The seed sample is mixed thoroughly and spread evenly over the tray. Seeds falling into the cups are collected and used as the working sample.

### **C-Modified Halving Method**

The seed sample is spread uniformly on a tray containing a grid of compartments. Alternate compartments are selected and combined to obtain a reduced sample. This method is commonly used for small-seeded crops.

### **D-Hand Halving Method**

The sample is mixed thoroughly and formed into a uniform pile. The pile is divided into two equal portions, and one portion is retained while the other is discarded. The process is repeated until the desired sample size is obtained.

### **Precautions During Sample Preparation**

Several precautions should be observed while preparing seed samples:

- Use clean sampling equipment and containers.
- Prevent mixing of different seed lots.
- Collect samples randomly from all parts of the seed lot.
- Mix samples thoroughly before reduction.
- Avoid mechanical injury to seeds.
- Protect samples from moisture, insects, and contamination.
- Label all samples properly.
- Follow standard seed testing procedures.
- Ensure that working samples remain representative of the original seed lot.

### **Physical Purity of Seed**

Physical purity is one of the most important parameters used in seed quality evaluation. A seed lot intended for sowing should contain only seeds of the designated crop and variety and should be free from impurities. During harvesting, threshing, processing, and storage, seeds may become mixed with

inert materials, weed seeds, seeds of other crops, broken seeds, and other contaminants. These impurities reduce the quality, market value, and planting efficiency of the seed lot. Physical purity is the percentage by weight of pure seed present in a seed lot in relation to the total weight of the sample submitted for analysis.

### Seed Certification Standards for Physical Purity

Seed certification agencies prescribe minimum standards of physical purity for different classes of seed. Although standards vary among crops, most certified seeds are required to have very high physical purity.

### General Physical Purity Standards

Component	Minimum/Maximum Requirement
Pure Seed	Minimum 98%
Inert Matter	Maximum 2%
Other Crop Seeds	As per crop standards
Weed Seeds	As per crop standards
Objectionable Weed Seeds	Nil or within permissible limits

### Germination of Seed

Germination is one of the most important characteristics used to evaluate seed quality. It refers to the ability of a seed to produce a normal and healthy seedling under favorable environmental conditions. The germination test is conducted to determine the planting value of a seed lot and to estimate the percentage of seeds capable of developing into normal plants. Germination is the emergence and development of the seed embryo into a normal seedling capable of continued growth under favorable environmental conditions.

**Germination percentage** is the proportion of seeds in a sample that produce normal seedlings under prescribed laboratory conditions.

### Moisture Content of Seed

Moisture content is one of the most critical factors affecting seed quality, viability, and longevity. It refers to the amount of water present in a seed and is usually expressed as a percentage of the seed's weight. Seed moisture content influences respiration, storage life, susceptibility to insect attack, fungal growth, and overall seed deterioration. Seeds harvested from the field generally contain high moisture content and must be dried to safe levels before storage. Proper moisture management is essential for maintaining seed viability and vigour during storage.

Moisture content is the amount of water present in a seed, expressed as a percentage of the seed's total weight.

### Methods of Moisture Determination

- 1- Oven Dry Method:** The oven dry method is the standard method used in seed testing laboratories. Seeds are weighed, dried in an oven at a specified temperature, and reweighed. The loss in weight represents the moisture content.
- 2- Moisture Meter Method:** Electronic moisture meters provide rapid estimates of seed moisture content and are commonly used in seed processing plants.

### Genetic Purity

Genetic purity refers to the trueness of a seed lot to its designated variety, hybrid, or parental line. A genetically pure seed lot contains seeds that possess the genetic characteristics of the variety as originally developed and released. Maintenance of genetic purity is one of the primary objectives of seed production because varietal contamination can reduce crop performance and affect the reliability of improved varieties.

Genetic purity is the degree to which a seed lot conforms genetically to the characteristics of the designated variety, hybrid, or parental line.

### Methods for Determining Genetic Purity

- 1. Physical Seed Examination:** Seeds are examined for differences in colour, size, shape, texture, and other visible characteristics. This method is useful when varieties possess distinct seed traits.
- 2. Grow-Out Test (GOT):** The grow-out test is the most widely used method. Seeds are grown in the field and plants are observed for varietal characteristics. Off-type plants are identified and genetic purity is calculated.
- 3. Biochemical Tests:** Biochemical methods use differences in proteins and enzymes among varieties. Common tests include electrophoresis and isozyme analysis.
- 4. Molecular Marker Techniques:** Modern methods such as DNA markers, PCR, RAPD, SSR, and SNP analysis provide highly accurate assessment of genetic purity and varietal identity.

### Genetic Purity Standards

Seed Class	Minimum Genetic Purity (%)
Breeder Seed	100
Foundation Seed	99.5

Certified Seed	99.0
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### Identification of Objectionable Diseases and Weeds at Seed Level

The presence of objectionable diseases and weed seeds in a seed lot is a major concern in seed production and certification. Certain diseases and weeds are designated as objectionable because they are difficult to control, spread rapidly through seeds, and cause serious economic losses. Therefore, seed certification agencies prescribe strict limits for objectionable diseases and weeds to ensure the distribution of healthy and pure seeds. Identification of objectionable diseases and weed seeds at the seed level is an important component of seed quality testing. Careful examination helps prevent the spread of harmful pathogens and weeds through seed distribution systems.

### Objectionable Diseases

Objectionable diseases are seed-borne diseases that are highly destructive, difficult to eradicate, and capable of spreading through infected seed lots. Seeds infected by these diseases often show characteristic symptoms such as discoloration, shrivelling, deformation, fungal growth, or abnormal appearance.

### Common Objectionable Diseases Identified at Seed Level

Crop	Objectionable Disease	Seed-Level Symptoms
Wheat	Loose smut ( <i>Ustilago tritici</i> )	Usually detected through laboratory testing and grow-out tests
Wheat	Karnal bunt ( <i>Tilletia indica</i> )	Partial black powdery infection of grains
Rice	Bunt disease	Black powdery masses replacing grains
Pearl Millet	Ergot ( <i>Claviceps fusiformis</i> )	Dark elongated sclerotia replacing grains
Sorghum	Grain smut	Smut sori replacing normal grains
Groundnut	Seed rot fungi	Discoloured and shrivelled kernels
Tomato	Bacterial canker	Detected through laboratory and grow-out tests
Cotton	Bacterial blight	Infected seeds may show discoloration
Crucifers	Black rot	Seed contamination with pathogen

The presence of objectionable diseases beyond permissible limits can lead to rejection of the seed lot during certification.

### Objectionable Weeds

Objectionable weeds are weed species whose seeds are difficult to separate from crop seeds and whose presence causes serious agricultural problems. These weeds compete with crops for nutrients, water, sunlight, and space, resulting in reduced yields and increased production costs.

### Common Objectionable Weed Seeds

Weed	Scientific Name	Important Characteristics
Congress grass	<i>Parthenium hysterophorus</i>	Small black seeds; highly invasive
Wild oat	<i>Avena fatua</i>	Similar to oat seed; difficult to separate
Dodder	<i>Cuscuta spp.</i>	Small, rough, irregular seeds
Johnson grass	<i>Sorghum halepense</i>	Similar to sorghum seeds
Bermuda grass	<i>Cynodon dactylon</i>	Difficult to eradicate perennial weed
Wild mustard	<i>Brassica spp.</i>	Similar in appearance to mustard seeds
Bathua	<i>Chenopodium album</i>	Small shiny black seeds
Phalaris	<i>Phalaris minor</i>	Similar to wheat grains

Seed certification standards often specify that objectionable weed seeds must be absent or remain below prescribed limits.

### Certification Standards of Important Crops at Seed Level

Seed certification standards are minimum quality requirements prescribed by seed certification agencies to ensure the production and distribution of high-quality seeds. These standards specify acceptable levels of physical purity, germination, moisture content, genetic purity, and the presence of other crop seeds, weed seeds, and objectionable weed seeds. Seed lots must meet these standards before they can be certified and marketed. The standards vary among crops because of differences in seed size, biology, and production practices.

**Important Seed-Level Certification Standards****Cereals**

<b>Crop</b>	<b>Pure Seed (%)</b>	<b>Inert Matter (%) Max.</b>	<b>Germination (%) Min.</b>	<b>Moisture (%) Max.</b>
Rice	98	2	80	13
Wheat	98	2	85	12
Maize	98	2	90	12
Sorghum	98	2	75	12
Pearl Millet	98	2	75	12

**Pulses**

<b>Crop</b>	<b>Pure Seed (%)</b>	<b>Inert Matter (%) Max.</b>	<b>Germination (%) Min.</b>	<b>Moisture (%) Max.</b>
Chickpea	98	2	85	9
Pigeon Pea	98	2	75	9
Green Gram	98	2	75	9
Black Gram	98	2	75	9
Pea	98	2	75	9

**Oilseed Crops**

<b>Crop</b>	<b>Pure Seed (%)</b>	<b>Inert Matter (%) Max.</b>	<b>Germination (%) Min.</b>	<b>Moisture (%) Max.</b>
Groundnut	96	4	70	9
Soybean	98	2	70	9
Mustard	99	1	75	8
Sunflower	98	2	70	8

Sesame	97	3	70	8
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**Vegetable Crops**

Crop	Pure Seed (%)	Inert Matter (%) Max.	Germination (%) Min.	Moisture (%) Max.
Tomato	98	2	70	8
Brinjal	98	2	70	8
Chilli	98	2	60	8
Onion	98	2	70	8
Cabbage	98	2	75	8

**General Standards for Certified Seed**

Parameter	Standard
Physical Purity	Generally, 98% minimum
Germination	Crop-specific standards
Moisture Content	8–13% depending on crop
Genetic Purity	99.0% minimum
Objectionable Weed Seeds	Nil or within prescribed limits
Seed Health	Free from objectionable diseases

**Activities****Activity 1-** Preparation of seed sample

**Materials Required:** Practical notebook, pencil, pen, seed samples, sample divider, trays, containers, observation sheet, etc.

**Procedure:**

- Collect a representative seed lot for sampling.
- Observe and record the method used for drawing the seed sample.
- Mix the seed lot thoroughly to ensure uniformity.
- Prepare a working seed sample using appropriate sampling methods or equipment.

- Note the precautions followed to avoid contamination and maintain sample purity.
- Record the quantity and type of seed used for sample preparation.
- Write the importance of proper seed sample preparation in seed testing and quality evaluation.

**Activity 2-** Demonstrate determination of physical purity, germination and moisture content of a seed lot

**Materials Required:** Practical notebook, pencil, pen, seed samples, germination paper/trays, moisture meter, weighing balance, observation sheet, etc.

**Procedure:**

- Collect a representative sample from the seed lot.
- Separate the sample into pure seeds, inert matter, weed seeds, and other crop seeds to determine physical purity.
- Calculate the percentage of pure seed and impurities present in the sample.
- Conduct a germination test by placing seeds under suitable conditions and observe seedling development.
- Count the number of normal seedlings and determine the germination percentage.
- Measure the moisture content of the seed sample using a moisture meter or standard laboratory method.
- Record and interpret the results obtained for physical purity, germination percentage, and moisture content.

**Activity 3-** Identification of genetic purity (ODV-Other Distinguishable Variety), objectionable diseases and weeds

**Materials Required:** Practical notebook, pencil, pen, seed/crop samples, observation sheet, field guide, etc.

**Procedure:**

- Observe the seed crop or seed sample for varietal characteristics.
- Identify and record any plants or seeds belonging to Other Distinguishable Varieties (ODV).
- Compare the observed characteristics with those of the recommended variety.
- Inspect the crop for the presence of objectionable diseases affecting seed quality.
- Identify and record the symptoms of important seed-borne and field-borne diseases.

- Observe the field for objectionable weeds and record their names and distinguishing features.
- Assess the impact of ODV, diseases, and weeds on seed quality and genetic purity.
- Record all observations in the practical notebook.

### Check Your Progress

#### A. Fill in the Blanks

1. A small quantity of seed taken from one point in a seed lot is called a \_\_\_\_\_ sample.
2. The sample prepared by combining all primary samples is known as the \_\_\_\_\_ sample.
3. The standard laboratory method for determining seed moisture is the \_\_\_\_\_ dry method.
4. \_\_\_\_\_ purity is expressed as the percentage by weight of pure seed in a sample.
5. The most widely used method for determining genetic purity is the \_\_\_\_\_ test.

#### B. Multiple Choice Questions

1. Which sample is sent to the seed testing laboratory?
  - a. Primary sample
  - b. Working sample
  - c. Submitted sample
  - d. Duplicate sample
2. What is the minimum pure seed percentage generally required for certified seed?
  - a. 90%
  - b. 95%
  - c. 98%
  - d. 100%
3. Which disease causes partial black powdery infection of wheat grains?
  - a. Karnal bunt
  - b. Loose smut
  - c. Black rot
  - d. Grain smut
4. Which objectionable weed is highly invasive and produces small black seeds?
  - a. Wild oat

- b. Dodder
  - c. Congress grass
  - d. Phalaris
5. Which sample is finally used for a specific laboratory test?
- a. Composite sample
  - b. Submitted sample
  - c. Primary sample
  - d. Working sample

**C. Match the Following**

Column A	Column B
A. Primary Sample	1. Measures seed moisture quickly
B. Grow-Out Test	2. Collected from a single point in a seed lot
C. Moisture Meter	3. Determines genetic purity
D. Composite Sample	4. Formed by combining primary samples
E. Physical Purity	5. Percentage of pure seed in a sample

**D. Descriptive Questions**

1. Define seed sample preparation and explain its importance.
2. Describe the different types of seed samples used in seed testing.
3. Explain the procedure for preparation of a working sample.
4. What is genetic purity? Describe any two methods used for its determination.

# Module 2

## Packaging, Storage and Marketing of Seed

### Module Overview

The quality of seed must be preserved and maintained throughout its journey from production to the farmer's field. This unit focuses on the essential aspects of seed packaging, storage, transportation, and marketing, which play a vital role in ensuring seed viability, vigour, and availability. Learners will understand the importance of appropriate packaging materials, scientific storage practices, and safe transportation methods for preventing seed deterioration and maintaining quality standards. The unit also introduces the concepts of seed marketing, demand and supply dynamics, and their significance in the seed industry. Furthermore, it highlights various government schemes and initiatives that support seed production, distribution, and accessibility for farmers. Through these sessions, students will gain practical knowledge of the post-production seed management system and the factors influencing the successful marketing and distribution of quality seed.

This module introduces students to the essential post-production activities involved in the handling and distribution of seeds. It focuses on the methods and practices required for packaging, storing, and transporting seeds to maintain their quality and viability. In Session 1, students will learn about suitable packaging materials, storage conditions, and transportation practices that help protect seeds from physical damage and deterioration. Session 2 covers the principles of seed marketing, including demand and supply dynamics, market channels, and the factors influencing seed sales and distribution. The module emphasizes the importance of efficient seed management and marketing systems in ensuring the availability of quality seeds to farmers and supporting the growth of the seed industry.

### Learning Outcomes

After completing this module, you will be able to:

- Explain the methods and importance of proper packaging, storage, and transportation practices for maintaining seed quality.
- Describe the concepts of seed marketing, demand, and supply, and their role in the effective distribution of seeds.

- Identify the factors influencing seed market operations and the availability of quality seeds to farmers.

## Module Structure

Session 1: Packaging, Storage, and Transportation of seed

Session 2: Marketing, Demand and supply of seed

### Session 1: Packaging, Storage, and Transportation of seed

#### Packaging and Labelling of Seed

Packaging and labelling are important operations in the seed distribution system. After seed processing, testing, and certification, seeds are packed in suitable containers and labelled before storage, transportation, and marketing. Proper packaging protects seeds from mechanical injury, moisture, insects, diseases, and contamination, while labelling provides essential information regarding seed quality and identity. Packaging and labelling help maintain seed quality from the processing plant to the farmer's field. They also ensure compliance with seed certification regulations and facilitate traceability of seed lots. Therefore, these operations are essential components of seed quality assurance programs.

#### Packaging of Seed

Packaging refers to the process of placing processed and tested seeds into suitable containers for storage, transport, and sale. The packaging material should protect seeds from environmental factors and maintain seed quality throughout the storage period.

The choice of packaging material depends on the crop, storage duration, climatic conditions, and moisture content of the seed. An ideal seed package should be strong, durable, moisture-resistant, easy to handle, and economical.

#### Types of Seed Containers

- **Cloth Bags:** Cloth bags are commonly used for packing cereal, pulse, and oilseed crops. They are inexpensive and allow air circulation. However, they are permeable to moisture and therefore suitable only for short-term storage under dry conditions.
- **Jute Bags:** Jute bags are widely used for packaging large quantities of seeds. They are strong and economical but permit exchange of moisture with the surrounding atmosphere.
- **Paper Bags:** Paper bags are commonly used for vegetable and flower seeds. They are lightweight and inexpensive but provide limited protection against moisture.
- **Polyethylene Bags:** Polyethylene bags are moisture-resistant and protect seeds from atmospheric humidity. They are widely used for certified and foundation seeds.

- **Aluminium Foil Packets:** Aluminium foil packets are moisture-proof and suitable for long-term storage of high-value seeds such as vegetable, flower, and breeder seeds. They effectively protect seeds from moisture and environmental fluctuations.
- **Laminated Containers:** Modern seed packaging often uses laminated materials consisting of multiple layers of plastic, foil, and paper. These containers provide excellent protection against moisture and mechanical damage.



Fig. 2.1: Packaging bag

### Characteristics of an Ideal Seed Package

An ideal seed package should possess the following characteristics:

- High mechanical strength.
- Resistance to moisture and pests.
- Easy handling and transportation.
- Durability during storage.
- Protection against contamination.
- Economical and readily available.
- Capability to preserve seed quality.

### Labelling of Seed

Labelling is the process of attaching a label or tag containing essential information about the seed lot. Labels provide details regarding seed identity, quality, certification status, and source. Proper labelling helps farmers make informed decisions and ensures transparency in seed marketing. Each seed container must carry a label prescribed by seed certification agencies or regulatory authorities.

### Objectives of Seed Labelling

- To provide information about the seed lot.
- To establish seed identity and traceability.

- To indicate seed quality parameters.
- To facilitate certification and inspection.
- To protect farmers against misbranding and adulteration.

### Information Provided on Seed Labels

A seed label generally contains the following information:

- Name of crop.
- Variety or hybrid name.
- Class of seed (Breeder, Foundation, Certified).
- Lot number.
- Date of testing.
- Germination percentage.
- Physical purity percentage.
- Moisture content.
- Net weight of seed.
- Name and address of producer.
- Certification agency seal or tag.
- Treatment details, if any.

### Colour of Certification Tags

Different classes of seed are identified by specific coloured tags.

Class of Seed	Tag Colour
Breeder Seed	Golden Yellow
Foundation Seed	White
Certified Seed	Azure Blue
Truthfully Labelled Seed	Opal Green

These colours help in quick identification of seed classes during marketing and inspection.

Proper packaging and labelling ensure that seed quality is maintained until sowing. They protect seeds from environmental hazards and provide essential quality information to farmers. Effective packaging reduces storage losses, while accurate labelling ensures authenticity, traceability, and compliance with certification standards. Packaging and labelling are essential operations in seed

technology that help maintain seed quality, identity, and market value. Appropriate packaging materials protect seeds from physical and environmental damage, while labels provide important information regarding seed quality and certification status. Together, they ensure the safe distribution of high-quality seeds to farmers.

### **Storage of Packaged Seeds**

Seed storage is the process of preserving seeds from the time of processing until they are planted in the field. The objective of seed storage is to maintain seed viability, vigour, and quality for the longest possible period. Since seeds are living organisms, they continue to respire even during storage. Improper storage conditions can accelerate deterioration and reduce germination capacity. After processing, testing, packaging, and labelling, seeds are stored in suitable facilities until distribution or use. Proper storage practices are therefore essential for maintaining seed quality and ensuring successful crop establishment.

Seed storage is the preservation of seeds under suitable environmental conditions to maintain their viability, vigour, and planting value for future use.

### **Principles of Seed Storage**

Successful seed storage depends primarily on controlling moisture and temperature. Seed deterioration increases rapidly under conditions of high moisture and temperature. The general principles of seed storage are:

- Store only clean, healthy, and mature seeds.
- Dry seeds to safe moisture levels before storage.
- Maintain low temperature and low humidity.
- Protect seeds from insects and rodents.
- Use suitable packaging materials.
- Inspect seed lots regularly.

### **Factors Affecting Seed Storage**

- **Seed Moisture Content:** Moisture content is the most important factor affecting seed longevity. High moisture content increases respiration, fungal growth, and seed deterioration. Therefore, seeds should be dried to safe moisture levels before storage.
- **Temperature:** High temperatures accelerate seed ageing and reduce viability. Low temperatures slow down metabolic activities and prolong storage life.
- **Relative Humidity:** Seeds absorb moisture from humid air. High relative humidity increases seed moisture content and promotes deterioration.
- **Seed Quality:** Only high-quality seeds with good germination and vigour should be stored. Damaged or diseased seeds deteriorate rapidly.

- **Storage Containers:** The type of container influences moisture exchange between seeds and the environment. Moisture-proof containers provide better protection than porous containers.
- **Insects and Rodents:** Insect pests and rodents cause direct damage to seeds and increase storage losses. Proper sanitation and pest control measures are essential.

### Types of Seed Storage

1. **Ordinary Storage:** Seeds are stored under normal warehouse conditions without environmental control. This method is suitable for short-term storage.
2. **Controlled Storage:** Temperature and relative humidity are regulated to maintain seed quality. This method is commonly used for foundation and certified seeds.
3. **Cold Storage:** Seeds are stored at low temperatures and controlled humidity. Cold storage is particularly useful for vegetable, flower, and breeder seeds.

### Storage Conditions for Packaged Seeds

Seed Type	Safe Moisture Content (%)	Recommended Storage Condition
Cereals	10–12	Cool and dry storage
Pulses	8–10	Low humidity storage
Oilseeds	7–9	Moisture-proof containers
Vegetable Seeds	6–8	Cold storage preferred
Breeder Seed	5–8	Controlled environment storage

### Factors to be Observed During Seed Storage

- **Seed Moisture Content:** Moisture content is the most important factor affecting seed longevity. Seeds with high moisture content respire rapidly and are more susceptible to fungal infection, insect attack, and deterioration. Therefore, seeds should be dried to safe moisture levels before storage. Generally, cereals are stored at 10–12% moisture content, pulses at 8–10%, oilseeds at 7–9%, and vegetable seeds at 6–8%.
- **Temperature :** Storage temperature has a direct effect on seed viability. High temperatures accelerate metabolic activity and ageing, while low temperatures slow down deterioration. Seeds stored at lower temperatures generally

maintain viability for longer periods. The principle of seed storage states that lower temperature and lower moisture content increase seed longevity.

- **Relative Humidity:** Seeds are hygroscopic in nature and absorb moisture from the surrounding atmosphere. High relative humidity increases seed moisture content, which accelerates deterioration. Therefore, storage rooms should maintain low relative humidity and proper ventilation. A dry storage environment is essential for preserving seed quality.
- **Seed Quality Before Storage:** Only high-quality seeds should be stored. Seeds that are immature, damaged, diseased, or mechanically injured deteriorate more rapidly than healthy seeds. Therefore, proper cleaning, grading, and drying should be completed before storage. High initial seed quality ensures longer storage life.
- **Storage Containers:** The type of container influences seed longevity. Moisture-proof containers such as polyethylene bags, laminated pouches, and aluminium foil packets provide better protection against atmospheric moisture than cloth or jute bags. The choice of container depends on the crop, storage duration, and environmental conditions.
- **Insect Pests:** Storage insects cause serious damage to seeds by feeding on them and reducing their viability. Infested seeds often show reduced germination, lower vigour, and increased susceptibility to fungal infection. Regular inspection and pest control measures are necessary to prevent storage losses.
- **Rodents:** Rodents consume and contaminate stored seeds. They also damage storage structures and packaging materials. Proper sanitation and rodent control programs should be implemented in seed storage facilities.
- **Fungal and Microbial Infection:** High moisture and humidity favour fungal growth. Storage fungi such as *Aspergillus* and *Penicillium* reduce germination and produce toxins that affect seed quality. Seeds should be adequately dried and stored under sanitary conditions to prevent fungal development.
- **Ventilation:** Proper ventilation helps maintain uniform temperature and humidity inside the storage facility. Good air circulation prevents moisture accumulation and reduces the risk of fungal growth.
- **Duration of Storage:** Seed viability decreases gradually with time. The rate of deterioration depends on storage conditions and crop species. Seeds should therefore be distributed and used as early as possible while maintaining the required quality standards.

### Transportation of Seeds

Transportation is an important step in the seed supply chain. After processing, testing, certification, packaging, and storage, seeds are transported from production areas to storage centres, processing plants, distribution agencies, and

ultimately to farmers. Proper transportation ensures that seed quality is maintained throughout the movement process.

Transportation of seeds refers to the safe movement of packaged seed lots from one location to another while maintaining their physical, physiological, and genetic quality.

### **Importance of Seed Transportation**

Efficient transportation is essential for maintaining the quality of certified and foundation seeds. Improper transportation may lead to mechanical damage, moisture absorption, seed mixing, and deterioration. Proper transport practices ensure that seeds reach farmers in good condition and retain their planting value.

### **Precautions During Seed Transportation**

- **Protection Against Moisture:** Seeds should be protected from rain, water leakage, and high humidity during transportation. Moisture absorption may increase seed respiration, fungal growth, and deterioration.
- **Prevention of Mechanical Damage:** Seed bags should be handled carefully during loading and unloading. Throwing, dropping, or excessive stacking may cause mechanical injury and reduce germination. Careful handling preserves seed viability and vigour.
- **Avoidance of Excessive Heat:** Exposure to high temperatures during transportation can accelerate seed ageing and reduce germination. Seed consignments should be protected from direct sunlight and excessive heat. Transportation during cooler periods of the day is often preferred.
- **Prevention of Mixing:** Different varieties, classes, and seed lots should be transported separately and properly labelled. Mixing may result in loss of varietal identity and certification status. Proper documentation and labelling help maintain traceability.
- **Clean Transport Vehicles:** Vehicles used for seed transportation should be clean and free from contaminants such as soil, chemicals, weed seeds, fertilizers, and grain residues. Clean vehicles help prevent contamination and maintain seed purity.
- **Protection from Insects and Rodents:** Seeds should be protected from insect pests and rodents during transit. Packaging materials should be intact and vehicles should be inspected before loading.

### **Activities**

**Activity-** Demonstrate packaging and factors to be observed during storage

**Materials Required:** Practical notebook, pencil, pen, seed packets, packaging materials, storage containers, observation sheet, etc.

**Procedure:**

- Observe the different types of packaging materials used for seed storage and transportation.
- Identify and record the information provided on seed package labels.
- Examine the methods used for packing, sealing, and labeling seed containers.
- Observe the storage conditions maintained for preserving seed quality.
- Record the factors affecting seed storage such as moisture content, temperature, relative humidity, and ventilation.
- Identify the precautions taken to protect seeds from insects, pests, rodents, and diseases during storage.
- Assess the importance of proper packaging and storage in maintaining seed viability and quality.
- Record all observations in the practical notebook.

### Check Your Progress

#### A. Fill in the Blanks

1. Packaging protects seeds from moisture, insects, diseases and \_\_\_\_\_.
2. \_\_\_\_\_ bags are moisture-resistant and protect seeds from atmospheric humidity.
3. \_\_\_\_\_ foil packets are suitable for Long-term storage of high-value seeds.
4. The certification tag colour of Foundation Seed is \_\_\_\_\_.
5. Seeds absorb moisture from humid air because they are \_\_\_\_\_ in nature.
6. Proper \_\_\_\_\_ helps maintain seed quality during movement from one place to another.

#### B. Multiple Choice Questions

1. Which packaging material is commonly used for vegetable and flower seeds?
  - a. Jute bags
  - b. Cloth bags
  - c. Paper bags
  - d. Gunny bags
2. Which seed package provides excellent protection against moisture and mechanical damage?
  - a. Cloth bag
  - b. Paper bag
  - c. Jute bag
  - d. Laminated container

3. Which of the following is NOT an objective of seed labelling?
  - a. Pest multiplication
  - b. Traceability
  - c. Certification
  - d. Seed identity
4. What is the tag colour of Truthfully Labelled Seed?
  - a. Azure Blue
  - b. Opal Green
  - c. Golden Yellow
  - d. White
5. Which type of storage is suitable for short-term seed storage?
  - a. Cold storage
  - b. Controlled storage
  - c. Ordinary storage
  - d. Vacuum storage
6. Which factor is most important for seed longevity during storage?
  - a. Seed colour
  - b. Moisture content
  - c. Seed shape
  - d. Seed size
7. Which storage fungi commonly reduce seed germination?
  - a. Rhizobium and Azotobacter
  - b. Aspergillus and Penicillium
  - c. Lactobacillus and Bacillus
  - d. Nitrosomonas and Nitrobacter

### C. Match The Following

Column A	Column B
A. Breeder Seed	1. Azure Blue
B. Foundation Seed	2. Opal Green
C. Certified Seed	3. Golden Yellow
D. Truthfully Labelled Seed	4. White

### D. Descriptive Questions

1. Explain the characteristics of an ideal seed package.
2. Describe the factors affecting seed storage.

3. Explain the different types of seed storage.
4. Write the precautions to be followed during seed transportation.

PSSCIVE Draft Study Material @Not to be Published

## Session 2: Marketing, Demand and supply of seed

### Marketing Channels

Marketing is an essential component of seed business management because production alone does not ensure profitability unless the seeds reach farmers and other buyers at the right time, place, and price. In the seed sector, marketing involves all activities related to movement of seeds from producers to final users. Since seeds are seasonal, perishable in quality, and highly dependent on timely distribution, an efficient marketing system is necessary for successful seed business operation. Marketing channels refer to the pathways through which seeds move from seed producers to consumers. These channels include various intermediaries such as wholesalers, retailers, cooperatives, government agencies, seed companies, and distributors who help in storage, transportation, promotion, and sale of seeds. Selection of an appropriate marketing channel is important because it influences seed availability, pricing, customer satisfaction, business profitability, and market expansion.

### Types of Marketing Channels

**Direct Marketing Channel-** In direct marketing, seed growers sell seeds directly to farmers without involving intermediaries. This channel is commonly used by small-scale seed producers, Seed Villages, Farmer Producer Organizations, and local seed entrepreneurs. Direct marketing may take place through farm gate sales, local markets, agricultural fairs, exhibitions, farmer meetings, and demonstration programmes. In some cases, growers also supply seeds directly to institutions, cooperatives, or government agencies. The direct marketing channel provides several advantages to seed growers. It reduces marketing costs because intermediaries are not involved. Growers can communicate directly with farmers, understand their requirements, and build long-term relationships. Farmers may also obtain seeds at lower prices because additional dealer margins are avoided.

**Indirect Marketing Channel-** In indirect marketing, intermediaries such as wholesalers, distributors, dealers, and retailers participate in seed distribution. This is the most common marketing system used in the seed industry because it allows seeds to reach a larger number of farmers across different regions. Under this system, seeds generally move from the producer to wholesalers or distributors, then to retailers or dealers, and finally to farmers. Seed companies often establish large dealer networks to distribute seeds efficiently during sowing seasons. Indirect marketing channels provide wide market coverage and reduce the burden of direct selling on seed producers. Dealers and retailers maintain regular contact with farmers and provide information regarding market demand, customer preferences, and competitor products.

### **Demand and Supply Analysis**

Demand and supply analysis is one of the most important aspects of seed production and seed business management. A quality seed grower must understand the market requirement for different crops and varieties before starting seed production. Seed production requires investment in land, labour, irrigation, fertilizers, processing, storage, certification, and marketing. Therefore, scientific planning based on market demand and supply conditions is essential for reducing risk and ensuring profitability.

Unlike ordinary grain production, seed production is market-oriented because seeds are produced for commercial sale and agricultural development. Farmers purchase seeds with the expectation of obtaining better yield, disease resistance, uniform crop growth, and higher income. Hence, seed growers must produce seeds according to market requirements and maintain high quality standards. Demand and supply analysis helps the grower decide which crop seeds to produce, how much quantity to produce, when to supply the market, and how to maintain profitability in the enterprise. In agriculture, demand and supply are not constant. They change according to climatic conditions, cropping patterns, government policies, farmer preferences, technological developments, and market prices. A seed grower who understands these changes can take better production and marketing decisions. Proper demand and supply analysis also helps in avoiding overproduction, reducing storage losses, and ensuring timely availability of quality seeds to farmers.

### **Factors Affecting Demand for Seeds**

Several factors influence the demand for seeds. One of the most important factors is crop profitability. Farmers generally prefer crops that provide better economic returns. If market prices of a crop increase, more farmers cultivate that crop, resulting in higher demand for its seeds. Similarly, when improved varieties or hybrids become popular due to higher yield or disease resistance, farmers prefer purchasing those seeds over traditional farm-saved seeds.

**Climatic conditions** also play an important role in determining seed demand. Rainfall distribution, temperature, and weather forecasts influence cropping decisions. During years of good monsoon, farmers cultivate larger areas and invest more in quality seeds. In drought-prone areas, farmers may prefer drought-tolerant varieties. Availability of irrigation facilities also encourages the adoption of high-yielding and hybrid varieties, thereby increasing seed demand.

**Government policies** and agricultural programmes significantly affect demand for quality seeds. Distribution of subsidized seeds, crop insurance schemes, minimum support prices, and agricultural extension programmes encourage farmers to adopt improved seed varieties. Government promotion of crops such

as pulses, oilseeds, millets, and vegetables often creates additional demand for seeds of those crops.

**Farmer awareness and education** are equally important. Farmers who understand the benefits of certified seeds are more willing to purchase quality seeds regularly. Demonstrations, training programmes, agricultural fairs, and extension activities help farmers gain confidence in improved varieties. As farmers observe higher productivity and better crop performance, demand for quality seeds gradually increases.

**Population growth** and increasing food requirements also contribute to rising seed demand. To produce more food from limited agricultural land, farmers need high-yielding and scientifically developed seed varieties. Therefore, quality seeds have become an essential input in modern agriculture.

### **Identifying Target Customers**

Identifying target customers is an important step in establishing and managing a successful seed business. A quality seed grower produces seeds for commercial purposes, and therefore it is essential to know who will purchase and use those seeds. In the absence of proper customer identification, seed production may not match market demand, resulting in unsold stock, financial loss, and inefficient use of resources. A seed grower should understand the needs, preferences, and purchasing behaviour of different groups of customers before planning production and marketing activities.

Target customers refer to the group of buyers for whom the seed products are specifically produced and marketed. In the seed industry, customers are not limited to farmers alone. Many organizations and institutions also purchase seeds for agricultural development programmes, commercial distribution, research activities, and contract farming operations. A quality seed grower must identify the most suitable customer groups according to the type of seed produced, local agricultural conditions, and market opportunities. For example, hybrid vegetable seeds may be targeted toward commercial vegetable farmers, while certified cereal seeds may be supplied to government agencies or cooperatives. Similarly, drought-resistant varieties may be promoted in rainfed regions, whereas high-yielding varieties may be targeted toward irrigated farming areas.

Identifying target customers helps in understanding:

- Which crops and varieties are in demand
- Quantity of seed required
- Preferred seed quality and packaging
- Purchasing capacity of customers
- Seasonal buying patterns

- Market competition
- Suitable marketing channels

### **Types of Target Customers in Seed Business**

- **Farmers as Primary Customers-** Farmers are the most important customers in the seed sector because they directly use seeds for cultivation. Their seed requirements depend on farm size, cropping pattern, irrigation availability, climate, soil type, and economic condition. Farmers may be classified into small, medium, and large farmers, and each category has different purchasing behaviour. Small and marginal farmers generally prefer affordable seeds with reliable performance under local conditions.
- **Seed Dealers and Retailers** - Seed dealers and retailers are important intermediaries between seed producers and farmers. They purchase seeds in bulk from seed growers or seed companies and sell them to farmers during sowing seasons. Dealers possess good knowledge about local market conditions, customer preferences, and competitor products. A strong dealer network helps seed growers expand market coverage and maintain regular sales.
- **Cooperative Societies and Farmer Producer Organizations-** Cooperative societies and Farmer Producer Organizations (FPOs) are increasingly becoming important customers in the agricultural sector. These organizations purchase seeds collectively and distribute them among member farmers. They often participate in government agricultural programmes and support group-based farming activities.

### **Preparation of Business Plan**

A business plan is a written document that describes the objectives, activities, resources, financial requirements, and future direction of a business enterprise. In the seed sector, preparation of a business plan is essential for establishing and managing a successful seed production enterprise. A quality seed grower must prepare a systematic plan before starting seed production activities because seed production involves investment, technical management, quality control, processing, storage, and marketing.

A business plan acts as a roadmap for the enterprise. It helps the seed grower understand business opportunities, estimate costs and returns, identify risks, and organize resources efficiently. It also provides guidance for production planning, marketing strategies, and financial management. A well-prepared business plan improves decision-making and increases the possibility of success in the seed business.

### **Components of a Business Plan**

**Business Description-** The business description explains the nature and scope of the seed enterprise. It includes information regarding the type of seed

production business, crops and varieties to be produced, location of the enterprise, production area, and scale of operation. The grower should clearly mention whether the enterprise will produce certified seeds, hybrid seeds, foundation seeds, or truthfully labelled seeds. The description should also include the mission and long-term vision of the enterprise.

**Market Analysis-** Market analysis is one of the most important components of a business plan. It involves studying demand and supply conditions, customer preferences, market competition, and sales opportunities. The seed grower should identify target customers such as farmers, dealers, cooperatives, government agencies, and seed companies. Information regarding cropping patterns, preferred varieties, seasonal demand, and competitor products should also be collected.

**Production Planning-** Production planning includes details regarding seed production activities and management practices. It explains how the seeds will be produced, processed, stored, and marketed. The production plan should include:

- Selection of crops and varieties
- Source of breeder or foundation seed
- Land preparation methods
- Isolation distance requirements
- Irrigation facilities
- Fertilizer and plant protection measures
- Harvesting and processing techniques
- Storage arrangements
- Quality control and certification procedures

**Organizational and Management Structure-** This component describes the management system of the enterprise. It includes information regarding ownership, responsibilities, labour management, technical supervision, and decision-making processes. In small seed enterprises, the owner may directly manage all activities. In larger enterprises, different individuals may be responsible for production, processing, marketing, finance, and quality control.

**Financial Planning-** Financial planning is a critical part of the business plan because seed production requires considerable investment. Financial analysis helps estimate costs, income, and profitability of the enterprise. The financial plan should include:

- Initial investment requirements
- Cost of land preparation
- Seed procurement expenses

- Labour charges
- Fertilizer and pesticide costs
- Irrigation expenses
- Machinery and equipment costs
- Storage and transportation charges
- Processing and packaging costs
- Marketing expenses

**Marketing Plan** -The marketing plan explains how the seeds will be promoted and sold in the market. Since seed demand is seasonal and competitive, proper marketing strategies are necessary for business success. The marketing plan should include:

- Identification of target customers
- Pricing strategy
- Distribution channels
- Dealer networks
- Promotional activities
- Packaging methods
- Transportation arrangements

**Risk Assessment and Management** -Agriculture and seed production involve several risks such as drought, floods, pest attacks, diseases, market fluctuations, and storage losses. A business plan should identify possible risks and suggest preventive measures. Risk management strategies may include:

- Crop diversification
- Scientific storage practices
- Crop insurance
- Contract farming arrangements
- Use of resistant varieties
- Proper pest and disease management

### **Sources of Funding**

Funding is one of the most important requirements for establishing and managing a successful seed production enterprise. A quality seed grower requires financial resources for land preparation, purchase of source seed, irrigation, fertilizers, pesticides, labour, machinery, processing, storage, certification, packaging, and marketing. Since seed production involves higher investment and technical

management compared to ordinary crop cultivation, proper financial planning is essential for smooth business operation and long-term sustainability.

### **Internal Sources of Funding**

- **Personal Savings-** Personal savings are one of the most common and reliable sources of funding for small seed growers. Many entrepreneurs start seed production enterprises using their own savings or family resources. Funding through personal savings has several advantages. It does not require payment of interest or repayment to external agencies. It also gives the grower complete control over business decisions without external interference.
- **Income from Existing Farming Activities-** Many seed growers use income generated from crop cultivation, livestock farming, or other agricultural activities as a source of funding. Profits earned from previous farming seasons may be reinvested into seed production activities. This method reduces dependence on borrowed capital and improves financial stability. Farmers with diversified agricultural enterprises often use internal income for purchasing inputs and meeting operational expenses.
- **Retained Earnings-** Established seed enterprises may use retained earnings as a source of funding. Retained earnings refer to the portion of profit that is reinvested into the business instead of being spent or distributed. Reinvestment of profits helps in business expansion, purchase of machinery, improvement of storage facilities, and adoption of new technologies. It also strengthens the financial position of the enterprise over time.

### **External Sources of Funding**

- **Bank Loans-** Commercial banks and regional rural banks are important sources of funding for seed growers. Banks provide short-term, medium-term, and long-term loans for agricultural and seed production activities. Short-term loans are generally used for purchasing inputs such as seeds, fertilizers, pesticides, and labour payments. Medium-term and long-term loans are used for purchasing machinery, constructing storage structures, establishing processing units, and developing irrigation facilities.
- **Cooperative Credit Societies-** Cooperative societies play an important role in providing financial support to farmers and seed growers, especially in rural areas. Cooperative credit institutions provide loans for agricultural production, input purchase, and seed business activities. Cooperative loans are generally easier to access for small and marginal farmers. Interest rates are often lower, and repayment conditions may be more flexible compared to private lenders.
- **Microfinance Institutions and Self-Help Groups-** Microfinance institutions and Self-Help Groups (SHGs) provide small loans to rural entrepreneurs and farmers who may not have access to formal banking systems. These organizations are especially important for women farmers, small-scale seed growers, and rural youth. Loans from SHGs and microfinance institutions are

generally used for small-scale seed production, input purchase, and marketing activities.

- **Government Funding and Subsidies-** Government agencies provide financial assistance through various agricultural development programmes and subsidy schemes. Funding support may be available for seed production, irrigation systems, farm mechanization, storage construction, processing units, and entrepreneurship development. Subsidies reduce the financial burden on seed growers and encourage adoption of improved technologies. Government support is particularly important for promoting certified seed production and increasing seed replacement rates.
- **NABARD and Agricultural Development Institutions-** National and regional agricultural development institutions provide financial and technical support for agricultural enterprises. Institutions such as agricultural development banks and rural development agencies support seed production projects through refinance schemes, entrepreneurship development programmes, and rural infrastructure funding.
- **Private Investors and Agribusiness Companies-** Private agribusiness firms and investors may also provide funding support to seed growers. In contract farming systems, seed companies often supply source seed, technical guidance, and financial assistance for production activities. Private investment may support infrastructure development, technology adoption, and large-scale commercial seed production. However, such arrangements usually involve agreements regarding production standards and seed supply commitments.

### **Government Schemes for Seed Production**

The Government of India gives high priority to the development of the seed sector because quality seeds are considered the foundation of agricultural productivity and food security. Improved and certified seeds help farmers obtain better yields, resistance against pests and diseases, improved crop quality, and stable income. To strengthen seed production and ensure timely availability of quality seeds to farmers, both Central and State Governments implement various schemes and programmes related to seed production, seed distribution, infrastructure development, and farmer training.

- 1- **Sub-Mission on Seed and Planting Material (SMSP)-** The Sub-Mission on Seed and Planting Material (SMSP) is one of the most important schemes implemented by the Department of Agriculture and Farmers Welfare under the umbrella programme of Krishonnati Yojana. The scheme focuses on increasing the availability of certified and quality seeds across the country and strengthening the seed production system. The primary objective of SMSP is to increase production and distribution of quality seeds and improve Seed Replacement Rate among farmers. The scheme also supports modernization of seed infrastructure and promotes scientific seed production technologies.

Through this programme, financial assistance is provided for seed production activities, establishment of seed processing units, development of seed storage facilities, seed testing laboratories, and seed treatment infrastructure. The scheme supports State Seed Corporations, agricultural universities, cooperatives, Farmer Producer Organizations, and private seed producers involved in seed multiplication and distribution. Farmers and seed growers receive assistance for producing certified seeds and improving the quality of farm-saved seeds. SMSP has contributed significantly to strengthening the seed supply chain and improving availability of improved varieties to farmers in different regions of the country.

- 1. Seed Village Programme-** The Seed Village Programme is an important component implemented under the Sub-Mission on Seed and Planting Material. The programme aims to promote production and distribution of quality seeds at the village level by involving farmers directly in seed production activities. Under this programme, selected farmers are trained in scientific seed production techniques and encouraged to produce seeds locally within their villages. The programme helps ensure timely availability of quality seeds and reduces dependence on external markets. Since seeds are produced locally, transportation costs and delays are reduced, and farmers can obtain seeds that are better adapted to local agro-climatic conditions. The programme provides support in the form of foundation seed supply, seed treatment chemicals, training, demonstrations, and technical guidance. Farmers are educated about proper isolation distance, rouging, harvesting, drying, processing, and storage practices necessary for maintaining seed quality.
- 2. National Food Security Mission (NFSM)-** The National Food Security Mission (NFSM) is a centrally sponsored scheme aimed at increasing production and productivity of important food crops such as rice, wheat, pulses, coarse cereals, and oilseeds. Seed production and seed distribution are important components of this mission. The scheme promotes adoption of improved and high-yielding crop varieties through distribution of certified seeds, seed minikits, demonstrations, and farmer training programmes. Under NFSM, farmers receive support for using quality seeds and adopting improved agricultural practices to increase crop productivity. Demonstration programmes conducted under the mission allow farmers to observe the performance of improved varieties under field conditions. Such demonstrations encourage adoption of scientifically developed seeds and modern cultivation practices. The mission also supports cluster demonstrations and awareness programmes to improve knowledge among farmers regarding crop management and seed quality.
- 3. Mission for Aatmanirbharta in Pulses-** The Mission for Aatmanirbharta in Pulses is a recently approved national mission introduced to achieve self-reliance in pulse production in India. The mission aims to reduce dependence on pulse imports and increase domestic pulse production through scientific farming and improved seed systems. Seed development and seed distribution

form major components of this mission. The programme promotes production and distribution of improved pulse varieties that are climate-resilient, pest-resistant, and suitable for different agro-climatic regions. Under the mission, state-wise seed production plans are prepared to ensure availability of breeder, foundation, and certified seeds. Farmers receive support through free seed kits, demonstrations, and training programmes. The mission also focuses on strengthening scientific seed authentication and traceability systems for maintaining seed quality standards. The programme is expected to improve pulse productivity, strengthen nutritional security, and increase farmer income. By promoting improved pulse varieties and scientific seed production practices, the mission contributes to sustainable agricultural development.

**4. Assistance for Seed Infrastructure Development-** The Government of India also provides assistance for development of seed infrastructure under various agricultural development programmes. Infrastructure development is necessary for maintaining seed quality during processing, storage, testing, and marketing. Financial assistance is provided for establishment of seed processing plants, construction of storage godowns, installation of grading and packaging machinery, and development of seed testing laboratories. Support is also available for cold storage and seed treatment facilities. Proper infrastructure helps reduce post-harvest losses and maintain seed viability and germination quality. It also improves efficiency in seed processing and marketing. Modern seed infrastructure strengthens the overall seed supply chain and ensures timely availability of quality seeds to farmers.

### **Economics of Seed Production**

Seed is one of the most important inputs in agriculture because it directly influences crop productivity, quality, and profitability. Quality seed production is a specialized agricultural activity that involves scientific management, strict quality control, and careful handling at every stage of production, processing, and storage. Compared to ordinary grain production, seed production requires additional investment, technical knowledge, labour, certification procedures, and infrastructure facilities. Therefore, understanding the economics of seed production is essential for ensuring profitability and sustainability of the seed enterprise.

### **Cost Components in Seed Production**

- **Land Preparation Cost-** Land preparation is the first step in seed production and involves activities such as ploughing, harrowing, leveling, and field preparation. Proper land preparation is necessary for good seed germination and crop establishment. The cost of land preparation depends on soil type, machinery use, labour charges, and fuel expenses. In seed production, additional care is often required to maintain field cleanliness and isolation standards.

- **Cost of Seed Material-** Seed production requires breeder seed or foundation seed obtained from authorized agencies. The cost of source seed is generally higher than ordinary grain seed because it must meet genetic purity and quality standards. The quantity of source seed required depends on crop type, sowing method, and seed rate. Hybrid seed production may involve higher seed cost due to specialized parental lines.
- **Labour Cost-** Labour is one of the major cost components in seed production. Seed production requires more labour compared to ordinary crop cultivation because additional operations such as rouging, field inspection, pollination management, harvesting, grading, and processing must be carried out carefully. Labour costs include wages for sowing, irrigation, fertilizer application, weeding, harvesting, drying, processing, packaging, and transportation activities.
- **Fertilizer and Nutrient Management Cost-** Proper nutrient management is necessary for healthy crop growth and high-quality seed production. Costs are incurred on fertilizers, organic manure, micronutrients, and soil amendments. Balanced fertilization improves seed yield, seed size, and germination quality. However, excessive or improper fertilizer use may increase production costs unnecessarily.
- **Irrigation Cost-** Irrigation is essential for maintaining proper moisture during crop growth and seed development. Irrigation expenses include water charges, electricity or diesel costs, labour, and maintenance of irrigation systems. The number of irrigations required depends on crop type, soil condition, and climatic factors.
- **Plant Protection Cost-** Seed crops must be protected from pests, diseases, and weeds to maintain seed quality and productivity. Expenses on pesticides, fungicides, herbicides, and plant protection equipment form an important part of production cost. Integrated Pest Management practices may help reduce chemical costs and improve sustainability.
- **Certification and Inspection Cost-** Certified seed production requires field inspections, seed testing, and certification procedures conducted by authorized agencies. Seed growers must pay certification fees and comply with quality standards. Costs may also include expenses related to field tagging, laboratory testing, and documentation.
- **Processing and Storage Cost-** After harvesting, seeds require cleaning, grading, drying, treatment, packaging, and storage. Processing costs include machinery use, labour, electricity, and packaging materials. Storage costs involve construction or rental of storage facilities, maintenance of proper temperature and humidity, and protection against insects and rodents.
- **Transportation and Marketing Cost-** Transportation expenses are incurred for movement of seeds from production fields to processing units, storage facilities, markets, or dealers. Marketing costs include promotion, dealer

commissions, packaging, and advertisement expenses. Efficient transportation and marketing systems help reduce losses and improve profitability.

### Activities

**Activity-** Visit to local seed suppliers/shop to collect information on business plan and market analysis

**Materials Required:** Practical notebook, pencil, pen, observation sheet, questionnaire, etc.

**Procedure:**

- Visit a local seed supplier or seed retail shop.
- Interact with the owner or staff to understand the nature of the seed business.
- Collect information on the types of seeds sold and the major crops covered.
- Observe and record the sources of seed procurement and distribution channels.
- Gather information about pricing, demand, seasonal sales, and customer preferences.
- Study the marketing strategies adopted for promoting seed sales.
- Collect information related to business planning, investment, storage, and profit margins.
- Record observations on market trends, competition, and opportunities in the seed business.

### Check Your Progress

**A. Fill in the Blanks**

1. Demand and supply analysis helps seed growers avoid \_\_\_\_\_.
2. \_\_\_\_\_ are the primary customers in the seed sector.
3. \_\_\_\_\_ are one of the most common and reliable internal sources of funding.
4. Seed Village Programme promotes seed production at the \_\_\_\_\_ level.

**B. Multiple Choice Questions**

1. Which factor directly increases demand for a crop's seed when its market price rises?
  - a. Storage loss
  - b. Crop profitability
  - c. Transportation cost
  - d. Packaging

2. Which of the following is an intermediary between seed producers and farmers?
  - a. Research station
  - b. Warehouse
  - c. Irrigation department
  - d. Seed dealer
3. Which institution provides short-term, medium-term, and long-term loans to seed growers?
  - a. Commercial bank
  - b. Seed dealer
  - c. FPO
  - d. Extension office
4. The Seed Village Programme is implemented under:
  - a. NFSM
  - b. SMSP
  - c. PM-KISAN
  - d. MGNREGA
5. Which cost component includes expenses on cleaning, grading, drying, and packaging?
  - a. Irrigation cost
  - b. Labour cost
  - c. Seed material cost
  - d. Processing and storage cost

### C. Match the Following

Column A	Column B
A. Farmers	1. Intermediary between producer and farmer
B. Seed Dealers	2. Primary customers
C. Personal Savings	3. Internal source of funding
D. Bank Loans	4. External source of funding
E. SMSP	5. Seed and Planting Material

### D. Descriptive Questions

1. Write a short note on target customers in the seed business.
2. Describe the major components of a business plan for a seed enterprise.
3. Explain the different sources of funding available to seed growers.
4. Write briefly about the Seed Village Programme and its objectives.

# Module 3

## Maintain Health and Safety at Work Place

### Module Overview

Different work places have different levels of challenges especially in terms of physical hazards inherent in the nature of work or the workplace. Workplace accidents deal a heavy, harmful, unfortunate & counterproductive impact on workers, their co-workers, and their families. They suffer pain, disability, stress and in some cases even loss of employment. Hazard is defined as a dangerous condition or event that portends or has the potential to cause injury, threaten life, damage property, etc. Hazards in agriculture include mechanical hazards, ergonomic hazards, chemical hazards, accidents, hazards related to the occupancy of confined places, occupational diseases and various other hazards arising from associated land, water and air. All efforts are necessary for personal safety of the workers and users of agrochemicals & farm machinery on ethical, health and professional grounds.

Accidents may occur while actually at work in the field, transporting animals and crops, or by falling, slipping, tripping, drowning, machinery hits or even bad/unhealthy work practices. Hazards caused by human factors, such as those caused by awkward postures and damage to muscles and tendons, mainly due to poorly designed tools, are of common occurrence at agricultural farms.

This module introduces students to the essential health and safety practices required in agricultural workplaces. It focuses on identifying workplace hazards and adopting safe procedures to prevent accidents, injuries, and health risks. In Session 1, students will learn about the safe handling, storage, application, and disposal of agrochemicals, along with the use of personal protective equipment (PPE) and environmental safety measures. Session 2 covers the safe operation, maintenance, and handling of agricultural machinery to minimize workplace accidents and ensure efficient farm operations. The module emphasizes the importance of following safety standards and practices to create a safe and healthy working environment in agriculture.

### Learning Outcomes

After completing this module, you will be able to:

- Explain the safe handling, storage, application, and disposal practices for agrochemicals in agricultural operations.
- Describe the safety measures and precautions required for the operation and maintenance of agricultural machinery.

- Identify workplace hazards and apply appropriate health and safety practices to prevent accidents and ensure a safe working environment.

### **Module Structure**

Session 1: Safe Use of Agrochemicals

Session 2: Safe use of Agricultural Machinery

### **Session 1: Safe Use of Agrochemicals**

Chemical hazards in agriculture are related to the dangerous pesticides during use, as well as in maintenance of plant protection equipment's and spraying of pesticides. The term 'pesticides' is indeed a non-specific and broad-based one, and includes as diverse group of chemicals as herbicides, fungicides, insecticides, nematocides, rodenticides, molluscicides, acaricides, plant growth regulators, and chemical fertilizers, commonly used in agriculture.

### **Harmful effects of agrochemicals**

Majority of the pesticides can cause severe to very severe damage to central nervous system, kidney or cause increased risk of cancer. Initial symptoms may be variable and misleading such as muscular weakness, headache, dizziness and nausea. Continuous use of certain agrochemicals, especially pesticides with which our body comes in contact or is exposed, result in long term damage to organs like kidney, liver or the nervous and the endocrinal system inside our body.

Pesticides should not, but often do enter into food products due to following reasons:

- Indiscriminate and extensive use of chemical pesticides
- Non-observance of prescribed safety norms
- Discriminate or indiscriminate sourcing/use of unsafe or sub-standard pesticides
- Wrong advice and supply of pesticides to the farmers by vendors of agrochemicals.
- Leakage or lack of care in disposal of agrochemicals or its waste by-products by manufacturers.
- Unclean or improper maintenance of the premises of agrochemical storage and preparation area by farmers
- Not using appropriate apparels necessary for personal safety of the field operators and many other factors.

#### **a. Safety procedures in pesticide usage**

Individuals who handle and use pesticides should review safety procedures on a regular basis. These are generally exhibited on pesticide container labels or in the literature provided with the market product.

Some important Do's and Don'ts:

- Read and follow label information and directions carefully
- While working with hazardous products, do wear clean personal protective equipment
- Do remove contact lenses before handling pesticides
- Do wash hands after you have handled or have had a contact with a pesticide especially & more so, before eating, drinking, smoking, or using the toilet after handling pesticide
- Do remove and wash off contaminated clothing and any spilled pesticide on an affected person.
- Do Shower and wash the hair and clean under-fingernails at the end of each day.
- Do take proper care in respect of pesticide as per toxicity labels marked on the pesticide packing.



**Fig.3.1: Labels of Colours showing toxicity of pesticide**

### **b. Selecting and buying right Pesticides and in required quantity**

Safety begins with choosing and buying a pesticide as per need only.

Carry out following check before buying a pesticide:

- Label shows the pesticide as approved for the intended use
- Pesticide can be used in an integrated pest management programme.
- Purchase just as much as is needed by carefully calculating on the basis of cropped or storage area to be covered.
- Read and follow the instructions that come with the agrochemicals.

### **c. Properly protecting oneself while using equipments**

Several articles of personal dressing or covering are essential while using hazardous chemicals or working with powered machines, viz., rubber gloves, respiratory guards/filters, full overalls but not loose fitting (missing buttons/zips), etc.



Fig.3.2: Safety apparel for preparing spray solutions

**d. Safety protocol for mixing or applying a pesticide**

- Pesticides should be mixed and used at prescribed/recommended rates.
- Use pesticides under favourable weather conditions only; avoid bad weather.
- Don't use muddy unclean water for mixing with pesticide and for personal clean up.
- Whenever handling pesticides, clean water tanks should be nearby.
- Never smoke or eat in between or while mixing or applying pesticides.
- Some pesticide products are flammable. Take care against fire breaking out due to smoking or other use of matchsticks or fireplace.
- Read and follow the instructions on the user guide/label properly
- Use correct pesticide for the pest/disease for which it is meant

**e. Use the recommended dose and quantity only**

\* For preparing the aqueous solution of the pesticide, use outdoor open space

- Use the recommended amounts and recommended dilutions strictly.
- Do not prepare larger amounts than are necessary for field application on a given day only; never try to store for possible future use.

**f. During application of pesticides:**

- Don't undertake pesticide spraying on a windy day.
- Position yourself in a way that the wind drift blows pesticide spray (or dust) away from your face.
- Before indoor spraying, close the doors and windows of hall/home.

- During the spray operation, keep the nozzle close to the target plants to avoid waste of solution by drift
- Spraying excess quantities will be wasteful and leave residual harmful amounts on the produce, which if consumed will be detrimental to the health of the consumer
- While preparing spray solution of pesticide, try to stay away from an open well used to draw drinking water



Fig.3.3: Caution signage's while pesticide spraying



Figure 3.4: Signage for pesticide applied at field

### **Cleaning and disposal of empty pesticide containers**

Pesticide containers should be cleaned when emptied, removing pesticide residues before they dry. When emptying a pesticide container:

- For liquids, transfer the pesticide into a spray tank or mixing tank. Let the last drop get emptied. Use a strong nozzle to triple rinse or pressure rinse metal, plastic, or glass containers, unless otherwise instructed on the label.
- Likewise, for solids, gently shake the bag into tank or hopper until no loose foggy dust is visible. Gently single rinse bags if possible, unless otherwise instructed on the label.

### **Pesticide Disposal**

#### **Disposal of Concentrated Pesticide**

Planning your pesticide purchases will minimize excess pesticide concentrates left over after an application or use season. Review records of prior applications. Use the pesticide that is on hand before buying more. Contact the pesticide manufacturer or a local vendor to be sure that old stocks are still effective.

It is best to prepare just the right quantity of pesticide concentrate or solution to avoid disposal problems. It is safer to prepare less quantity than to prepare excess which may have to be disposed of unsafely.

Unopened containers may sometimes be returned to the manufacturer or local dealer. Applicators can also contact the pesticide regulatory body for advice on

proper disposal of unused pesticides. If excess quantities are left in storage, either use yourself or let a neighbouring farmer use it, if possible.

- Don't stockpile –buy and use as per need.

If you must have to store pesticides, keep high enough out of reach of children. Do lock all pesticides in a cabinet in a well-ventilated utility area or farm shed.

### **Disposal of surplus tank mixture:**

'Prevention is better than cure' has to be the guiding principle.

- Accurately measure the area to be treated
- Confirm application rates of agrochemicals
- Calibrate application equipment

Best if mixing tank is emptied by using up all the solution prepared. If there is still something left in tank mix at the end of an application, use it according to label directions on another area that requires the same pesticide.

### **First Aid, Treatment and Safety Equipment's**

Accidents might happen in spite of all precautions and care. It is essential for the students to know about immediate medical aid for a chemical accident and to learn about the safety devices to prevent them.



Fig.3.5: First Aid Box

### **Chemical poisoning and first aid measures**

Chemical poisoning may result from continuous contact, absorption through skin, inhalation of toxic vapour or swallowing it directly. Common symptoms of pesticide poisoning are headache, nausea, vomiting, tremors, convulsion, and difficulty in respiration. A first-aid kit with necessary antidotes should be available at work site for each type of poisoning. Antidotes are always mentioned on the pesticide containers.

#### **Treatment for simple chemical poisoning**

- Swallowed poison:** If the poison has been swallowed, induce vomiting immediately. Mustard oil or table salt in a glass of warm water is good for this

purpose. Touching the throat internally with finger or any smooth, blunt and hard spatula will also induce vomiting. Vomiting process should be continued till clear liquid starts coming out of the stomach. If the patient goes into convulsions or in unconscious state, vomiting should be induced. If the poison is due to ingestion of mercury compounds, egg white and milk should be given first and then vomiting should be induced. At the end of inducing vomiting, soothing substances like raw egg white (mixed with water), butter or cream milk should be given.

- I. **Skin contamination:** Contaminated clothes may at once be removed. Contaminated skin should be washed with soap and water also flushed with plenty of water to reduce the extent of injury.
- II. **Eye poisoning:** Eyes of the victim may be flushed with plenty of water, keeping the eye-lids open. A quick decisive action is desirable, as a delay of a few seconds may greatly increase the extent of injury. Refer to an eye specialist immediately.
- III. **Inhaled poisons:** The victim of inhaled poison should be immediately exposed to open area with fresh air. Keep the patient quiet as far as possible. Provide a blanket to avoid chilling. If breathing is stopped, artificial respiration technique through mouth may be used.

### **Safety and protective devices**

Protective and safety devices will minimize chances of a major accident. The protective and safety equipment essentially include a gas mask, hand gloves, shoes, eye shields, head gear, protective clothing, respiratory devices, *etc.*

- i. **Gas mask:** It is a device to protect the eyes and respiratory tract from toxic gases, and aerosols. It gives clean air to the operator by removing contamination from ambient air by using a filter or bed of absorbent material.
- ii. **Hand gloves:** Always use rubberized waterproof gloves, not ones made of leather, cotton or any fluid-absorbing materials.
- iii. **Shoes:** Shoes made of rubber or any synthetic waterproof materials are used instead of leather or canvas shoes.
- iv. **Eye shields** -: Must be worn to prevent eye poisoning
- v. **Protective clothing:** The skin should be protected by wearing an apron while working with treated crops. Wash clothing before reuse.



*Fig. 3.6: Common PPE required for farm workers*

### **Health and safety awareness in the workplace**

- Encourage seniors to keep an eye on those working at the workplace.
- Use charts and visuals to demonstrate commitment to health and safety.
- Safe work practices, discouraging unsafe work practices.
- Even at the cost of repetition, do communicate that safety is of prime importance while at work.
- Those new to undertaking spray or pesticide applications, must be supervised or advised to report immediately, any adverse developments concerning health of the operator.
- Respond and act promptly to all health and safety concerns.
- Set example in use of all preventive and protective materials and practices.
- Keep children away from operational area or supervise them personally to ensure they are not close to a working machinery or handling devices and equipments for which they are not trained to use.

### **Amenities and environment**

- Train all workers rotationally in use of first aid equipment and provide first aid kits at easily accessible points.
- Insist on first aid training for all field workers.

- There should be a free access to wash room and toilet facilities with running water or stored clean water.
- There should be free access to potable, clean and cool drinking water.
- As far as possible, take steps to prevent entry of poisonous creatures like scorpions, snakes, leeches, *etc.*
- Don't keep flammable materials in large quantities or in easily approachable/accessible areas prone to fire hazard.

### Emergency response

- Train a task force for emergency response action for the workplace (e.g. snakebite, fire, confined space entry, heat stress or chemical spill).
- Keep safety awareness level of workers high at all times.
- Maintain emergency response equipment.

### Manual tasks for personal safety

- When and where required, use appropriate restraint systems.
- Take care to avoid crush injuries to hands.
- When and where possible use aids to lift or move down/injured animals.
- Try and minimise risk of slips, trips and falls; provide non-slip flooring.

## Activities

**Activity-** Demonstration of safety devices and measures to be followed.

**Materials Required:** First-aid kit, Gas mask, Protective clothing, Eye shields, Hand gloves, Shoes and pictorial charts.

### Procedure:

1. Identify the different types of protective devices used while handling and applying chemicals.
2. Understand their use through pictorial charts.
3. Identify and understand about each item and its uses.
4. Discuss about different types of chemical poisoning. What are the immediate symptoms?
5. Demonstrate the use of different protective devices.
6. Prepare chart showing different protective devices and their use.

## Check Your Progress

### Fill in the Blanks:

1. To induce vomiting \_\_\_\_\_ and \_\_\_\_\_ can be used.

2. On contaminated skin \_\_\_\_\_ should be done.
3. To protect eyes and respiratory tract from toxic gases \_\_\_\_\_ is used.
4. Hand gloves made up of \_\_\_\_\_ should be used to handle chemicals.
5. For inhaled poisons first aid can be \_\_\_\_\_.

**Multiple choice questions:**

1. Common symptoms of pesticide poisoning are:
  - a. Headache
  - b. Vomiting and Nausea
  - c. Difficulty in respiration
  - d. All of these
2. To prevent hazards at working place following materials should be ensured:
  - a. SDS
  - b. First aid kits
  - c. Protective clothing
  - d. All of these
3. Emergency services are comprised of:
  - a. Ambulance
  - b. Fire brigade
  - c. Both a and b
  - d. None of these
4. Potentially dangerous creatures around house and office buildings include:
  - a. Lizards
  - b. Snakes
  - c. Spiders and Scorpions
  - d. All of these
5. What safety measures are required during application of pesticides to the crop?
  - a. Mixing of correct quantity of pesticide and clean water and spray during evening time
  - b. Use of any type of nozzle and spray mixture
  - c. Spraying of insecticides with flat nozzle against the direction of wind
  - d. Spraying at any time during the day
6. What safe pesticide handling practices are required to be followed by the farmers?
  - a. Wearing clean personal protective equipment (PPE)
  - b. Wash hands with clean water before any activity which involves food intake or use of area around mouth, eyes, nostrils, etc.
  - c. If an insecticide or its solution happens to fall on the clothing or body of an individual, give a proper wash to remove the pesticide as completely as possible
  - d. All of the above

**Subjective questions**

1. What are the first aid treatment measures for chemical poisoning?
2. What protective devices are meant for protection in agriculture field?
3. Define agro-chemicals?
4. Discuss various types of harmful effects of agro-chemicals?

**Match the Column A & B**

<b>A</b>	<b>B</b>
1. Eye	a. Rubber
2. Shoe	b. shield
3. Protective Clothes	c. Apron

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## Session 2: Safe use of Agricultural Machinery

Agricultural field operations today are dependent on various agricultural machinery, tools and equipment's. Use of machinery demands great care with all necessary safe guards.

The accidents associated with agricultural machineries are caused due to the following reasons:

- Lack of adequate or proper training to operators
- Poor maintenance of tools and machinery
- Using a machine that is not right or suitable for the task at hand
- Failure in following proper norms of a safe system of work
- Failing to follow safe operating or 'safe stop' procedures
- Missing or defective safety devices or machine guards, thus exposing workers to accidents
- Unsafe methods for clearing blockages on the premises or for making adjustments.

### Checking the tools and machinery before use

Before starting to work with a tool or machinery, one should carry out a check to make sure that it is in good working condition and is safe to use. While specific needs would vary with the machine to be used, basic checks must always be adopted/exercised:

Check the operator manual of the machine for pre-operative instructions and follow them as advised

- Particular attention is warranted to items like brakes, wheels, moving parts of machine (if openly visible) and tires of tractors/vehicles.
- Make sure that guards and protective covers are securely positioned so that these would not come out lose or allow catching loose articles or body parts
- Promptly repair or replace defective/damaged parts of machine, if any
- Stopping devices should be functioning correctly, e.g., brakes, emergency stops (electric switches).
- While coupling/engaging/attaching equipment or a part to machines, make sure that the coupling/attachment is properly fit and is of appropriate size/specification & is not lose. Don't use wrong/makeshift coupling devices/pieces.
- Vehicular type machines must have clear rear view mirrors and fit, fine, properly working reversing aids.

- If guards over moving parts of a machine are missing, get them fitted out and properly covered before using the machine

### **Daily/periodic mandatory inspections for use of machinery**

1. Check water, fuel, fan belts, *etc.*
2. Inspect hydraulic lines for kinks, cracks and general wear & tear.
3. Once engine is running, check hand and/or air brakes, this ensures that brakes will hold while loading.
4. Inspect the cracks in the metal which may cause equipment to break or parts may come off unexpectedly.
5. Keep a safe distance from the equipment when loading or unloading.
6. Take care if there are any overhead power lines, particularly during loading and offloading or while lift-removing of produce or materials.
7. Do discuss any unsafe actions that come to notice of supervisors so that preventive measures can be taken.

### **Safety precautions during harvesting and threshing machinery**

Guidelines to avoid accidents & enhance safety while at work:

- Familiarize yourself with safety risks & measures to overcome the same.
- Harvesting and threshing machines are most prone to debilitating accidents, *viz.*, crushing, cutting, seizing of body parts, especially hands, feet, trunk.
- Caution operators accordingly
- During field operations with moving vehicles, machinery with moving parts, handling a moving part of a machine, do ensure to wear tight clothing and head/hair cover to avoid entanglement.
- Never clean, maintain, adjust or clear jams when the machine is on.
- Stay clear of outlets, discharges, and all moving parts of machine.
- If equipment breaks down, don't just improvise, get it repaired.
- Avoid coming close to moving parts of a powered machine
- Don't leave a machine with engine running – never.
- Don't let children come near a machine while at work
- Don't refuel machine with engine running
- Don't let flammable articles or substances (like fuel, straw, *etc.*) close to working area or machine in operation

- Do not oil, grease, or adjust the machine during operation. Wait for engine & moving parts to come to a full stop before doing this. Remember, the feeding area of a thresher is the most dangerous. Do not let your hand or a loose sleeve of shirt enter feeding area of a thresher.
- Totally avoid working a petrol or diesel driven machine in a closed shed or garage. Exhaust fumes are dangerous to your health

### **Health and safety during Combine harvesting**

Following points may be mentioned even at the cost of repetition as most of the steps are common to all the heavy duty machines with moving parts.

- Never attempt to lubricate, clean, adjust, or unplug harvesters when the machine or engine is running
- Do not allow anyone to climb onto the machine while it is in motion
- Keep children at a safe distance from the machine
- Always have a fire-extinguisher at hand on engine-operated equipment
- Ensure that the fuel system has no leaks
- While refueling, stop the engine and do not smoke
- When operating around machinery, wear work clothes that fit snugly.

### **Protective measures during operating machinery**

Use of protective clothing is an extra measure of protection. All workers operating machines must wear protective clothing or personal protective equipment as a protection against accident/hazards. Also make sure that the protective dress is safe and fitting to body (not loose or with loose ends).

Features of Protective dress and equipment:

- Good fit, appropriate and cleaned/well maintained.
- Safe and preventive storage to avoid damage, cuts, insect infestation
- No rough edges
- Overall body and coverage using overalls, aprons, vests, socks, gloves
- Avoid/prevent noise pollution while at work.
- Hard hats are always desirable for head protection
- Make sure protective clothing is available for different parts of the body.
- Kept clean, fully functional, and sanitized.

**Activities**

**Activity-** Demonstrate general inspections for use of the machinery.

**Materials required:** Different types of equipments, users guide, pen, and notebook.

**Procedure:**

- Identify and select the machinery
- Check the different parts of machinery
- Identify the open moving parts or feeding parts which pose hazard
- Check assembling of each part of the equipments
- Demonstrate use of machinery after inspection.

**Check Your Progress****Fill in the blanks**

1. During harvesting ensure that the operators should wear \_\_\_\_\_ and secure their \_\_\_\_\_ to avoid entanglement.
2. Need to protect not to allow anyone to \_\_\_\_\_ onto the machine while it is in motion.
3. Operators must wear \_\_\_\_\_ clothing.

**Multiple choices question**

1. What is necessary to check machinery before start?
  - (a) Farm operations
  - (b) Fill the fuel
  - (c) check the tires
  - (d) check the lights
2. What type of care is required to avoid any machinery accident?
  - (a) Using a machine that is unsuitable for the task
  - (b) Using unsafe methods for operations
  - (c) Guards and other safety devices missing or defective
  - (d) Using safe operating procedures
3. Which of the following safety precautions are necessary while refueling of tractor or other machinery?
  - (a) Engine in running condition
  - (b) Engine in off position

- (c) Engine in off and no open flame nearby
- (d) All of these

**Subjective questions**

1. Enlist the general inspections of the machinery before use.
2. Describe the health and safety during combine harvesting.
3. Describe the use of protective clothing during machinery operations.

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## Glossary

**Acaricide** – A pesticide specifically used to control mites and ticks that damage crops and stored produce.

**Adulteration** – The practice of mixing inferior, impure, or unauthorized materials with seeds or agricultural products, reducing their quality and reliability.

**Aerodynamic Properties** – Characteristics that determine how seeds behave in moving air and are used during seed cleaning and grading operations.

**Agrochemicals** – Chemical substances used in agriculture to improve crop production and protection, including fertilizers, pesticides, and plant growth regulators.

**Antidote** – A substance used to neutralize or counteract the harmful effects of a poison or toxic chemical.

**Aerosol** – Tiny liquid or solid particles suspended in air, often produced during pesticide spraying.

**Bagging** – The process of packing processed seeds into bags or containers for storage, transportation, and marketing.

**Calibration** – The adjustment and setting of equipment or machinery to ensure accurate and efficient operation.

**Cancer Risk** – The increased possibility of developing cancer due to prolonged exposure to certain hazardous chemicals.

**Capsule** – A dry fruit that splits open at maturity to release seeds.

**Certification** – An official quality assurance process that verifies seed lots meet prescribed standards of purity, germination, and identity.

**Certification Tag** – An official label attached to seed containers indicating seed class, quality standards, and certification status.

**Chaff** – Lightweight plant material separated from seeds during threshing and cleaning.

**Chemical Hazard** – A potential source of harm arising from exposure to hazardous chemicals.

**Chemical Poisoning** – A harmful condition caused by swallowing, inhaling, or absorbing toxic chemicals.

**Cob** – The central core of a maize ear to which kernels are attached.

**Cold Storage** – A storage system that maintains low temperature and controlled humidity to preserve seed viability for extended periods.

**Composite Sample** – A representative sample formed by combining several primary samples collected from different parts of a seed lot.

**Contamination** – The accidental presence of foreign materials, pests, pathogens, chemicals, or seeds of other varieties in a seed lot or product.

**Consumer** – The final user who purchases and uses a product; in the seed industry, farmers are the primary consumers.

**Contract Farming** – An agreement between farmers and companies specifying production standards and purchase arrangements.

**Convulsion** – Sudden involuntary muscle contractions or seizures that may occur during severe poisoning.

**Dealer Network** – A group of authorized distributors and retailers involved in marketing and distributing seed products.

**Demand Analysis** – The systematic study of factors affecting the quantity of seeds required by customers in the market.

**Density** – The mass of a seed relative to its volume, often used in seed grading and separation.

**Distribution Channel** – The pathway through which products move from producers to consumers.

**Dormancy** – A condition in which a viable seed does not germinate even under favourable environmental conditions.

**Embryo** – The living part of a seed that develops into a new plant during germination.

**Endocrine System** – A network of glands that produce hormones regulating growth, metabolism, and reproduction.

**Enterprise** – An organized business activity undertaken for income generation and profit.

**Entrepreneur** – A person who establishes and manages a business while assuming financial risks.

**Ergot** – A fungal disease in cereals and millets where fungal structures replace normal grains.

**Exposure** – Contact with a chemical through the skin, eyes, respiratory tract, or digestive system.

**Field Emergence** – The appearance of seedlings above the soil surface after sowing.

**Financial Planning** – The process of estimating costs, income, investments, and profitability to manage a business efficiently.

**Food Security** – A condition in which all people have access to sufficient, safe, and nutritious food.

**Fungal Growth** – Development of fungi on seeds or stored produce, often leading to deterioration and loss of viability.

**Fungicide** – A pesticide used to prevent or control fungal diseases.

**Gas Mask** – A protective device that filters harmful gases, vapours, and airborne particles from inhaled air.

**Gelatinous Layer** – A sticky substance surrounding seeds in fruits such as tomato that is removed during seed extraction.

**Hardseededness** – A condition where seeds have hard, impermeable seed coats that restrict water absorption.

**Hazardous Substance** – Any material capable of causing injury, illness, or environmental damage.

**Herbicide** – A chemical used to control or destroy weeds.

**Hygroscopic** – The property of seeds to absorb or release moisture depending on atmospheric conditions.

**Imbibition** – The process by which dry seeds absorb water and initiate germination.

**Imbibitional Injury** – Damage caused when very dry seeds absorb water too rapidly.

**Infrastructure** – Physical facilities such as storage structures, laboratories, processing plants, and transportation systems that support agricultural operations.

**Inert Matter** – Non-seed materials such as soil, dust, stones, and plant debris present in a seed lot.

**Inhalation** – The process of breathing in air, gases, vapours, or chemical particles.

**Integrated Pest Management (IPM)** – A pest management approach combining biological, cultural, mechanical, and chemical methods for effective and sustainable control.

**Intermediary** – A person or organization acting between producers and consumers in the marketing chain.

**Inventory Management** – The systematic monitoring and control of stored seed quantities and stock movement.

**Isozyme Analysis** – A biochemical technique used to identify genetic differences among varieties by studying enzyme patterns.

**Kernel** – The mature grain or seed of cereal crops such as maize and wheat.

**Label Instructions** – Official directions provided on pesticide or seed containers regarding safe handling, use, storage, and disposal.

**Longevity** – The length of time a seed remains viable during storage.

**Lodging** – The bending or falling over of crop plants before harvest due to wind, rain, or weak stems.

**Lot Number** – A unique identification code assigned to a seed lot for traceability.

**Market Competition** – Rivalry among businesses seeking to attract customers and increase sales.

**Mechanical Damage** – Physical injury to seeds caused during harvesting, processing, storage, or transportation.

**Misbranding** – Providing false or misleading information about a product's quality, identity, or certification status.

**Molluscicide** – A pesticide used to control snails and slugs.

**Moisture-Proof Container** – A packaging material designed to prevent moisture exchange between the seed and the environment.

**Mould** – Visible fungal growth on seeds caused by high moisture conditions.

**Nematicide** – A pesticide used to control plant-parasitic nematodes.

**Normal Seedling** – A healthy seedling capable of developing into a mature plant under favourable conditions.

**Off-Type Plant** – A plant that differs from the standard characteristics of the designated variety.

**Panicle** – A branched flower cluster found in crops such as rice and sorghum.

**Pathogen** – A disease-causing organism such as a fungus, bacterium, virus, or nematode.

**PCR (Polymerase Chain Reaction)** – A molecular technique used to amplify and analyze DNA for varietal identification and genetic purity testing.

**Perishable Quality** – The tendency of seed quality to deteriorate gradually over time.

**Personal Protective Equipment (PPE)** – Protective clothing and equipment such as gloves, masks, goggles, boots, and overalls worn to reduce exposure to hazards.

**Pesticide** – A substance used to prevent, destroy, repel, or control pests affecting crops, livestock, or stored products.

**Pesticide Residue** – Small amounts of pesticide remaining on crops, food products, soil, or water after application.

**Plant Growth Regulator** – A chemical substance used to influence plant growth processes such as flowering, fruiting, and ripening.

**Planting Value** – The usefulness of a seed lot for sowing, determined by factors such as purity, germination, and vigour.

**Poisoning** – A harmful condition caused by toxic substances entering the body.

**Pressure Rinsing** – A method of cleaning pesticide containers using pressurized water to remove residues.

**Pricing Strategy** – A plan for determining product prices to remain competitive while ensuring profitability.

**Processing History** – The complete record of operations performed on a seed lot from harvest to marketing.

**Profitability** – The ability of a business to generate profit after meeting all expenses.

**Risk Assessment** – The process of identifying and evaluating potential hazards or business risks.

**Risk Management** – The implementation of strategies to reduce or control identified risks.

**Rodenticide** – A pesticide used to control rats, mice, and other rodents.

**Safety Protocol** – A set of procedures designed to minimize risks and ensure safe operations.

**Sampling Bias** – Error that occurs when a sample does not accurately represent the entire population or seed lot.

**Sclerotia** – Hard, dark fungal structures produced by certain fungi such as ergot.

**Seed-Borne Disease** – A disease carried on or within seeds and transmitted to the developing plant.

**Seed Replacement Rate (SRR)** – The percentage of cultivated area sown with certified or quality seed instead of farm-saved seed.

**Seed Village Programme** – A programme that promotes local production and distribution of quality seeds by farmers within a village.

**Shelling** – The process of removing seeds or grains from cobs, pods, or husks.

**Shrivelled Seed** – A poorly developed seed that is wrinkled, lightweight, and often has poor germination.

**Skin Absorption** – The entry of chemicals into the body through the skin.

**Specific Gravity** – The relative density of a seed compared with water, used in grading and separation.

**Storage Fungus** – A fungus that develops on stored seeds under high moisture conditions, causing deterioration.

**Subsidy** – Financial assistance provided by the government to reduce production costs or encourage adoption of technologies.

**Toxicity** – The degree to which a substance can cause harm to living organisms.

**Traceability** – The ability to track the origin, processing history, storage, and distribution of a product.

**Umbel** – A flower cluster in which flower stalks arise from a common point, forming an umbrella-like shape.

**Varietal Contamination** – The unintended mixing of seeds from different varieties, reducing genetic purity.

**Vapour** – The gaseous form of a liquid chemical that may be inhaled and cause health effects.

**Ventilation** – The movement and replacement of air in an area to reduce harmful fumes and maintain a safe environment.

**Viability** – The ability of a seed to remain alive and germinate under suitable conditions.

**Vigour** – The overall strength and performance potential of a seed during germination and seedling establishment.

**Warehouse** – A building used for storing seeds and agricultural products under suitable conditions.

**Wholesaler** – A trader who purchases products in bulk and supplies them to retailers or dealers.

**Answer Keys****Unit 1 Session 1****Fill in the Blanks**

1. Harvestable
2. Physiological
3. 30–35
4. Sickles
5. Threshing

**Multiple Choice Questions**

1-b, 2-a, 3-c, 4-b, 5-c, 6-d, 7-b

**Match the Following**

A – 2, B – 1, C – 3, D – 4

**Unit 1 Session 2****Fill in the Blanks**

1. Seed lot
2. Drying
3. Fermentation
4. Scarification
5. Grading
6. 80–85

**Multiple Choice Questions**

1-c, 2-c, 3-b, 4-c, 5-a, 6-d, 7-d, 8-a

**Match the Following**

A → 3, B → 2, C → 1, D → 4, E → 5

**Unit 1 Session 3****Fill in the Blanks**

1. Primary
2. Composite
3. Oven
4. Physical
5. Grow-Out

**Multiple Choice Questions**

1-c, 2-c, 3-a, 4-c,5-d

**Match the Following**

A → 2 , B → 3, C → 1, D → 4, E → 5

**Unit 2 Session 1****Fill in the Blanks**

1. Contamination
2. Polyethylene
3. Aluminium
4. White
5. Hygroscopic
6. Transportation

**Multiple Choice Questions**

1-c, 2-d, 3-a, 4-b,5-c, 6-b, 7-b

**Match the Following**

A → 3, B → 4, C → 1, D → 2

**Unit 2 Session 2****Fill in the Blanks**

1. Overproduction
2. Farmers
3. Personal savings
4. Village

**Multiple Choice Questions**

1-b, 2-d, 3-a, 4-b,5-d

**Match the Following**

A → 2, B → 1, C → 3, D → 4, E → 5

**Unit 3 Session 1****Fill in the Blanks**

1. Table Salt and Mustard Oil
2. Wash with soap
3. Gas Mask
4. Rubber

## 5. Artificial Respiration

**Multiple Choice Questions**

1.- d, 2.- d, 3.- c, 4.- d, 5.- a, 6.- d

**Match the Following**

1-b, 2- a, 3- c

**Unit 3 Session 2****Fill in the Blanks**

1. Tighen clothes
2. Climb
3. Protective

**Match the Following**

1-c, 2-d, 3- d

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**List of Credits****DAAH (Ai Generated)**

Fig. 1.1

Fig. 1.2

Fig. 1.3

Fig. 1.4

Fig. 1.5

Fig. 1.6

Fig. 2.1

Fig. 3.1

Fig. 3.2

Fig. 3.3

Fig. 3.4

Fig. 3.5

Fig. 3.6

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**PSS CENTRAL INSTITUTE OF VOCATIONAL EDUCATION**

(a constituent unit of NCERT, under MoE, Government of India)

**Shyamla Hills, Bhopal- 462 002, M.P., India**

**[www.psscive.ac.in](http://www.psscive.ac.in)**