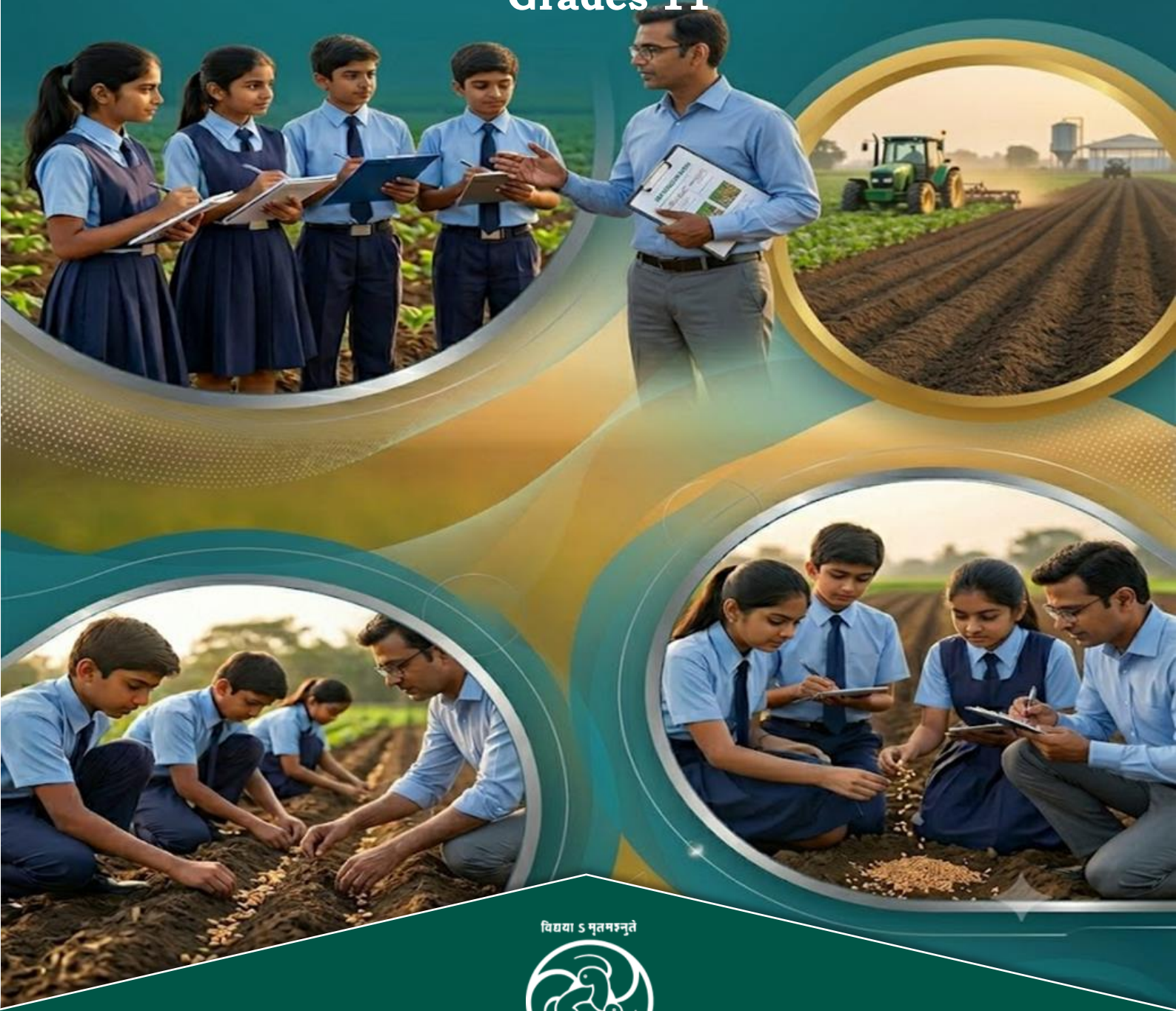
Draft Study Material

Quality Seed Grower

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

Sector: Agriculture

Grades 11



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NCERT

PSS CENTRAL INSTITUTE OF VOCATIONAL EDUCATION

(a constituent unit of NCERT, under MoE, Government of 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.

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Module 1
Overview & Importance of Quality Seed Production

Module Overview

Agriculture has been the foundation of human civilization since ancient times and continues to play a vital role in the economic, social, and environmental development of nations across the world. It is not merely an occupation but a primary source of livelihood for billions of people and a major contributor to food security, industrial growth, and rural prosperity. The agriculture industry encompasses a wide range of activities including crop cultivation, horticulture, animal husbandry, fisheries, forestry, and agro-based industries. In developing countries especially, agriculture serves as the backbone of the economy by generating employment opportunities, supplying raw materials to industries, and supporting national income. Over the years, the agriculture sector has undergone significant transformation due to advancements in science and technology. Traditional farming practices have gradually evolved into modern agricultural systems characterized by mechanization, improved irrigation methods, precision farming, biotechnology, and digital agriculture. Crop farming is the most important and widely practiced segment of agriculture. It involves the cultivation of crops for food, fiber, fodder, and industrial use. Crop farming can be divided into different categories such as food crops, cash crops, plantation crops, and horticultural crops. Crop farming provides food for the growing population and raw materials for agro-based industries. It is the backbone of rural economies in many countries.

Types of Crops

- **Food grain Crops:** Rice, wheat, maize, pulses, and millets
- **Cash Crops:** Cotton, sugarcane, tobacco, jute, and oilseeds
- **Plantation Crops:** Tea, coffee, rubber, and cocoa
- **Horticultural Crops:** Fruits, vegetables, flowers, and spices

This module introduces students to the fundamental concepts of oilseed crops and the agricultural seed industry, highlighting their role in agricultural productivity and sustainable farming. In Session 1, students will learn about the agriculture seed industry, its structure, functions, and contribution to crop improvement and seed production. Session 2 focuses on the importance of the seed industry in ensuring the availability of quality seeds, enhancing crop yields, supporting food security, and promoting agricultural development. The module

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provides an overview of the significance of seeds as a vital input in agriculture and the opportunities associated with the seed sector.

Learning Outcomes

After completing this module, you will be able to:

- Explain the concept and significance of the agriculture seed industry and its role in crop production.
- Describe the importance of the seed industry in providing quality seeds, improving agricultural productivity, and supporting sustainable agricultural development.

Module Structure

Session 1 Introduction to agriculture Seed industry

Session 2: Importance of the Seed Industry

Session 1 Introduction to agriculture Seed industry

In India, where agriculture remains a major source of employment and livelihood, the seed industry has gained strategic importance in achieving food security and agricultural sustainability. Seeds are the basic and most critical input in agricultural production, as the quality of seeds directly influences crop yield, productivity, disease resistance, and overall farm profitability. A healthy and progressive seed industry contributes significantly to agricultural development by ensuring the availability of high-quality, certified, and improved seeds to farmers.

The seed industry involves a systematic process of research, breeding, production, testing, certification, marketing, and distribution of seeds. Both public and private sector organizations play a crucial role in the development of improved seed varieties that can withstand adverse climatic conditions, resist pests and diseases, and produce higher yields. In recent decades, rapid advancements in biotechnology, genetic engineering, and plant breeding techniques have accelerated innovation within the seed sector, making it one of the most dynamic segments of the agricultural economy.

Overview of Seed Industry

The seed industry is one of the most important sectors within agriculture, as seeds form the basic foundation of crop production and agricultural development. A seed is a living biological resource that contains the genetic potential necessary for plant growth and productivity. The quality of seeds used by farmers directly influences crop yield, resistance to diseases and pests, adaptability to climatic conditions, and the overall quality of agricultural produce. Therefore, the seed industry plays a vital role in ensuring food security, improving agricultural

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productivity, and supporting sustainable farming practices. The seed industry comprises all activities related to the research, development, production, processing, testing, certification, marketing, and distribution of seeds. It involves the combined efforts of agricultural scientists, plant breeders, research institutions, government agencies, and private seed companies to develop improved seed varieties suitable for different environmental and agricultural conditions. The primary objective of the industry is to provide farmers with high-quality seeds that can produce higher yields and better-quality crops.

The seed industry can be broadly divided into public and private sectors. Public sector organizations, including agricultural universities and government research institutions, focus on the development of improved crop varieties for public benefit. Private seed companies invest heavily in research and development to produce hybrid and specialized seeds with superior performance characteristics. The collaboration between public and private sectors has contributed significantly to the growth and expansion of the seed market worldwide. Seed production in India can be broadly categorized into the following categories:

1. **Public Sector Seed Companies** – Public sector seed companies are government-owned organizations established to support agricultural development and food security. Their primary objective is to produce and distribute quality seeds at affordable prices while promoting the cultivation of improved crop varieties.
2. **Private Seed Companies** – Private seed companies are commercial enterprises involved in seed research, breeding, production, processing, marketing, and export. Over recent decades, the private sector has become a dominant force in the global seed industry, particularly in hybrid seed production and biotechnology.
3. **Research Institutions** – Research institutions form the scientific backbone of the seed industry. These institutions include agricultural universities, government research centers, biotechnology laboratories, and international agricultural organizations involved in plant breeding and seed technology research.

Types of Seeds

Seeds form the foundation of agricultural production and play a critical role in determining crop yield, quality, adaptability, and resistance to environmental stresses. With advancements in agricultural science and plant breeding, several categories of seeds have been developed to meet the diverse needs of farmers and the agricultural industry. Each type of seed possesses distinct characteristics, advantages, and limitations that influence its suitability for specific farming systems and environmental conditions.

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Fig. 1.1: Different types of seeds

- **Hybrid Seeds -** Hybrid seeds are produced through the controlled cross-pollination of two genetically distinct parent lines. The primary objective of hybridization is to combine desirable traits from both parents in order to obtain superior offspring exhibiting greater vigor, productivity, and uniformity. This phenomenon is known as hybrid vigor or heterosis. Hybrid seeds are widely used in commercial agriculture because they generally produce higher yields, improved disease resistance, better adaptability, and enhanced quality characteristics. Crops such as maize, rice, sunflower, cotton, tomato, and many vegetable crops are commonly cultivated using hybrid seeds.
- **Open-Pollinated Varieties (OPV)-** Open-pollinated varieties are seeds produced through natural pollination mechanisms such as wind, insects, birds, or self-pollination. Unlike hybrids, OPV seeds maintain stable genetic characteristics over successive generations when properly isolated from cross-pollination. Farmers can save seeds from OPV crops and reuse them for future planting without significant loss of quality or performance. This feature makes OPV seeds highly suitable for small-scale and traditional farming systems. Open-pollinated varieties also contribute to the conservation of genetic diversity and local crop adaptation.
- **Genetically Modified (GM) Seed-** Genetically modified seeds are developed through biotechnology techniques that involve the direct modification of a plant's genetic material. Scientists introduce specific genes into crops to provide desired traits such as insect resistance, herbicide tolerance, drought resistance, or enhanced nutritional value. GM seeds have significantly influenced modern agriculture by improving crop productivity and reducing losses caused by pests and diseases. For example, Bt cotton contains genes from the bacterium Bacillus thuringiensis, enabling the crop to resist harmful insect pests. Herbicide-tolerant crops allow farmers to control weeds more effectively.

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- **Certified Seeds-** Certified seeds are seeds that have undergone official inspection, testing, and quality control procedures to ensure genetic purity, physical purity, germination capacity, and overall seed health. These seeds are produced under strict standards established by seed certification agencies or government authorities. Certified seeds provide farmers with assurance regarding quality, performance, and reliability. They are carefully monitored during production, processing, storage, and distribution to maintain high standards. Certified seeds generally possess better germination rates, uniform growth, and reduced risk of seed-borne diseases.

Activities

Activity : Visit to Nearby Seed Industries to Know Their Significance

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

Procedure:

- Visit a nearby seed industry or seed processing unit.
- Observe the different activities carried out in the seed industry.
- Write the name of various sections/departments in the seed industry (seed cleaning, grading, treatment, packaging, storage, etc.).
- Record the importance and functions of each section.
- Note down the different machines and equipment used in seed processing.
- Write the following points:
  - Name of the seed industry
  - Crops for which seeds are produced
  - Types of seeds produced
  - Seed production method
- Interact with the staff and collect information about seed production, processing, testing, and storage.

Check Your Progress

Fill in the Blanks

1. The quality of _____ directly influences crop yield.
2. Hybrid seeds are produced through controlled _____ pollination.
3. The phenomenon of greater vigor in hybrid seeds is called _____.
4. OPV stands for Open-Pollinated _____.
5. GM seeds are developed using _____ techniques.

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Multiple Choice Questions

1. Which type of seed is commonly used in commercial agriculture?
   a) Wild seeds
   b) Hybrid seeds
   c) Forest seeds
   d) Organic waste seeds
2. Which crop is commonly cultivated using hybrid seeds?
   a) Maize
   b) Tea
   c) Coffee
   d) Rubber
3. Open-pollinated varieties are produced through:
   a) Artificial colouring
   b) Cloning
   c) Chemical treatment
   d) Natural pollination
4. Bt cotton is an example of:
   a) Certified seed
   b) OPV seed
   c) GM seed
   d) Wild seed
5. Certified seeds generally have better:
   a) Colour only
   b) Germination rates
   c) Packaging only
   d) Weight only

Descriptive Questions

1. Explain the importance of the seed industry in agriculture.
2. Write a short note on public sector seed companies.
3. Describe the characteristics of hybrid seeds, Explain the advantages of Open-Pollinated Varieties (OPV).

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Session 2: Importance of the Seed Industry

Seed

A **seed** is a mature ovule that contains a living embryo, stored food reserves, and a protective seed coat. It is the basic unit of plant reproduction and is used for raising the next generation of crops. In agriculture, a seed refers to any planting material that is capable of producing a new plant and is used for sowing purposes.

According to the Seed Act, a seed is a living, viable planting material intended for propagation and multiplication of crops.

Characteristics of a Good Seed

- High genetic purity
- High germination percentage
- Free from weed seeds and inert matter
- Free from diseases and insect damage
- Proper moisture content
- High vigor and viability

Components of a Seed

1. **Embryo** – The young plant that develops into a new plant.
2. **Endosperm/Cotyledons** – Store food for seed germination.
3. **Seed Coat** – Protects the seed from physical injury and pathogens.

Seed vs Grain

Although seeds and grains may appear similar, they differ significantly in purpose, quality, and handling.

Feature	Seed	Grain
Purpose	Used for planting and crop production	Used for food, feed, or processing
Genetic Purity	High genetic purity maintained	Purity is not essential
Germination	Must possess high germination capacity	Germination ability is not important
Quality Standards	Subjected to seed certification and testing	Generally not certified for planting
Treatment	Often treated with fungicides/insecticides	Usually not treated for planting purposes

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Production	Produced under controlled conditions	Produced mainly for consumption
Cost	More expensive due to quality assurance	Relatively cheaper

Importance of Seed

Seed is the most fundamental and essential input in agriculture. It serves as the carrier of the genetic potential of a crop variety and plays a vital role in determining crop productivity.

Importance of Quality Seed

1. **Carrier of Genetic Potential:** Quality seed contains the desirable genetic traits of a variety, such as high yield, disease resistance, drought tolerance, and superior quality characteristics.
2. **Increased Crop Yield:** The use of certified and high-quality seeds can increase crop yield by 15–25% or even more when combined with good agronomic practices.
3. **Better Germination and Establishment:** Good-quality seeds exhibit high germination rates and produce vigorous seedlings, leading to a uniform crop stand.
4. **Resistance to Pests and Diseases:** Seeds of improved varieties often possess resistance or tolerance to major pests and diseases, reducing crop losses.
5. **Efficient Use of Inputs:** Quality seeds make better use of fertilizers, irrigation water, and other agricultural inputs, resulting in higher productivity.
6. **Uniform Growth and Maturity:** A crop raised from quality seed shows uniform growth, flowering, and maturity, facilitating efficient crop management and harvesting.
7. **Higher Economic Returns:** Improved productivity and quality result in increased income and profitability for farmers.
8. **Foundation of Agricultural Development:** Seed is often called the "**carrier of technology**" because new agricultural technologies and genetic improvements are transferred to farmers through seed.

Variety

A **variety** is a group of cultivated plants within a species that possesses distinct, uniform, and stable characteristics and can be distinguished from other varieties of the same crop.

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The selection of an appropriate variety is one of the most important decisions in crop production because it directly influences yield, quality, adaptability, and profitability.

Importance of Crop Variety

1. **Higher Yield Potential:** Improved varieties are developed to produce higher yields compared to traditional varieties.
2. **Resistance to Pests and Diseases:** Many modern varieties possess genetic resistance to important pests and diseases, reducing dependence on pesticides.
3. **Adaptation to Different Environments:** Different varieties are developed for specific climatic conditions, soil types, and cropping systems.
4. **Improved Quality Traits:** Varieties may be selected for superior grain quality, nutritional value, fiber quality, oil content, taste, or processing characteristics.
5. **Tolerance to Abiotic Stresses:** Some varieties can tolerate drought, salinity, flooding, heat, or cold stress, ensuring stable production under adverse conditions.
6. **Early or Desired Maturity:** Varieties with different maturity periods help farmers fit crops into various cropping systems and avoid unfavorable weather conditions.
7. **Efficient Resource Utilization:** Improved varieties utilize water, nutrients, and sunlight more efficiently, leading to enhanced productivity.
8. **Increased Farmer Income:** Higher yields, better quality produce, and reduced production costs contribute to greater profitability.

Importance of the Seed Industry

The importance of the seed industry became particularly evident during the Green Revolution, which introduced improved seed varieties along with fertilizers, irrigation, and modern farming techniques. The adoption of high-yielding seeds led to remarkable increases in agricultural output and helped many countries achieve self-sufficiency in food production. Since then, the seed industry has become an essential component of agricultural modernization and rural development.

Modern seed industries operate through a systematic process that includes plant breeding, genetic improvement, seed multiplication, quality control, certification, packaging, and marketing. Seed testing and certification ensure that farmers receive pure, viable, and disease-free seeds that meet established quality standards. Government organizations and regulatory authorities also play a crucial role in monitoring seed quality, protecting farmers' interests, and promoting agricultural research.

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- **Enhancing Agricultural Productivity-** One of the most important contributions of the seed industry is the enhancement of agricultural productivity. High-quality seeds developed through scientific breeding programs possess superior genetic potential, which enables crops to produce higher yields compared to traditional varieties. Improved seeds contribute to efficient utilization of land, water, fertilizers, and other agricultural inputs, thereby increasing overall farm productivity.
- **Disease and Pest Resistance-** Crop losses caused by pests and diseases represent a major challenge to agricultural production across the world. The seed industry addresses this challenge by developing crop varieties with built-in resistance to harmful insects, pathogens, fungi, bacteria, and viruses. Disease-resistant and pest-resistant seeds help reduce crop damage, improve yield stability, and minimize dependence on chemical pesticides.
- **Climate Adaptability**- Climate change has emerged as one of the greatest threats to global agriculture. Rising temperatures, irregular rainfall patterns, droughts, floods, salinity, and extreme weather events increasingly affect crop production and food security. In this context, the seed industry plays a vital role in developing climate-resilient crop varieties capable of adapting to changing environmental conditions. Modern breeding programs focus on producing seeds with tolerance to drought, heat, cold, waterlogging, and salinity. These climate-adaptive seeds enable farmers to maintain agricultural productivity even under unfavorable conditions.
- **Improving Crop Quality and Yield-** The seed industry also contributes significantly to improving the quality and market value of agricultural produce. Modern seed varieties are developed not only for higher yields but also for enhanced nutritional content, appearance, taste, storage life, and processing characteristics. Higher yields combined with improved product quality increase profitability for farmers and fetch better price opportunities.

Role and Responsibilities of a Quality Seed Grower

A quality seed grower plays an essential role in the agricultural production system by producing seeds that meet prescribed standards of purity, germination, vigor, and health. Since seeds are the basic input for crop production, the quality of seeds directly affects agricultural productivity, crop performance, and food security. Quality seed growers act as a vital link between plant breeders, seed companies, certification agencies, and farmers by ensuring that improved crop varieties reach farmers in pure and viable form. The production of quality seeds requires scientific knowledge, technical skills, and strict adherence to seed certification standards. A quality seed grower has the following responsibilities:

- **Selection of Suitable Land-** The selection of appropriate land is one of the foremost responsibilities of a quality seed grower. The land selected for seed

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production should be fertile, well-drained, and free from volunteer plants, objectionable weeds, and serious soil-borne diseases. The field should possess a suitable cropping history in order to minimize the possibility of contamination and disease incidence.

- **Use of Approved Source Seed-** A quality seed grower must use approved and authenticated source seeds obtained from recognized agencies or institutions. Depending upon the class of seed being produced, breeder seed, foundation seed, or certified seed should be used as the source material.
- **Maintenance of Genetic Purity-** The maintenance of genetic purity is one of the most critical functions of a quality seed grower. Genetic purity ensures that the seed produced retains the original characteristics of the variety, including yield potential, maturity duration, resistance to pests and diseases, and quality traits.
- **Maintenance of Isolation Distance-** Isolation distance refers to the minimum prescribed distance maintained between the seed crop and other crops of the same species to prevent unwanted cross-pollination and contamination. The required isolation distance varies according to the pollination behavior of the crop and the class of seed being produced.
- **Roguing of Off-Type Plants-** Roguing is the process of identifying and removing undesirable plants that differ from the true characteristics of the variety being cultivated. A quality seed grower must regularly inspect the seed field and remove off-type plants, diseased plants, volunteer crops, and objectionable weeds at different stages of crop growth.
- **Adoption of Recommended Crop Management Practices-** A quality seed grower is required to adopt recommended agronomic and crop management practices to ensure optimum seed production. These practices include timely sowing, proper spacing, balanced fertilizer application, irrigation management, weed control, and suitable plant protection measures.
- **Pest and Disease Management-** Protection of the seed crop from pests and diseases is an essential responsibility of a quality seed grower. Seed-borne diseases and insect infestations may adversely affect seed viability, vigor, and marketability.
- **Proper Harvesting Practices-** Harvesting of the seed crop should be carried out at the appropriate stage of physiological maturity to ensure maximum seed viability and vigor. The grower must ensure that harvesting operations are conducted carefully to avoid mechanical injury, admixture, and contamination.
- **Seed Processing and Cleaning-** After harvesting, the seeds must undergo proper cleaning, grading, drying, and processing. The objective of seed

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processing is to remove inert matter, damaged seeds, weed seeds, and other impurities in order to improve physical purity and seed quality.

- **Safe Storage of Seeds-** A quality seed grower is responsible for storing seeds under suitable environmental conditions to preserve seed viability and vigor until distribution or marketing. The storage facility should be clean, dry, well-ventilated, and protected from insects, rodents, and excess moisture.
- **Maintenance of Records and Documentation-** Accurate record keeping is an important responsibility of a quality seed grower. The grower should maintain detailed records regarding source seed, field operations, fertilizer and pesticide applications, inspection reports, harvesting details, and storage conditions.

Employment opportunities of Quality Seed Grower

The seed industry has become an integral component of modern agriculture due to the increasing demand for high-quality seeds, improved crop varieties, and sustainable farming practices. Quality seed production requires scientific knowledge, technical expertise, and strict adherence to prescribed seed standards and certification procedures. Consequently, trained quality seed growers are provided with diverse employment opportunities in government organizations, private seed companies, research institutions, certification agencies, and agribusiness enterprises.

The various activities involved in seed production, processing, certification, storage, and marketing have led to the development of several specialized job roles within the seed industry. These roles contribute significantly to maintaining seed quality, enhancing agricultural productivity, and strengthening food security systems.

- **Seed Production Supervisor-** A Seed Production Supervisor is responsible for planning, organizing, and supervising seed production activities in accordance with prescribed standards and recommended agronomic practices. The supervisor monitors field operations, maintains genetic purity, ensures proper isolation distance, and oversees crop management practices throughout the seed production cycle. This role also involves coordinating with seed growers, certification agencies, and seed companies to ensure the successful production of quality seeds.
- **Field Inspection Officer-** A Field Inspection Officer is entrusted with the responsibility of conducting regular inspections of seed production fields to verify compliance with seed certification standards. The officer examines the seed crop for varietal purity, isolation distance, disease incidence, and the presence of off-type plants. Proper documentation and reporting of field observations form an important part of this role, which is essential for maintaining the quality and reliability of certified seeds.

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- **Seed Certification Assistant-** A Seed Certification Assistant supports the implementation of seed certification procedures by assisting certification officers during inspections, verification, and documentation processes. The assistant helps maintain records related to seed production and ensures that seed growers follow the prescribed certification standards and regulatory guidelines. This role contributes significantly to the effective functioning of the seed certification system.
- **Seed Processing Supervisor-** A Seed Processing Supervisor manages post-harvest seed processing operations such as cleaning, grading, drying, seed treatment, and packaging. The supervisor ensures that seeds are processed carefully to maintain physical purity, viability, and vigor. Proper supervision of processing equipment, hygiene standards, and moisture control measures is essential for preserving seed quality and improving market value.
- **Seed Storage Manager-** A Seed Storage Manager is responsible for maintaining appropriate storage conditions to preserve seed viability and vigor during storage periods. The manager supervises temperature and humidity conditions within storage facilities and ensures protection against insects, rodents, and fungal infestation. Proper stock management, packaging, and handling procedures are also important aspects of this role, which is essential for preventing seed deterioration.
- **Seed Analyst-** A Seed Analyst performs laboratory testing and evaluation of seed samples to determine quality parameters such as germination percentage, physical purity, moisture content, and seed health. The analyst conducts scientific tests according to prescribed standards and prepares analytical reports for quality assurance and certification purposes. This role is crucial for maintaining the reliability and quality of seeds distributed to farmers.
- **Agricultural Extension Officer-** An Agricultural Extension Officer provides technical guidance and educational support to farmers regarding scientific seed production and improved agricultural practices. The officer conducts training programs, demonstrations, and awareness campaigns to promote the adoption of improved crop varieties and modern farming technologies. This role helps bridge the gap between agricultural research institutions and farming communities.
- **Seed Marketing Officer -**A Seed Marketing Officer is responsible for promoting and distributing quality seeds to farmers and agricultural institutions. The officer provides technical information regarding seed varieties, crop suitability, and cultivation practices while managing dealer and distribution networks. Market analysis, farmer interaction, and promotional activities also form important aspects of this role, which contributes to the efficient distribution of quality seeds.

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- **Contract Seed Production Coordinator-** A Contract Seed Production Coordinator supervises seed production programs carried out through contractual arrangements between seed companies and farmers. The coordinator ensures that contract growers follow prescribed seed production standards and recommended agronomic practices. This role involves monitoring field operations, maintaining production records, and coordinating procurement and transportation activities for large-scale seed multiplication programs.

The responsibilities associated with quality seed production have created numerous specialized job roles within the seed industry and agricultural sector. These professional roles are essential for maintaining seed quality, ensuring successful certification, supporting agricultural productivity, and promoting sustainable farming practices. With the continuous growth of the seed industry and increasing adoption of improved agricultural technologies, employment opportunities for trained quality seed growers are expanding rapidly in both public and private sectors. These professionals play an important role in strengthening agricultural development, food security, and the overall progress of the agricultural economy.

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Activities

Activity : Demonstrate Different Types of Seeds and Seed Characteristics of Field Crops

Materials Required: Practical notebook, pencil, pen, different field crop seeds, observation sheet, etc.

Procedure:

- Collect different seeds of field crops for observation.
- Identify and write the names of seeds showing different seed structures.
- Observe and record the presence of cotyledons in different seeds (monocot and dicot seeds).
- Identify and write the role of the endosperm in seed development and nutrition.
- Observe and record the stages of seed germination in selected field crops.
- Study and write the meaning and importance of seed dormancy in field crops.
- Compare the characteristics of different seeds based on cotyledons, endosperm, germination, and dormancy.
- Record your observations in the practical notebook.

Check Your Progress

Fill in the Blanks

1. A seed is a mature _____ that contains a living embryo.

2. The young plant inside a seed is called the _____.
3. Good quality seed should have high _____ purity.
4. A _____ must possess distinct, uniform, and stable characteristics.
5. The process of removing undesirable plants from a seed field is called _____.

Multiple Choice Questions

1. Which component stores food for seed germination?
   a) Seed Coat
   b) Endosperm/Cotyledons
   c) Embryo
   d) Root
2. What is the main purpose of grain?
   a) Planting
   b) Crop production
   c) Food, feed, or processing
   d) Seed certification
3. Which characteristic is essential for a good seed?
   a) Low vigor
   b) High moisture content
   c) High germination percentage
   d) Presence of weeds
4. Quality seeds can increase crop yield by approximately:
   a) 1–5%
   b) 5–10%
   c) 50–60%x`
   d) 15–25%
5. Which factor helps varieties survive drought and salinity?
   a) Taste
   b) Abiotic stress tolerance
   c) Packaging
   d) Storage life
6. Which process ensures farmers receive pure and viable seeds?
   a) Marketing
   b) Packaging
   c) Seed testing and certification
   d) Transportation

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Match the Columns

Column A	**Column B**
A. Embryo	1. Protects the seed
B. Seed Coat	2. Young plant inside the seed
C. Seed Production Supervisor	3. Supervises seed production activities
D. Seed Storage Manager	4. Maintains seed viability during storage
E. Field Inspection Officer	5. Inspects seed fields

Descriptive Questions

1. Define seed and explain its components.
2. Differentiate between seed and grain.
3. Explain the importance of quality seed in agriculture.
4. Discuss the role and responsibilities of a quality seed grower.

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Module 2
Pre-Production Planning for Seed Production

Module Overview

The production of quality seeds is a fundamental requirement for successful agricultural development and sustainable crop production. Seed quality directly influences germination, crop establishment, productivity, resistance to pests and diseases, and overall agricultural performance. Therefore, scientific procurement, inspection, and storage practices are essential for maintaining seed purity, viability, and vigor throughout the seed production process.

Proper selection of fields, careful procurement of source seeds, systematic inspection procedures, and appropriate storage methods are important components of quality seed production. These practices help prevent contamination, maintain genetic purity, and ensure that seeds meet prescribed certification and quality standards.

This module introduces students to the essential pre-production activities required for successful seed production. It focuses on the procurement of quality inputs, proper inspection procedures, and effective storage practices to maintain seed quality and viability. In Session 1, students will learn about the methods and standards involved in procuring, inspecting, and storing seeds and related materials. Session 2 emphasizes field preparation techniques, including land selection, soil preparation, and field management practices necessary to create suitable conditions for seed production.

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Learning Outcomes

After completing this module, you will be able to:

- Explain the procedures and importance of procurement, inspection, and storage practices in seed production.
- Describe the methods for field preparation and quality seed production.

Module Structure

Session 1: Procurement, inspection, and storage practices

Session 2: Field Preparation for seed production

Session 1: Procurement, inspection, and storage practices

Criteria for Selecting a Field

The selection of a suitable field is the first and foremost step to ensure quality seed production. It is a decisive factor in maintaining the *genetic purity* (purity of seed and plant for the expression of a variety) , health and physical appearance of the seed crop. A well-chosen field sets the stage for successful cultivation and the attainment of prescribed seed standards.

Soil and site conditions: Seed production must be carried out on a field that is well-drained, uniformly leveled and composed of deep, fertile soil. Such conditions promote uniform germination and facilitate the healthy growth and development of plants. Poor drainage or uneven terrain can lead to patchy stands and compromised seed quality.

Cropping history of the field: The same crop or a different *variety* (A group of crop plants with uniform morphological traits, officially released and notified for cultivation) of the same crop should not have been grown in the previous season on the selected land (Table 1). The preceding crop requirement also helps to prevent the appearance of *volunteer plants* (unintended plants from shattered/leftover seeds of the previous year crop), which may compromise the genetic purity of the new seed crop.

Table 1 Cropping history of the field

Year	Crop	Variety	Recommendation
Last	Same	Same	May take seed production porgramme
		Other	Precautions has to be taken
	Other	-	May take seed production porgramme

To maintain genetic purity and prevent contamination from residual seeds or volunteer plants, a minimum interval of one to two years is recommended (Table 2) before initiating a seed production programme of the same crop but a different variety in the same field. This precautionary gap allows time for the natural degradation of shattered/leftover seeds to ensure the genetic purity of the variety sown for seed production; eliminate pathogens of the diseases carryover from the previous crop and restoration of soil health.

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Table 2 Minimum gap required for seed production programme of different varieties of the same crop in selected field

Gap	Crop
One season	Rice, wheat, pearl millet, sorghum, soybean, sesame and mustard
Two seasons	Groundnut, Egyptian clover

In a seed production programme for different variety of the same crop in a field previously used for the same crop residual seeds that may compromise genetic purity may be effectively achieved through a two-step field sanitation process:

Pre-sowing irrigation: The field is irrigated at least three weeks prior to sowing to encourage germination of leftover seeds of the previous crop, leading to the emergence of volunteer plants.

Post-emergence ploughing: after emergence of volunteer plants, the field is deeply ploughed to destroy them at initial stage before sowing of the seed crop. This practice ensures genetic purity and uniform germination of seed crop.

Soil Sampling and Soil Testing

Soil sampling and soil testing are important scientific practices in agriculture and seed production. The productivity and quality of a seed crop largely depend upon the fertility status and physical condition of the soil. Proper soil analysis helps determine nutrient availability, soil reaction, and the suitability of the field for crop cultivation. It also assists in identifying nutrient deficiencies, salinity, alkalinity, and other soil-related problems that may affect crop growth and seed quality.

Scientific soil sampling and testing enable farmers and seed growers to apply fertilizers and soil amendments in appropriate quantities, thereby improving crop productivity, maintaining soil health, and reducing unnecessary expenditure on fertilizers. These practices form an essential component of modern and sustainable agricultural systems.

Soil Sampling

Soil sampling refers to the process of collecting small quantities of soil from different portions of a field in a systematic manner to obtain a representative sample for laboratory analysis. Since soil properties may vary from one location to another within the same field, proper sampling is necessary to obtain accurate information regarding soil fertility and nutrient status. A representative soil sample reflects the actual condition of the field and provides reliable results for scientific crop and nutrient management practices.

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- **Selection of Sampling Area-** Before collecting soil samples, the field should be carefully examined and divided into uniform areas on the basis of soil type, crop history, slope, drainage conditions, and fertilizer application practices. Areas showing unusual conditions such as waterlogging, erosion, excessive weed growth, or poor crop performance should be sampled separately. Proper division of the field helps in obtaining accurate and representative soil samples for laboratory analysis.
- **Collection of Soil Samples -** Soil samples are generally collected from several locations within the field following a zigzag pattern to ensure uniform representation of the entire area. Before sampling, surface litter, plant residues, stones, and weeds should be removed from the soil surface. A spade, auger, or soil sampling tube may be used for collecting soil samples. Uniform sampling procedures help improve the reliability of soil test results.
- **Depth of Soil Sampling -**The depth of soil sampling depends upon the crop and purpose of analysis. For most field crops, soil samples are collected from a depth of approximately 15 to 20 centimeters. In the case of deep-rooted crops, samples may also be collected from deeper soil layers. Maintaining uniform sampling depth throughout the field is important for obtaining consistent and accurate results.
- **Preparation of Composite Sample-** After collecting soil from locations, the samples are thoroughly mixed in a clean container to prepare a composite sample. The soil is then spread uniformly on a clean surface and divided into four equal parts. Two opposite portions are rejected, while the remaining two portions are mixed again. This process of dividing and rejecting portions is repeated several times until the required quantity of soil sample is obtained for laboratory analysis. This method, commonly known as the quartering method, helps obtain a representative soil sample while reducing excess quantity. The final sample should be properly labeled with details such as field location, date of sampling, crop information, and name of the farmer or grower.

Soil Testing

Soil testing is the scientific analysis of soil samples in a laboratory to determine the physical, chemical, and biological properties of the soil. It helps evaluate nutrient availability and identify soil-related problems that affect crop growth and seed production. The information obtained through soil testing forms the basis for scientific nutrient management and soil improvement practices.

Soil samples are sent to nearby Krishi Vigyan Kendras (KVKs) or agricultural institutes for testing. Students can also perform soil testing themselves using a mobile soil testing kit. After testing, the recommended dose of nutrients and fertilizers should be incorporated and followed properly.

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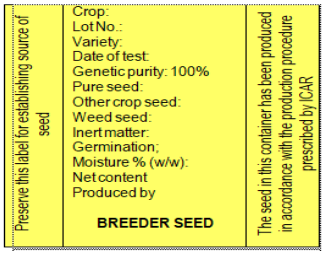
Different Classes of Seed

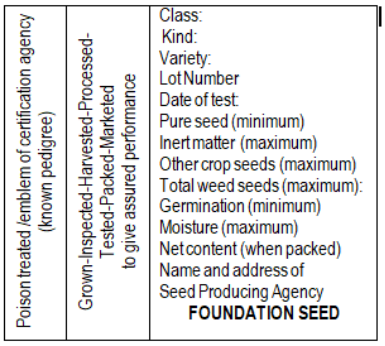
Seed production follows a well-defined hierarchy to ensure purity, quality and traceability. Each class of seed plays a vital role in the multiplication process, beginning with the most genetic pure form to the certified seed used by farmers.

1. **Nucleus Seed:** Nucleus seed represents the highest level of genetic and physical purity**,** developed and maintained by the *plant breeder* (a person specialized in developing new crop varieties through breeding techniques) who originally evolved the *variety*. This seed is preserved by the *research institute* (an organization dedicated to scientific studies in agriculture to develop new technologies, crop varieties and sustainable practices) responsible for the development of the variety. It serves as the foundational material and is supplied to authorized agencies on demand to initiate the seed multiplication chain.

2. **Breeder Seed:** Breeder seed is produced by sowing of Nucleus seed under the direct supervision of the plant breeder and a designated *monitoring committee* (an officially notified committee to observe and evaluate breeder seed production programme) to ensure compliance of seed certification norms/ standards. It retains the genetic and physical purity and seed quality required for the next stage of multiplication. Upon successful production, the seed is issued a **golden yellow certificate** (No. 356; IS 5-1978) by the producing agency, signifying its authenticity and quality.



3. **Foundation Seed:** Foundation seed is produced by sowing of Breeder seed through recognized seed-producing agencies in both public and private sectors. Its production is strictly supervised by the *Seed Certification Agency* (A national or state-level official body authorized to certify seeds), ensuring adherence to the *Indian Seed Certification Standards (*a comprehensive framework established by the Government of India to ensure the quality of seed supplied to farmers enforced through both field inspections and laboratory testing) as mandated under the Seeds Act, 1966 and its associated rules. A **white-coloured certificate** is issued for this class. Foundation seed is procured by *Seed Corporations* (National or state-level government organizations, or private entities, engaged in the production, processing and distribution of seeds) for production of Certified seed.



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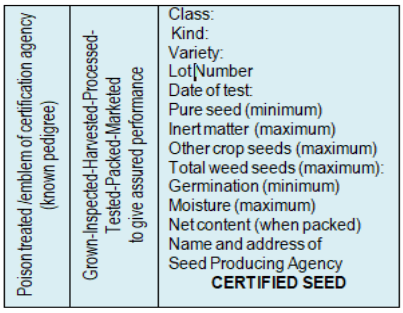
4. **Certified Seed:** Certified seed is the final product in the seed chain, produced by sowing of Foundation seed by registered seed growers. Its production is monitored by the Seed Certification Agency which ensures that the produced seed meets the prescribed Indian Seed Certification Standards. Upon verification, the agency issues a blue-coloured certificate (Shade ISI No. 104, Azure Blue), authorizing its distribution to farmers for commercial cultivation.



Source of Seed Procurement

In the process of seed certification, verifying the authenticity of the seed source is a crucial step conducted at the field level. The Seed Certification Inspector is responsible for confirming that the seed used for sowing originates from a recognized and approved class such as Breeder, Foundation, or Certified seed from the authentic source. To facilitate this verification, the seed grower must maintain and present proper documentation related to the seed purchase. These records typically include:

- Purchase receipts or invoices
- Seed tags or labels indicating class and lot number
- Certification documents issued by the producing agency
- Any other relevant papers confirming the origin and quality of the seed
- Container in which seed was purchased with related information

Such documentation must be preserved carefully and made available upon inspection, as outlined in Table 3. This practice ensures transparency, traceability, and compliance with the Indian Seed Certification Standards, thereby safeguarding the integrity of the seed production programme.

Table 3 Verification of the seed used for sowing purpose

Factors	**Class of seed used for sowing propose**		
	Breeder	**Foundation**	**Certified**
Source	Seed Corporation	Seed Corporation	Seed Corporation
Certificate	Breeder	Foundation	Certified
Colour of certificate	Yellow(No.356)	White	Azure blue (No.104)
Tag	Breeder	Foundation	Certified

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Seal	University/institute	Certification Agency	Certification Agency
Information on container	Breeder	Foundation	Certified
Purchase receipt	Seed Corporation	Seed Corporation	Seed Corporation

Precautions for storage of procured seed

To ensure optimal germination and safeguard the quality of seeds intended for sowing, the following precautions must be diligently observed

- **Verification prior to storage:** This ensures authenticity and viability. Each container of the fresh seed procured for sowing should be clearly labeled with the name of the crop, variety, date of purchase, and expiry date to ensure proper identification and timely usage. User must carefully examine the name of the variety, certification authority and the date of expiry or "best before" usage.
- **Dry and hygienic storage conditions:** Seed should be stored in a clean, dry and well-ventilated cool environment ideally below 25°C, protected from moisture and humidity to preserve their viability. Exposure to direct sunlight or fluctuating temperature shall be avoided.
- **Avoid contamination:** Under no circumstances the procured seed should be mixed with food grains or old seed stock. Such mixing may lead to deterioration, pest infestation, or loss of varietal purity apart from health hazard.
- **Placement of seed bags:** Seed bags shall be stored on wooden planks, elevated from the floor and positioned away from walls to prevent moisture absorption and pest infestation. A single heap must not exceed five bags stacked vertically. For long-term storage, the position of bags within the heap should be periodically rotated to avoid compaction and maintain aeration.
- **Restricted access:** Seed must be stored securely, out of reach of children, to prevent accidental misuse or damage.
- **Gentle and responsible handling:** Seed must be handled with utmost care to prevent physical damage. Activities such as dropping bags from height, sitting on containers, or walking over them are strictly prohibited. Rough handling can damage seed structure, reduce germination and adversely affect field performance.
- **Management of storage pests:** Effective precautions viz., sealing entry points, using pest-proof containers, maintaining cleanliness, application of pesticides must be taken to prevent the entry of insects, rodent and other pests into the store.

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- **Avoid exposure to agro-chemicals:** Seed shall never be stored alongside fertilizers, pesticides, or any agro-chemical substances that emit fumes or vapors. Such exposure can compromise seed viability and deteriorate seed health.
- **Periodic inspection and monitoring:** Stored seed shall be inspected at regular intervals for signs of moisture accumulation, fungal growth or pest infestation. If any container is found to be infested, it must be promptly discarded to prevent contamination of healthy stock.
- **Adopt principle of rotation:** For sowing purpose, older seed lots should be utilized first, following the First-In-First-Out method. This ensures that seeds are sown within their viability period and helps minimize wastage.
- **Storage of self-produced seed for future sowing:** To ensure viability and purity of seed retained from the previous harvest for use in the next cropping season, the portion of produce earmarked for seed use shall be thoroughly cleaned, properly dried to safe moisture levels and treated with recommended seed protectant before storage. It must be stored separately and securely, away from food grains intended for consumption, to prevent contamination and preserve its sowing quality.
- **Assessment of last season's seed stock:** Crop produced in the previous year and has to be used as seed in the current year shall be tested for germination after three months of storage and prior to sowing to ensure uniform field emergence and optimum plant population. Based on the test results, appropriate decisions shall be taken either to enhance the seed rate to compensate the reduced germination or to replace the seed lot if germination falls below acceptable standards.
- **Change of Seed:** When self-produced seed is used for sowing, it is essential to renew the seed stock of a variety at least once every three years to ensure consistent field performance. Whereas, in the case of hybrids, (first generation seed formed by hybridization) fresh hybrid seed must be purchased every year, as saved hybrid seed does not retain its original genetic characteristics and may result in poor crop uniformity (the consistency in the expression of morphological traits) and reduced yield.

Seed inspections and standards

Seed inspection and seed standards are essential components of seed technology and quality seed production. They ensure that farmers receive high-quality seeds with good genetic purity, physical purity, and germination capacity. Proper seed inspection and adherence to seed standards help in maintaining the quality of seeds from production to marketing, ultimately leading to higher crop yield and agricultural sustainability.

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Seed Inspection

Seed inspection is the systematic examination of seed crops, seed processing units, storage facilities, and seed lots to ensure that the seeds produced conform to the prescribed standards. Seed inspections are carried out by trained and authorized seed inspectors or certification officers at different stages of seed production and handling. The main objective of seed inspection is to maintain the genetic identity and purity of the seed variety and to prevent contamination by other varieties, weeds, or diseased plants.

Objectives of Seed Inspection

1. To maintain genetic purity and varietal identity of seeds.
2. To ensure the production of high-quality seeds.
3. To check the presence of diseases, insect pests, and weed seeds.
4. To verify whether recommended agronomic practices are being followed.
5. To ensure compliance with seed certification standards.
6. To provide quality seeds to farmers for better crop production.

Types of Seed Inspection

1. Field Inspection: Field inspection is conducted during the crop growth period. Seed inspectors visit the seed production field at different growth stages to check the crop condition and purity. Important observations during field inspection include:

- Verification of seed source and variety.
- Maintenance of proper isolation distance.
- Presence of off-type plants.
- Occurrence of diseases and insect pests.
- Weed infestation in the field.
- General crop condition and management practices.
- Rouging operations carried out by farmers.

2. Seed Processing Inspection: After harvesting, seeds are processed to remove inert matter, damaged seeds, weed seeds, and other impurities. Inspectors check whether the processing equipment is clean and functioning properly to avoid mechanical mixtures and contamination.

3. Storage Inspection: Proper storage conditions are necessary to maintain seed viability and vigor. During storage inspection, the following points are examined:

- Moisture content of seeds.
- Temperature and humidity of the storage area.

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- Cleanliness of storage structures.
- Protection against insects, rodents, and fungi.
- Proper labeling and stacking of seed bags.

4. Seed Sampling and Laboratory Inspection: Representative seed samples are collected and sent to seed testing laboratories. The laboratory tests help determine the quality of seeds according to prescribed standards.

Seed Testing Parameters: The following tests are commonly conducted in seed testing laboratories:

1. **Physical Purity Test:** This test determines the percentage of pure seeds, inert matter, weed seeds, and other crop seeds present in a seed lot.
2. **Germination Test:** The germination test measures the percentage of seeds capable of producing healthy seedlings under favorable conditions.
3. **Moisture Test:** Moisture content affects seed storage life and viability. Excess moisture can lead to fungal growth and deterioration of seeds.
4. **Seed Health Test:** This test identifies the presence of seed-borne diseases and pathogens.
5. **Genetic Purity Test:** Genetic purity testing ensures that the seed belongs to the claimed variety without contamination from other varieties.

Seed Standards of Genetic Purity

(a) Minimum Standards for Genetic Purity

All certified seed lots shall conform to the following Minimum Standards for genetic purity unless otherwise prescribed:

Class	**Minimum Genetic Purity (%)**
Foundation Seed	99.00
Certified Seed	
• Varieties, composites, synthetics & multilines	98.00
• Hybrids	95.00
• Hybrids of cotton, TPS, muskmelon, brinjal & tomato	90.00

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(b) Grow-out Test

The Certification Agency shall conduct a grow-out test to determine the genetic purity of a seed lot whenever it is required for the grant of a certificate or whenever doubt arises regarding the genetic purity of the seed. The grow-out test may also be supplemented with related laboratory tests. Samples for the grow-out test shall be drawn simultaneously with samples for other quality tests, and standard procedures shall be followed. During the test, recommended agronomic and cultural practices for individual crops shall be adopted for both the unknown sample and the control sample. Since cultivar identification is based on hereditary plant characteristics, crops should be grown under favourable conditions to ensure that genetic differences are clearly expressed.

In self-fertilizing species, individuals of a cultivar are generally identical, making purity determination easier, whereas cross-fertilizing species may contain several genetic types, requiring comparison with standard samples. Therefore, samples of the same cultivar should be sown in succession, with standard samples planted at suitable intervals. The test crop may be raised along with the control in recommended areas or off-season nurseries. Authentic control samples obtained from the originating breeder or breeding institute shall be maintained by the testing agency using standard procedures, and at least 200 plants from the control sample shall be grown along with the test crop. After testing, the percentage of other cultivars, species, or aberrant plants present may be calculated up to the first decimal place.

Storage of procured seeds

Storage of procured seeds is one of the most important operations in seed technology and seed management. After seeds are procured from farmers, seed producers, or seed agencies, they must be stored properly to maintain their viability, vigor, germination capacity, and genetic purity until they are distributed or planted. Improper storage conditions may lead to loss of seed quality due to high moisture, temperature fluctuations, insect attack, fungal growth, and rodent damage. Therefore, scientific seed storage practices are essential for preserving seed quality and ensuring successful crop production.

Importance of Proper Seed Storage

Proper storage of procured seeds is necessary because seeds are living organisms that continue metabolic activities even during storage. Poor storage conditions accelerate seed aging and deterioration. Effective storage helps in:

- Maintaining high germination percentage.
- Preserving seed vigor and viability.
- Preventing quantitative and qualitative losses.
- Protecting seeds from environmental damage.

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- Ensuring healthy crop establishment in the field.

Factors Affecting Seed Storage

Several environmental and biological factors influence the storage life of seeds. These factors must be carefully controlled for successful storage.

1. **Moisture Content of Seeds-** Moisture is the most critical factor affecting seed storage. High moisture content increases respiration, fungal growth, and insect infestation, resulting in rapid seed deterioration. Seeds should be dried to safe moisture levels before storage. Generally, seeds are stored safely at moisture contents between 8–12%, depending on the crop.
2. **Temperature -** High temperatures increase seed respiration and aging. Low temperatures help maintain seed viability for a longer time. For long-term storage, cool and dry conditions are preferred.
3. **Relative Humidity-** High relative humidity causes seeds to absorb moisture from the atmosphere, which reduces storage life. Therefore, seed stores should maintain low humidity conditions.
4. **Seed Quality-** Only healthy, mature, and properly processed seeds should be stored. Damaged or immature seeds deteriorate rapidly during storage.
5. **Insects and Rodents-** Storage pests such as beetles, weevils, moths, rats, and mice cause severe damage to seeds during storage. Proper pest management practices are essential.
6. **Storage Containers-** The type of storage container influences seed longevity. Moisture-proof and airtight containers are preferred for long-term seed storage.

Activities

Activity 1: Demonstrate Preparation of Soil Sample

Materials Required: Practical notebook, pencil, pen, soil auger/spade, bucket, polythene bag, labels, etc.

Procedure:

Write the following information:

- Visit a field and select representative spots for soil sampling.
- Collect soil samples from different locations and depths using a spade or soil auger.
- Remove stones, plant residues, and other unwanted materials from the samples.
- Mix all the collected soil thoroughly to prepare a composite soil sample.
- Dry the soil sample in shade and pack it in a clean, labeled bag.

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- Write the importance of soil sampling and its use in soil testing.
- Record the precautions to be followed during soil sample collection and preparation.

Activity 2: Identification of Classes/Source of Seed

Materials Required: Practical notebook, pencil, pen, seed samples, seed tags/labels, observation sheet, etc.

Procedure:

Write the following information:

- Collect and observe different seed samples and their tags/labels.
- Identify and write the different classes of seeds.
- Write the names of seed classes such as Nucleus Seed, Breeder Seed, Foundation Seed, Certified Seed, and Truthfully Labelled Seed.
- Observe and record the tag color associated with each class of seed.
- Write the characteristics and importance of each seed class.
- Identify the source from which each class of seed is produced and distributed.
- Record your observations in the practical notebook.

Activity 3: Demonstrate Precautions for Storage of Seed

Materials Required: Practical notebook, pencil, pen, seed samples, storage containers/bags, observation sheet, etc.

Procedure:

Write the following information:

- Observe the different methods and containers used for seed storage.
- Write the ideal conditions required for safe seed storage (temperature, moisture, and ventilation).
- Record the precautions taken to protect seeds from insects, pests, rodents, and diseases.
- Note the importance of using clean, dry, and properly labeled storage containers.
- Write the methods used to maintain seed quality and viability during storage.
- Observe and record the practices followed for regular inspection and monitoring of stored seeds.

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- List the important precautions to be followed for long-term storage of seeds.

Check Your Progress

Fill in the Blanks

1. Unintended plants arising from leftover seeds are called _____ plants.
2. Soil samples are generally collected in a _____ pattern.
3. The process of dividing and reducing a soil sample is called the _____ method.
4. _____ seed is maintained by the plant breeder.
5. Foundation seed is produced by sowing _____ seed.
6. Certified seed is issued a _____ coloured certificate.

Multiple Choice Questions

1. Which soil condition is most suitable for seed production?
   a) Waterlogged soil
   b) Saline soil
   c) Well-drained fertile soil
   d) Rocky soil
2. Why is cropping history important in seed production?
   a) To increase irrigation
   b) To prevent volunteer plants
   c) To reduce labor
   d) To increase storage
3. Soil samples for most field crops are collected from a depth of:
   a) 15–20 cm
   b) 10–12 cm
   c) 5–10 cm
   d) 25–30 cm
4. Which class of seed has the highest genetic purity?
   a) Certified Seed
   b) Foundation Seed
   c) Breeder Seed
   d) Nucleus Seed

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5. What is the colour of the Breeder Seed certificate?
   a) White
   b) Blue
   c) Golden Yellow
   d) Green
6. Which test determines the percentage of seeds capable of producing healthy seedlings?
   a) Moisture Test
   b) Germination Test
   c) Seed Health Test
   d) Genetic Purity Test
7. What is the minimum genetic purity standard for Foundation Seed?
   a) 90%
   b) 95%
   c) 98%
   d) 99%

Match the Columns

Column A	**Column B**
A. Nucleus Seed	1. Blue certificate
B. Breeder Seed	2. Highest genetic purity
C. Foundation Seed	3. Produced from breeder seed
D. Certified Seed	4. Produced under supervision of plant breeder
E. Soil Sampling	5. Representative sample for laboratory analysis

Descriptive Questions

1. Explain the criteria for selecting a field for seed production.
2. Describe the steps involved in soil sampling.
3. Write a short note on different classes of seed.
4. Explain the importance of proper storage of procured seeds.

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Session 2: Field Preparation for seed production

The field preparation is playing a vital role in seed production. Proper field preparation and the adoption of recommended package of practices are crucial for optimum seed yield and avoid contamination of seed.

Field Preparation for seed production

Field preparation involves tillage in order to provide a favorable soil environment for the crop establishment and proper plant growth. A well-prepared field further helps in weed control and provides congenial condition for direct seeding and for transplanting where necessary. Field preparation involves ploughing, harrowing and leveling of field. Traditionally, draft animals were used to operate harrows; however, today, in an era of mechanization, tractor operated implements are used for land preparation.

With introduction of modern technology in agriculture, innovative development of various machines and tools makes oilseed cultivation easier and more profitable than in past. Shortage of labour force and high labour wages increases the cost of cultivation. Secondly, labour is often not available at the time they are most required. This results in loss of yield and income to the cultivator. These factors motivate the farmer to switch towards mechanized farming. By itself, mechanized farming has several advantages, like it completes tasks in less time, saves labour cost, ease of operations and ease of availability when needed.

Ploughing

Ploughing is a primary and important tillage operation. Timely ploughing is very important to achieve timeliness in all subsequent field operations. It is done soon after a rain and/or after a normal irrigation. During kharif season, early ploughing helps in moisture retention and controls weeds. The crops weed biomass thus incorporated into soil gets converted into manure that may actually improve soil health.

Advantage of Ploughing

- Proper seed germination, crop establishment, good penetration and contact of roots with the soil.
- Enhance soil fertility by incorporating crop residues, stubbles and root in to soil.
- Uproot, cut and destroy weeds
- Create conducive soil conditions for soil aeration.
- Helps in destroying the insect, harmful pathogens.

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Harrowing

It is a secondary tillage operation performed after the ploughing. In this, soil is tilled at a shallow depth with the help of harrows which smoothen and pulverizes soil by breaking large clods (lumps of soil) into smaller fine soil structures suitable for seed sowing. Harrowing also helps mixing of farmyard manure and compost in the soil and also in cutting up weeds in the field,

Land leveling

Leveling helps to modify existing undulations of land for efficient agricultural production system and to provide adequate slope to a cropped area for surface irrigation coupled with unrestricted drainage.

Purpose of Leveling

- Efficient application of irrigation water.
- Enhancing the conservation of rain water.
- Minimizing soil erosion.
- Encouraging the efficient mechanization.

Tools, equipment, and PPE used in field preparation

There are some important tools and equipment which are used during field preparation and sowing.

1. **Mouldboard plough:** Mouldboard plough consist of carbon steel or steel alloy in a concave curved structure to cut and turn the soil upside down. This plough is prepared on right angle triangle base. The size of mould board plough is measured by the width of the furrow that is opened by the plough. Generally, it can open a furrow of about 20 cm. Tractor driven mould board ploughs can cut bigger slices and can be outfitted with more than one mould board plough at a time depending ipon soil types & tractor power.

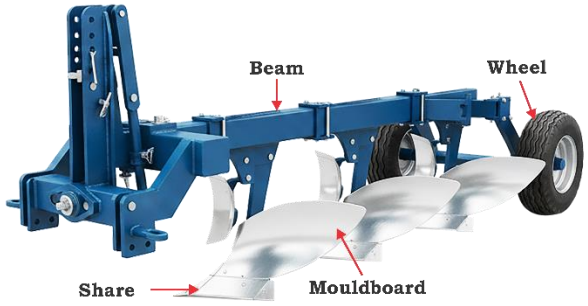

Fig. 2.1: Mouldboard plough

2. **Disc plough:** It consists of the moving circular edged steel discs of varying sizes (by its diameter and thickness). Discs in different ploughs used are 50-90 cm in diameter. Discs cut, turn and break furrow slices. It can work well

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in sticky soil as well as in too hard and dry soil. It is much heavier and leaves soil in rough and cloddy conditions.

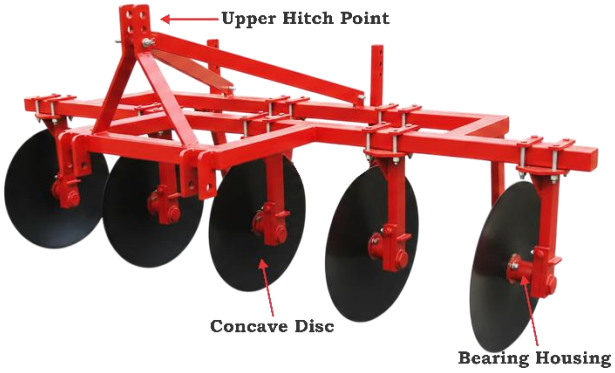

Fig. 2.2: Disc plough

3. **Rotavator:** It consists of moving blades on triangular base. It is a tractor drawn implement. As the tractor moves forward, the rotavator spins its many tines to pulverize any packed soil and remove large obstructions. It is used for preparing fine tilth and incorporation of crop residues and weeds into the soil. This is a heavy-duty version of cultivators with a deeper and stronger operation power.

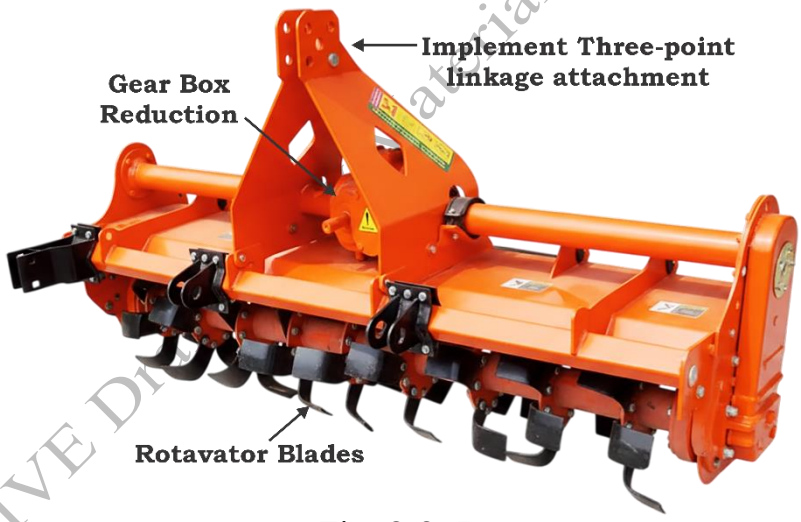

Fig. 2.3: Rotavator

4. **Cultivator**: They are used to stir and loosen the soil, breaking the clods and destroying the weeds in surface soil (15-18 cm). Cultivator performs the intermediary ploughing and harrowing. It also maintains the good tilth on soil surface, adequate aeration, prevent surface run off, and evaporation losses. Cultivators may be shovel, disc and blade types. DuTines and spike cultivators are used to prepare tilth on soils

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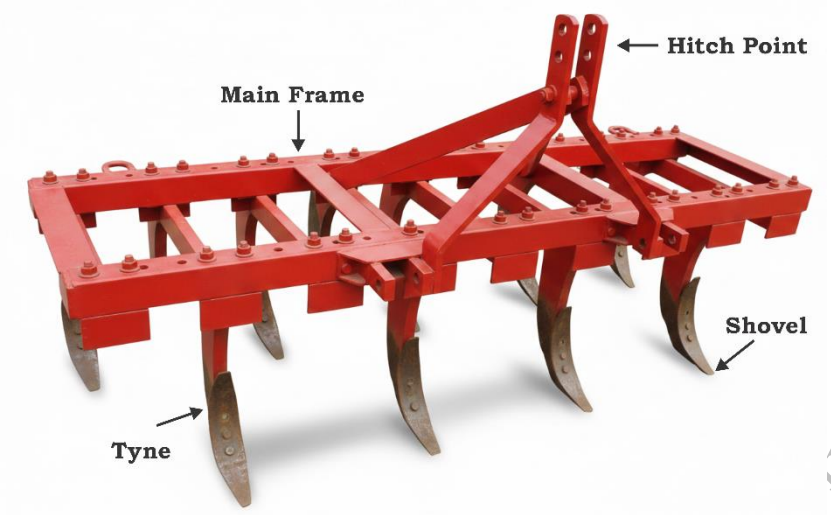

Fig. 2.4: Cultivator

5. **Harrows**: These are used for preparation of finer soil by breaking clod, cutting weeds, pulverising the soil surface during field preparation, called harrowing. The harrows may be disc, spike, spring or blade types.

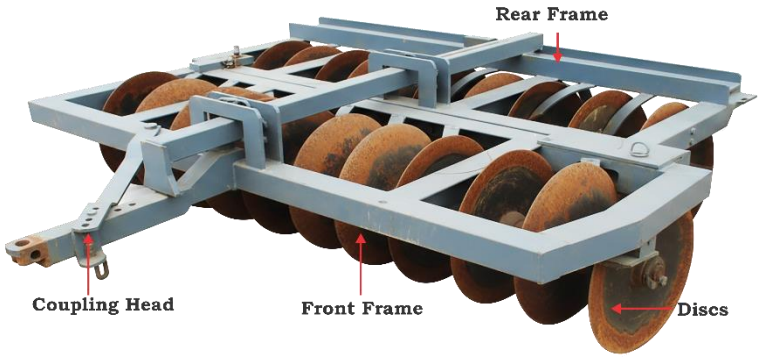

Fig. 2.5: Disc Harrows

6. **Plank**: It is a heavy wooden log, generally used for compacting and leveling used for seed-bed and field preparation for sowing the seeds. Planks are also used immediately after sowing the seeds, to ensure proper coverage of seeds with soil.

7. **Seed cum Fertilizer drill:** It is a line sowing equipment used for direct sowing of oilseed and application of fertilizer simultaneously. It requires 30 – 45 hp tractors to operate depending upon soil types. Important features are

   i. Adjustment of seed rate and fertilizer rate

   ii. Seed and fertilizer is placed at right soil depth

   iii. It helps to provide band placement of fertilizer (at a specified distance from seed) if necessary.

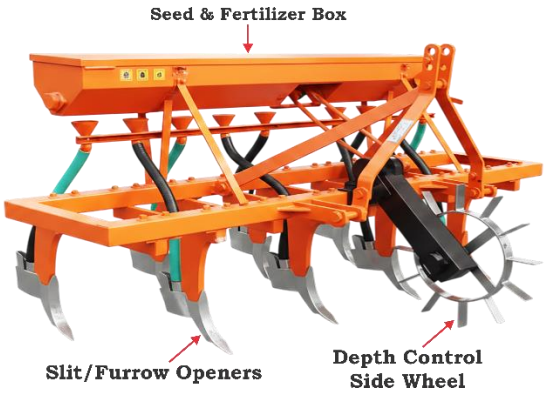

Fig. 2.6: Seed-cum-fertiliser drill

8. **Bund maker:** It is used to divide large cultivated field in to small leveled plots so that interculture operations and irrigations can be managed properly. It is very useful in field bunding to capture *in situ* conservation of rain water and not allowing excess water to run off from the field. Field bunds are often required for piecemeal irrigation. Slopy lands may require bunding for contour making this is required in all such situations.

Inputs Required for Seed Production

Seed production is a specialized agricultural activity aimed at producing high-quality seeds with high genetic purity, physical purity, and germination capacity. Successful seed production requires various inputs, including quality planting material, suitable land, fertilizers, irrigation facilities, plant protection measures, labor, and proper storage facilities. The availability and efficient use of these inputs ensure the production of healthy and certified seeds.

1. **Quality Source Seed :** The most important input in seed production is the use of genetically pure source seed. Depending on the class of seed being produced, Breeder Seed, Foundation Seed, or Certified Seed is used as the starting material. The source seed should be obtained from authorized agencies and must possess high genetic purity and germination percentage.
2. **Suitable Land:** The field selected for seed production should be fertile, well-drained, and free from volunteer plants and objectionable weeds. The field should have a known cropping history and should meet the isolation requirements prescribed for the crop. Proper land selection helps maintain seed quality and reduces the risk of contamination.
3. **Fertilizers and Manures:** Adequate nutrients are essential for vigorous plant growth and high seed yield. Organic manures such as farmyard manure (FYM), compost, and green manure improve soil fertility and structure. Chemical fertilizers containing nitrogen, phosphorus, and potassium should be applied according to the crop recommendation to ensure optimum seed development.
4. **Irrigation Facilities :** An assured source of irrigation is necessary for successful seed production. Water is required during critical growth stages

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such as germination, flowering, and seed formation. Proper irrigation management helps achieve uniform crop growth and improves seed quality.

5. **Plant Protection Chemicals:** Seed crops must be protected from pests, diseases, and weeds to maintain seed health and quality. Inputs such as insecticides, fungicides, herbicides, and biocontrol agents are used as required. Healthy crops produce seeds with better germination and vigor.
6. **Isolation Facilities:** Maintaining the recommended isolation distance is essential to prevent contamination through cross-pollination or mechanical mixtures. Isolation may be achieved through space isolation, time isolation, or physical barriers depending on the crop and production system.
7. **Farm Implements and Machinery:** Various agricultural implements and machinery are required for field preparation, sowing, intercultural operations, harvesting, threshing, cleaning, grading, and seed processing. The use of appropriate machinery improves efficiency and reduces seed damage.
8. **Skilled Labour:**Seed production requires trained and skilled labor for specialized operations such as rouging, emasculation, pollination, bagging, harvesting, and processing. Skilled labor ensures that seed production standards are properly maintained.
9. **Seed Processing Equipment:** After harvesting, seeds must be cleaned, dried, graded, and treated before storage. Seed processing equipment such as cleaners, graders, seed treaters, and drying units help improve physical purity and seed quality.
10. **Storage Facilities:** Proper storage facilities are necessary to maintain seed viability and vigor until distribution. Seeds should be stored in clean, dry, and well-ventilated godowns under suitable temperature and humidity conditions. Appropriate packaging materials should be used to protect seeds from moisture, insects, and rodents.
11. **Seed Testing Facilities** Seed testing is essential to evaluate seed quality parameters such as germination percentage, moisture content, physical purity, genetic purity, and seed health. Regular testing ensures that the produced seeds meet certification standards.

Isolation Distance for seed production

Isolation distance is the minimum distance maintained between a seed crop and other varieties or related crops grown in nearby fields to ensure the production of genetically pure seeds. It is one of the most important requirements in seed production because it prevents contamination through unwanted cross-pollination.

The required isolation distance depends on several factors, including the pollination behavior of the crop, the type of pollinating agents (such as wind or insects), the distance pollen can travel, the flowering period of the crop, and

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whether the seed crop is a variety or a hybrid. Cross-pollinated crops generally require greater isolation distances than self-pollinated crops because they have a higher chance of receiving foreign pollen.

Maintaining the prescribed isolation distance helps to:

- Preserve the genetic purity of the seed.
- Prevent contamination from other varieties or species.
- Ensure uniformity in crop characteristics.
- Produce high-quality seeds that meet certification standards.

Two methods of isolation are commonly practiced in seed production:

1. **Space Isolation:** Space isolation refers to maintaining a specific physical distance between the seed crop and other crops of the same species or related species. The required distance varies according to the crop and its mode of pollination.
2. **Time Isolation:** Time isolation involves adjusting the sowing dates so that the flowering period of the seed crop does not coincide with that of nearby crops. This prevents the transfer of pollen between crops even when they are grown close to each other.

Isolation Distance for Major Crops

S. No.	Crop	Pollination Type	Isolation Distance (m)
1	Paddy (Rice)	Self-pollinated	3
2	Wheat	Self-pollinated	3
3	Ragi (Finger Millet)	Self-pollinated	3
4	Groundnut	Self-pollinated	3
5	Blackgram and Greengram	Self-pollinated	10
6	Maize	Cross-pollinated	400
7	Pearl Millet (Bajra) Hybrid	Cross-pollinated	1000
8	Sunflower	Cross-pollinated	400

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9	Redgram (Pigeon Pea)	Often Cross-pollinated (up to 50%)	200
10	Sesame	Often Cross-pollinated (up to 50%)	100

Bagging Technique

Bagging is a mechanical method of isolation used in seed production and plant breeding to prevent unwanted pollination by insects, wind, or other external agents. In this technique, the floral parts of a plant are covered with suitable materials before the flowers open. The covering acts as a barrier and prevents foreign pollen from reaching the stigma.

Materials commonly used for bagging include paper bags, butter paper bags, mosquito nets, muslin cloth, nylon stockings, and polythene bags with ventilation holes. The bag is carefully placed over the flower or inflorescence and securely tied around the stem. A cotton plug may be used at the opening to prevent the entry of insects while allowing proper air circulation.

Fig. 2.7: Bagging in Maize

Objectives of Bagging

- To prevent unwanted cross-pollination.
- To maintain genetic purity during seed production.
- To facilitate controlled pollination in plant breeding programmes.
- To ensure accurate hybridization and selection work.

Advantages of Bagging

- Provides effective mechanical isolation.

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- Maintains the purity of breeding materials.
- Suitable for controlled pollination studies.
- Easy to implement on individual plants or flowers.

Limitations of Bagging

- Labor-intensive and time-consuming.
- Not practical for large-scale seed production.
- May affect normal pollination if not properly managed.

Example

Bagging is commonly practiced in crops such as **Tomato, Brinjal, Chilli, Cotton, and various ornamental plants**, where controlled pollination or maintenance of genetic purity is required.

Isolation distance and bagging are essential techniques used in seed production to prevent genetic contamination and maintain the purity and quality of seeds. While isolation distance is suitable for large-scale seed production, bagging is particularly useful for small-scale seed production and plant breeding experiments.

Activities

Activity 1: Identify tools and implements used for field preparation

Materials Required: Practical note book, pencil, pen, implements, *etc.*

Procedure: Write following information

- Identify different types of tools and implement
- Write the name of the tools and implements
- Use of tools and implements
- Draw a diagram, and show different parts of tools and implements

Activity 2: Demonstration of field preparation for seed production

Materials Required

Plough, harrow, leveller or plank, field area, etc.

Procedure:

1. Visit nearby field for demonstration.
2. Observe the condition of the soil before preparation.
3. Collect different implements used for field preparation.
4. Demonstrate ploughing and explain how it loosens and turns the soil.
5. Demonstrate harrowing to break soil clods into fine particles.

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6. Show leveling of the field using a leveller or plank.
7. Remove weeds and crop residues from the field.
8. Write down the observations and uses of each implement.

Activity 3: Demonstrate Methods to Keep the Seed Crops Under Isolation

Materials Required: Practical notebook, pencil, pen, field observation sheet, measuring tape, etc.

Procedure:

- Visit a seed production field and observe the isolation practices followed.
- Identify and write the type of isolation used (distance isolation, time isolation, barrier isolation, etc.).
- Record the recommended isolation distance maintained for the seed crop.
- Observe and note the methods used to prevent cross-pollination and maintain genetic purity.
- Write the importance of isolation in seed production.
- Record the crops or varieties that require isolation during seed production.
- Note the precautions followed to maintain the prescribed isolation standards in the field.

Check Your Progress

Fill in the Blanks

1. Field preparation involves _____ to provide a favorable soil environment.
2. Ploughing is a _____ and important tillage operation.
3. Early ploughing during kharif season helps in moisture _____.
4. Harrowing is a _____ tillage operation performed after ploughing.
5. Seed cum fertilizer drill requires _____ hp tractors to operate.

Multiple choice Questions

1. Which operation is done soon after rain or irrigation?
    a) Leveling
    b) Ploughing
    c) Sowing
    d) Bunding
2. Which implement works well in sticky and hard dry soil?
    a) Cultivator

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b) Rotavator

c) Disc plough

d) Plank

3. Harrowing helps in:

a) Harvesting crops

b) Breaking large soil clods

c) Irrigation

d) Transplanting

4. Rotavator is mainly used for:

a) Cutting crops

b) Harvest storage

c) Water drainage

d) Preparing fine tilth

5. Cultivator is used to loosen soil up to:

a) 5–10 cm

b) 10–12 cm

c) 15–18 cm

d) 25–30 cm

6. Plank is mainly used for:

a) Compacting and leveling

b) Spraying

c) Harvesting

d) Weeding only

Match the Following

Column A	Column B
1. Harrow	a. Divides field into plots
2. Rotavator	b. Breaks clods into fine soil
3. Bund maker	c. Prepares fine tilth
4. Seed cum fertilizer drill	d. Line sowing and fertilizer application

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Subjective Questions

1. Describe various types of implements used for field preparation.
2. Write in brief on following topics:
   - **i)** Harrow
   - **ii)** Cultivator
3. Describe ploughing and its advantages.
4. Explain purpose of levelling.

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Module 3
Package and practice for Seed Production

Module Overview

Proper Package and practices is very important for seed production of cereals, pulses, vegetable crops etc. Quality seed is the foundation of successful farming, as it ensures better germination, healthy crop growth, higher productivity, and resistance to pests and diseases. This unit introduces learners to the scientific methods and practical techniques used in producing pure and healthy seeds while maintaining varietal characteristics and genetic purity. It also highlights the importance of proper field management, isolation, rouging, harvesting, processing, and storage in seed production.

This module introduces students to the package of practices followed in seed production for major crop groups, including cereals, pulses, and vegetables. It focuses on the scientific methods and management practices required to produce high-quality seeds while maintaining genetic purity and seed standards. In Session 1, students will learn about the seed production techniques for cereal crops. Session 2 covers the principles and practices involved in pulse crop seed production, while Session 3 focuses on the methods and requirements for vegetable crop seed production. The module emphasizes the importance of crop-specific practices in achieving quality seed production and enhancing agricultural productivity.

Learning Outcomes

After completing this module, you will be able to:

- Explain the package of practices and seed production techniques for major cereal crops.
- Describe the methods and requirements for seed production of pulse crops while maintaining seed quality standards.
- Identify the key practices involved in vegetable crop seed production and their role in producing quality seeds.

Module Structure

Session 1: Seed Production of Cereal Crops

Session 2: Seed Production of Pulses Crops

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Session 3: Seed Production of Vegetable Crops

Session 1: Seed Production of Cereal Crops

Seed Production of Rice

Rice is one of the most important food crops in the world and forms the staple diet for millions of people, especially in Asian countries. In India, rice occupies a major share of the cultivated area and plays an important role in food security and the economy of farmers. The success of rice cultivation largely depends on the quality of seed used for planting.

Rice belongs to the family Poaceae and is mainly a self-pollinated crop. Its inflorescence is known as a panicle. Flowering usually takes place during the morning hours, generally between 7 A.M. and 10 A.M. Since rice is self-pollinated, the chances of natural cross-pollination are very low, but proper management practices are still essential to maintain varietal purity during seed production. Scientific seed production methods help in preserving the desirable characters of a variety and ensure the supply of quality seed to farmers.

Selection of Soil

Selection of suitable Soil is one of the most important requirements for successful seed production in rice. The field selected for seed production should be fertile, levelled, and provided with proper irrigation and drainage facilities. The Soil should be free from volunteer plants because such plants may cause admixture and reduce the genetic purity of the seed crop. It is also necessary that the same field should not have been cultivated with another variety of rice in the previous season. If rice was previously grown, it should be the same certified variety to avoid contamination.

Isolation Distance

Isolation distance is maintained to prevent mixing with other rice varieties. In rice seed production, an isolation distance of at least 3 meters should be maintained around the seed production field. This isolation prevents mechanical mixtures during irrigation, harvesting, and threshing operations. Proper isolation helps in maintaining the genetic purity of the variety and ensures that the produced seed meets certification standards.

Seed Treatment

Rice seeds often exhibit dormancy immediately after harvest, which prevents germination for a certain period. Dormancy may last from a few days to several weeks depending on the variety. To overcome dormancy, seeds may be treated with potassium nitrate solution before sowing. Seed treatment is also carried out to protect seeds from seed-borne diseases and storage pests. Seeds may be treated with fungicides such as captan, thiram, or bavistin before storage.

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Nursery Management

Rice is generally transplanted from a nursery to the main field. Therefore, proper nursery management is very important for obtaining healthy seedlings. About 800 square meters of nursery area is required for planting one hectare of rice field. The nursery area should be well prepared by puddling the soil thoroughly and levelling it properly. Channels should be formed between nursery beds for irrigation and drainage purposes.

Pre-germinated seeds are usually sown in the nursery. For pre-germination, seeds are soaked in water for 24 hours and incubated for another 12 hours until small sprouts emerge from the seeds. These sprouted seeds establish quickly and uniformly under wet conditions.

Proper nutrient management is essential in the nursery for vigorous seedling growth. Fertilizers such as diammonium phosphate are applied before sowing. Water management in the nursery is also important. Excess water should be drained after sowing to avoid poor germination. Later, a thin layer of water is maintained to support seedling growth. Weed growth in the nursery is controlled by applying herbicides such as butachlor or pendimethalin. Seedlings should also be protected from pests and diseases such as thrips, blast, and brown spot through suitable plant protection measures.

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Fig. 3.1: Seed Production of Rice

Transplanting and Cultural Operations

Healthy seedlings are transplanted into the main field at the proper age. Short-duration varieties are generally transplanted at 18 to 22 days after sowing, medium-duration varieties at 25 to 30 days, and long-duration varieties at 35 to

40 days. Seedlings should be carefully uprooted from the nursery without damaging the roots. They should not be allowed to dry before transplanting.

The main field should be well puddled and levelled before transplanting. Farmyard manure or compost is added to improve soil fertility and structure. Green manure crops may also be incorporated into the soil to increase organic matter content. Proper fertilizer application is essential for obtaining healthy crop growth and good seed yield. Nitrogen, phosphorus, and potash are applied according to the duration of the crop and soil fertility status.

Seedlings are transplanted at recommended spacing to ensure proper aeration and sunlight penetration. Short-duration varieties are usually transplanted at 20 × 10 cm spacing, while medium and long-duration varieties require wider spacing. Generally, two to three seedlings are transplanted per hill. Proper spacing facilitates easy rouging and helps in reducing disease incidence.

Water management is one of the most important aspects of rice cultivation. A shallow water layer is maintained during the early growth stages, while about 5 cm standing water is maintained during active growth. Excess water should be drained to prevent yellowing of plants. Critical stages requiring adequate water supply include panicle initiation, booting, flowering, and grain filling stages.

Weed Management

Weeds compete with the crop for nutrients, water, sunlight, and space, thereby reducing seed yield and quality. Effective weed management is therefore essential in rice seed production. Weed control is achieved through a combination of herbicides and manual weeding. Pre-emergence herbicides such as butachlor, thiobencarb, and pendimethalin are commonly used to control weeds in the field. Hand weeding is also carried out whenever necessary.

For Pre emergence herbicide use butachlor 2.5l/ha or thiobencarb 2.5l/ha fluchloralin 2l/ha or pendimethalin 3l/ha as pre emergence on third day and is to be followed by hand weeding on 30-35 days. On the failure of pre emergence application, hand weed at 15 days and spray 2-4 D sodium salt with a high volume sprayer 3 weeks after transplanting when the weds are in 3-4 leaf stage

Pest and Disease Management

Rice seed crops are attacked by several insect pests such as stem borers, leaf folders, brown plant hoppers, earhead bugs, and thrips. These pests damage leaves, stems, and grains, resulting in yield reduction and poor seed quality. Proper pest management practices, including timely application of insecticides, are necessary to protect the crop.

Diseases such as blast, sheath blight, bacterial leaf blight, grain discoloration, and brown spot are common in rice fields. These diseases affect seed formation and reduce germination capacity. Suitable fungicides and bactericides are applied

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to control disease incidence. Integrated pest and disease management practices help in maintaining healthy crops and high-quality seed production.

Rouging and Field Inspection

Rouging is one of the most important operations in rice seed production. It involves the removal of off-type plants, diseased plants, volunteer plants, and objectionable weeds from the seed production field. Off-type plants differ from the original variety in characteristics such as plant height, leaf shape, grain type, or flowering duration. If these plants are not removed, they may contaminate the seed lot and reduce varietal purity.

Rouging should be carried out regularly from the early growth stages until harvest. Plants suspected of being off-types should be removed immediately along with their roots. Field inspections are also conducted by seed certification officers during flowering and before harvest to ensure that the field meets prescribed certification standards.

Seed Yield

The yield of crop varies from 3000 to 7000 kg /ha depending on genotypes, location, season management practices and pest infestation

Harvesting, Threshing, and Processing

Rice seed crop should be harvested at the correct stage of maturity. The crop reaches physiological maturity when the panicles turn golden yellow and begin to droop downward. At this stage, the seed moisture content is usually around 18 to 20 percent. Delayed harvesting may lead to seed shattering, lodging, and deterioration of seed quality.

Harvested plants should be bundled carefully and stacked properly to avoid heating and moisture accumulation. Threshing should be done carefully to prevent mechanical injury to seeds. Mechanical threshers may be used, but machine speed should be adjusted properly to minimize seed damage.

After threshing, seeds are cleaned and winnowed to remove chaff, dirt, and broken seeds. Seeds are then dried under sunlight to reduce moisture content to about 13 percent for safe storage. Drying should not be done during the hottest part of the day because excessive heat may reduce seed viability. Grading is carried out using seed graders to separate bold and healthy seeds from undersized and damaged seeds.

Storage and Seed Certification

Proper storage is essential for maintaining seed viability and vigor. Rice seed is generally a good storer and can remain viable for one to three years under suitable conditions. Seeds should be stored in clean and dry storage structures using moisture-proof containers such as HDPE bags or polylined gunny bags. Storage areas should be free from insects, rodents, and excess humidity. Seed certification

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is an official process conducted to ensure that seed produced meets prescribed quality standards. Certified seed should possess minimum genetic purity, physical purity, and germination percentage. In rice, the minimum germination standard is usually 80 percent, while pure seed percentage should be at least 98 percent. Seed certification helps farmers obtain reliable and high-quality seed for cultivation.

Seed Production of Maize

Maize is one of the most important cereal crops cultivated throughout the world for food, feed, and industrial purposes. It is commonly known as corn and occupies an important place in the agricultural economy of many countries. Maize grains are rich in carbohydrates, proteins, vitamins, and minerals, making them an important source of nutrition for humans and animals. The crop is also widely used in industries for the manufacture of starch, oil, glucose, alcohol, and several other products.

Floral Characteristics and Pollination

Maize is a monoecious plant in which both male and female flowers are present separately on the same plant. The tassel is the male inflorescence and produces a large quantity of pollen grains. The cob is the female inflorescence and bears silks that receive pollen grains during pollination. Each silk is connected to an ovule that later develops into a kernel after fertilization.

Maize exhibits protandry, which means that pollen shedding takes place before the silks become receptive. Pollen shedding generally occurs during the morning hours and continues for several days. The pollen grains are very light and are carried by wind from one plant to another. The silks remain receptive for about one week, allowing pollination and fertilization to occur effectively. Since maize is highly cross-pollinated, contamination from nearby fields is common. Therefore, maintaining isolation distance and conducting proper rouging are essential for preserving varietal purity in seed production plots.

Season and Soil Requirement

Selection of proper season is very important in maize seed production. The best seasons for maize seed production are June to July, November to December, and January to February. Flowering should not coincide with heavy rainfall or high relative humidity because such conditions interfere with pollination and seed setting. Maturity and drying of cobs should occur during dry weather to obtain good quality seed. A temperature of around 37°C is considered favorable for proper pollination and seed development.

The Soil selected for seed production should be fertile, well drained, and free from volunteer plants. Poor or problematic soils reduce pollen fertility and seed set, resulting in poor seed quality. The field should not have been cultivated with another maize variety in the previous season because volunteer plants from the

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earlier crop may contaminate the seed field. If maize was previously grown, it should be the same certified variety.

Isolation Distance

Isolation distance is one of the most important requirements in maize seed production because maize is naturally cross-pollinated through wind. Pollen grains from neighboring maize fields can easily contaminate the seed crop and reduce genetic purity. To avoid such contamination, seed production plots must be isolated from other maize fields by maintaining a specific distance. For foundation seed production, an isolation distance of 400 meters is maintained, while for certified seed production, a distance of 200 meters is required. Isolation helps prevent unwanted cross-pollination from nearby fields containing different varieties or poor-quality plants. In some cases, border rows are planted around the seed field to reduce pollen contamination and maintain varietal purity according to certification standards.

Selection and Treatment of Seed

The seed used for seed production should always be obtained from authenticated and certified sources. For foundation seed production, breeder seed is used, while foundation seed serves as the source for certified seed production. The seeds selected for sowing should be healthy, bold, disease-free, and possess high germination percentage. The recommended seed rate for maize seed production is about 20 kilograms per hectare.

Pre-sowing seed treatment is an important practice because it protects the seed from pests, diseases, and unfavorable environmental conditions. Seeds are treated with fungicides such as bavistin to protect against seed-borne and soil-borne diseases. Insecticidal treatments with carbofuran or chlorpyriphos are given to protect seedlings from shoot fly attack. Seeds may also be treated with azospirillum to improve nitrogen fixation and enhance crop growth. Polymer coating treatments are sometimes adopted to improve seed appearance and vigour.

Sowing and Crop Management

Maize is directly sown in the main field because nursery raising is not suitable for this crop. Seeds are generally sown on ridges and furrows or under beds and channels. Proper spacing is essential for healthy growth, efficient pollination, and better seed development. Common spacing followed in maize seed production is 45 × 10 cm or 60 × 20 cm depending upon the variety.

Seeds are usually sown at a depth of about 2 to 4 centimeters. After germination, thinning and gap filling are carried out within one week to maintain uniform plant population. Proper crop stand is essential because uneven growth may affect pollination and seed setting. Organic manures such as farmyard manure or compost are incorporated into the soil during Soil preparation. Balanced fertilizer

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application is necessary for healthy vegetative growth and grain development. Nitrogen, phosphorus, and potash fertilizers are generally applied in split doses during different growth stages to ensure continuous nutrient supply.

Nutrient and Irrigation Management

Balanced nutrient management is essential for obtaining healthy plants and high seed yield. Maize requires adequate nitrogen, phosphorus, and potassium for proper growth, flowering, and grain formation. Micronutrients such as zinc and iron are also important because deficiency symptoms are commonly observed in maize crops. Foliar spraying of DAP solution during flowering helps improve seed setting and flowering synchronization. Zinc sulphate and micronutrient mixtures are applied whenever deficiency symptoms appear in the field.

Irrigation management plays a major role in successful seed production. The crop should be irrigated regularly, especially during critical stages such as vegetative growth, flowering, milky stage, and grain filling stage. Water stress during flowering affects pollination and reduces seed formation. Proper irrigation ensures bold grain development and increases seed yield.

Weed Management

Weed management is essential in maize seed production because weeds compete with the crop for nutrients, moisture, sunlight, and space. Heavy weed infestation reduces crop vigour and adversely affects seed development and yield. Weeds may also harbor insect pests and diseases, thereby increasing crop damage.

Effective weed control is achieved through chemical and manual methods. Pre-emergence herbicides such as atrazine are commonly applied after sowing to control weeds during the early growth stages. Hand weeding is also carried out to remove weeds that escape chemical control. Maintaining a weed-free field improves plant growth, facilitates field inspection, and promotes healthy cob development.

Pest and Disease Management

Maize seed crops are attacked by several pests and diseases that reduce both seed yield and quality. Important insect pests include shoot fly, stem borer, cob borer, and lesion nematodes. Shoot fly damages young seedlings, while stem borers bore into the stem and weaken the plants. Cob borers attack developing grains and reduce seed quality.

Diseases such as downy mildew and leaf spot commonly affect maize crops. These diseases reduce photosynthetic activity and interfere with grain development. Fungicides such as mancozeb and captan are applied to control disease incidence. Timely pest and disease management practices are necessary for maintaining healthy crop growth and producing vigorous seeds.

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Rouging

Rouging is one of the most important operations in maize seed production. It involves the removal of off-type plants, diseased plants, volunteer plants, and undesirable plants from the seed production field. Since maize is highly cross-pollinated, contamination from off-type plants can easily occur through pollen transfer. Off-type plants are identified based on differences in plant height, stem colour, leaf shape, tassel characteristics, silk colour, cob shape, and grain colour. Rouging should be carried out regularly from seedling stage to harvest. Undesirable plants must be removed before pollen shedding to prevent contamination and maintain varietal purity according to certification standards.

Seed Yield

Under favorable environmental conditions and proper management practices, maize seed production generally yields about 3 to 4 tonnes of seed per hectare. Timely harvesting and proper post-harvest handling further help in maintaining seed quality and reducing losses during storage.

Fig. 3.2: Rouging in Maize

Harvesting and Processing

The maize seed crop reaches physiological maturity about 30 to 35 days after flowering. At maturity, the husk covering the cob turns straw yellow in colour and the seed moisture content becomes around 25 to 30 percent. Harvesting should be carried out at the proper stage to avoid deterioration of seed quality.

After harvest, the husk covering the cobs is removed manually in a process known as dehusking. The cobs are then sorted carefully to remove diseased, poorly filled,

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discoloured, and damaged cobs. Only healthy cobs with characteristic grain colour and regular row arrangement are selected for seed purposes.

The cobs are dried under sunlight before shelling. Shelling is done manually or mechanically to separate seeds from the cobs. Care should be taken to avoid mechanical damage because damaged seeds lose viability during storage. The seeds are further dried to about 8 to 10 percent moisture content for safe storage. Cleaning and grading are carried out to remove immature, undersized, and damaged seeds.

Storage and Seed Certification

Proper storage is necessary to maintain seed viability and vigour for a longer period. Maize seeds are generally stored in gunny bags for short-term storage and in HDPE or polylined bags for long-term storage. Storage rooms should be clean, dry, and protected from insects and rodents. Storage pests such as grain weevil and flour beetles can cause severe damage to maize seeds. Therefore, seeds are treated with suitable fungicides and insecticides before storage. Under proper conditions, maize seeds can be stored safely for about one year, while moisture-proof storage at low temperature can preserve seed viability for several years. Seed certification ensures that the produced seed meets prescribed standards of genetic purity, physical purity, and germination percentage. Field inspections and laboratory tests are conducted before certification. Certified maize seed should possess high germination percentage and good physical quality for successful cultivation.

Activities

Activity : Visit Nearby Seed Production Farm to Demonstrate Seed Production of Cereal Crops

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

Procedure:

Write the following information:

- Visit a nearby seed production farm of cereal crops.
- Identify and write the name of the cereal crop grown for seed production.
- Observe and record the different stages of seed production followed in the farm.
- Note the field preparation, sowing method, and crop management practices adopted.
- Record the isolation distance and rouging practices followed to maintain seed purity.

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- Collect information about harvesting, processing, and storage of cereal crop seeds.

Check Your Progress

Fill in the Blanks

1. Rice belongs to the family _____.
2. The inflorescence of rice is known as a _____.
3. In rice seed production, an isolation distance of _____ meters is maintained.
4. Maize is a _____ pollinated crop.
5. The male inflorescence of maize is called the _____.
6. For foundation seed production of maize, an isolation distance of _____ meters is required.
7. The process of removing the husk from maize cobs is called _____.

Multiple Choice Questions

1. Rice flowering generally occurs between:
   a) 4 A.M. – 6 A.M.
   b) 7 A.M. – 10 A.M.
   c) 12 P.M. – 2 P.M.
   d) 6 P.M. – 8 P.M.
2. Which chemical is used to overcome dormancy in rice seeds?
   a) Potassium nitrate
   b) Urea
   c) Zinc sulphate
   d) DAP
3. How much nursery area is required for one hectare of rice field?
   a) 400 m^2
   b) 600 m^2
   c) 800 m^2
   d) 1000 m^2
4. Which herbicide is commonly used in rice nursery for weed control?
   a) Atrazine
   b) Bavistin
   c) Mancozeb
   d) Butachlor
5. Maize is a:
   a) Dioecious plant
   b) Self-pollinated plant

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c) Monoecious plant

d) Parasitic plant

6. The female inflorescence of maize is called:
   a) Tassel
   b) Cob
   c) Panicle
   d) Spike
7. What is the recommended seed rate for maize seed production?
   a) 10 kg/ha
   b) 15 kg/ha
   c) 20 kg/ha
   d) 30 kg/ha

Descriptive Questions

1. Describe the nursery management practices followed in rice.
2. Write a short note on weed management in rice seed production.
3. Describe the process of rouging in maize seed production.
4. Explain the harvesting, processing, and storage of maize seeds.
5. Discuss the pest and disease management practices in rice seed production.

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Session 2: Seed Production of Pulses Crops

Seed Production of Black Gram

Black gram, commonly known as urd bean, is one of the most important pulse crops cultivated in India. It is widely grown because of its high nutritional value and its ability to improve soil fertility through nitrogen fixation. Black gram seeds contain a high amount of protein, carbohydrates, vitamins, and minerals, making the crop an important source of food for human beings. Apart from food purposes, the crop also plays a major role in sustainable agriculture because it enriches the soil by fixing atmospheric nitrogen through root nodules.

Seed production differs from ordinary grain production because greater care is required in maintaining genetic purity, physical purity, and seed viability. Proper field management, isolation, roguing, harvesting, processing, and storage practices are essential for producing quality seed. The success of black gram seed production depends upon the use of suitable Soil , certified seed source, proper agronomic practices, and scientific storage methods.

Climate and Soil Requirement

Black gram grows well in warm and humid climatic conditions. The crop requires moderate rainfall and can tolerate dry conditions better than excessive moisture. Temperature between 25°C and 35°C is considered suitable for proper germination, growth, flowering, and pod development. Excess rainfall during flowering and pod formation may result in flower shedding, disease incidence, and poor seed quality. Therefore, dry weather during maturity and harvesting is highly beneficial for seed production.

Well-drained loamy or sandy loam soils are ideal for black gram cultivation. Waterlogging is harmful because it affects root growth and nodulation. The soil should be fertile and rich in organic matter for better plant growth. Soil pH ranging from 6.0 to 7.5 is considered suitable. Fields selected for seed production should be free from volunteer plants and should not have been previously cultivated with another variety of black gram. Proper leveling of Soil is necessary to ensure uniform irrigation and nutrient distribution throughout the field.

Soil Preparation and Sowing

Soil preparation is an important step in black gram seed production. The field should be ploughed thoroughly to obtain a fine tilth. Usually, two or three ploughings followed by leveling are sufficient for proper seedbed preparation. Well-prepared soil helps in uniform germination, better root growth, and efficient nutrient absorption. Farmyard manure or compost may be incorporated during Soil preparation to improve soil fertility and soil structure.

Healthy and genetically pure seeds should be selected for sowing. Before sowing, seeds may be treated to improve germination and seedling vigor. Seed hardening

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practices are useful in improving drought tolerance and early establishment. The seeds can be soaked in zinc sulphate solution or treated with suitable bio-products for enhancing seed quality. After treatment, seeds should be shade dried to maintain the required moisture content before sowing.

Sowing should be done at the proper season according to regional climatic conditions. Seeds are generally dibbled at a depth of 3–4 cm with spacing of about 30 cm between rows and 10 cm between plants. Proper spacing helps in better aeration, sunlight penetration, and management of pests and diseases. Mechanized seed drills may also be used for uniform sowing and maintenance of plant population.

Nutrient Management

Balanced nutrient management is essential for obtaining healthy plants and quality seeds. Black gram requires nitrogen, phosphorus, potassium, and sulphur for proper growth and seed development. Although the crop fixes atmospheric nitrogen through root nodules, a small starter dose of nitrogen is beneficial during early growth stages. Phosphorus encourages root growth and nodulation, while potassium improves plant vigor and disease resistance. Sulphur plays an important role in protein synthesis and seed quality.

Fertilizers should generally be applied as basal dose during the final ploughing. Organic manures such as farmyard manure improve soil fertility and microbial activity. Micronutrient mixtures recommended for pulse crops can also be applied to improve nutrient availability and crop growth. During flowering stage, foliar spray of pulse nutrient formulations may be given to enhance flowering, pod setting, and seed filling. Spraying should preferably be done during morning or evening hours to avoid evaporation losses and leaf scorching.

Irrigation

Black gram is mostly grown as a rainfed crop, but irrigation at critical growth stages improves seed yield and quality. Adequate moisture is particularly important during flowering and pod formation stages. Excess irrigation should be avoided because waterlogging may lead to root diseases and poor plant growth. Irrigation should be managed carefully to maintain optimum soil moisture without causing stagnation of water.

Weed Management

Weeds compete with the crop for nutrients, water, sunlight, and space. Therefore, effective weed management is necessary for successful seed production. The field should be kept weed free especially during the early stages of crop growth. Hand weeding or intercultivation may be carried out at regular intervals. Weed control not only improves crop growth but also reduces contamination in the seed field and facilitates harvesting operations.

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Isolation and Roguing

Isolation is one of the most important requirements in seed production. The seed production field should be isolated from other black gram varieties to maintain genetic purity. A minimum isolation distance is maintained between seed fields and neighboring fields containing other varieties or impure crops. This prevents contamination through mechanical mixtures and accidental mixing during cultivation or harvesting.

Roguing is the removal of off-type plants, diseased plants, and undesirable plants from the field. Roguing should be done regularly from vegetative stage until maturity. Plants showing different growth habit, leaf shape, flower color, pod characters, or seed characteristics should be removed immediately. Diseased plants affected by mosaic virus or pest infestation should also be uprooted and destroyed. Timely roguing helps in maintaining varietal purity and ensuring high quality seed production.

Pest and Disease Management

Black gram is affected by several insect pests and diseases which reduce seed yield and quality. Common insect pests include pod borers, aphids, whiteflies, and leaf-eating caterpillars. These pests damage leaves, flowers, and pods, resulting in poor seed formation. Regular field monitoring is necessary for early detection and timely management of pests.

Diseases such as yellow mosaic virus, powdery mildew, leaf spot, and root rot are commonly observed in black gram fields. Use of healthy seeds, crop rotation, proper drainage, and resistant varieties help in reducing disease incidence. Removal of infected plants during roguing also prevents spread of diseases. Need-based application of suitable plant protection measures should be followed carefully to maintain healthy crop growth and good seed quality.

Harvesting and Threshing

Harvesting at the correct stage is essential for obtaining good quality seeds. Black gram pods should be harvested when about 80 percent of the pods turn black and reach physiological maturity. Delayed harvesting may result in shattering losses, while early harvesting may produce immature seeds with poor germination capacity. At physiological maturity, seed moisture content is generally around 17–18 percent.

Harvesting is usually done manually by cutting or uprooting plants. The harvested plants are dried under sunlight for a few days before threshing. Threshing should be carried out carefully using sticks or mechanical threshers to avoid seed damage. Clean and undamaged seeds should be separated from broken seeds, immature seeds, and inert materials.

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Seed Drying, Grading, and Storage

After threshing, seeds should be dried properly to reduce moisture content to safe storage levels. Drying is an important operation because excess moisture reduces seed viability and encourages fungal growth during storage. Seeds are generally dried under sunlight or shade until moisture content reaches about 8–9 percent.

Grading is done to remove undersized, damaged, and shriveled seeds. Proper grading improves seed uniformity, germination percentage, and market value. Sieves of suitable mesh size are used for grading operations. High quality graded seeds possess better physical purity and produce vigorous seedlings.

Before storage, seeds may be treated with suitable chemicals or eco-friendly formulations to protect them from storage pests and fungal infection. Seeds should be stored in clean, dry, and moisture-proof containers. Gunny bags, cloth bags, or polythene-lined bags are commonly used for storage depending on the storage duration. The storage room should be cool, dry, and free from insect infestation. Proper storage conditions help in maintaining seed viability and vigor for longer periods.

Seed Production of Pea

Pea is one of the most important pulse crops cultivated for its nutritious green pods and dry seeds. Pea is rich in proteins, carbohydrates, vitamins, and minerals and forms an important part of the human diet. It is widely grown during the winter season in many parts of the world. Apart from its value as a vegetable and pulse crop, pea also improves soil fertility through nitrogen fixation with the help of root nodules containing beneficial bacteria.

Good quality seed is one of the most important factors responsible for obtaining healthy crop growth and higher yield. The use of certified seed ensures better germination, uniform plant stand, resistance to pests and diseases, and superior grain quality. Therefore, proper seed production techniques must be followed to maintain the quality standards of pea seed.

Floral Characteristics and Pollination

Pea is a self-pollinated crop in which pollination usually takes place before the flowers open. The flowers are bisexual and contain both male and female reproductive organs. Due to self-pollination, natural crossing in pea is very low. However, contamination may still occur because of mechanical mixtures or occasional insect activity. Therefore, maintenance of proper isolation distance and regular rouging are essential during seed production.

Flowering generally starts about 30 to 40 days after sowing depending on the variety and environmental conditions. Successful pollination and fertilization result in proper pod formation and healthy seed development. Environmental

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factors such as temperature, moisture, and humidity influence flowering and seed setting in pea crops.

Climate and Soil Requirement

Pea is mainly grown during the cool season and performs well under moderate temperature conditions. Cool and dry weather is considered ideal for flowering, pod development, and seed maturity. Excessive rainfall and high humidity during flowering and harvesting are harmful because they increase disease incidence and reduce seed quality.

The Soil selected for seed production should be fertile, well drained, and free from volunteer plants. Waterlogged conditions are not suitable because they adversely affect root development and promote disease incidence. The field should not have been cultivated with another variety of pea in the previous season to avoid contamination through volunteer plants. Proper Soil preparation is essential for good seed germination and healthy crop establishment.

Isolation Distance

Isolation distance is maintained in pea seed production to preserve varietal purity and prevent mechanical mixtures. Since pea is mainly self-pollinated, the required isolation distance is comparatively less than cross-pollinated crops. Generally, an isolation distance of 10 meters is maintained for foundation seed production and 5 meters for certified seed production.

Proper isolation prevents contamination from neighboring fields of other pea varieties. Isolation also facilitates field inspection and helps in maintaining the genetic purity required for seed certification standards.

Seed Treatment

Seed treatment is an important practice in pea seed production because it protects seeds from seed-borne and soil-borne diseases. Seeds are generally treated with fungicides such as thiram or bavistin before sowing. Rhizobium inoculation is also commonly practiced to improve nitrogen fixation and enhance crop growth. Proper seed treatment ensures healthy seedling establishment and reduces disease incidence during early crop growth.

Sowing

Pea seeds are directly sown in the main field. The field is prepared thoroughly by ploughing and leveling to obtain a fine tilth suitable for seed germination. Seeds are usually sown in rows to facilitate intercultural operations and field inspection.

Proper spacing is maintained between rows and plants to ensure good aeration, sunlight penetration, and healthy crop growth. Adequate plant population is important for better flowering and pod formation. Organic manures such as farmyard manure or compost are incorporated into the soil during Soil preparation to improve soil fertility and structure.

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Nutrient Management

Balanced application of fertilizers is necessary for obtaining healthy plants and higher seed yield. Nitrogen, phosphorus, and potash fertilizers are applied according to soil fertility and crop requirement. Irrigation should be provided at critical stages such as flowering and pod formation. Excess irrigation should be avoided because it may increase disease incidence and reduce seed quality.

Weed Management

Weeds compete with pea plants for nutrients, water, sunlight, and space. Heavy weed infestation reduces plant growth, pod development, and seed yield. Weeds may also serve as alternate hosts for insect pests and diseases, thereby increasing crop damage.

Effective weed management is achieved through timely hand weeding and intercultural operations. In some cases, suitable herbicides may also be applied to control weeds during early crop growth. Maintaining a clean and weed-free field improves aeration, facilitates field inspection, and enhances crop growth and seed quality.

Pest and Disease Management

Pea seed crops are affected by several insect pests and diseases that reduce yield and seed quality. Important insect pests include aphids, pod borers, and bruchids. Aphids suck plant sap and weaken the plants, while pod borers damage developing seeds inside the pods. Bruchids are important storage pests that damage seeds both in the field and during storage.

To control bruchids, pre-harvest sanitation spraying is recommended before harvest. Spraying of suitable insecticides such as quinalphos helps in reducing infestation. Fungicides are applied to control diseases such as powdery mildew, rust, and wilt. Proper pest and disease management practices are essential for maintaining healthy crop growth and producing high-quality seeds.

Rouging

Rouging is an important operation in pea seed production because it helps maintain genetic purity of the variety. Rouging involves the removal of off-type plants, diseased plants, volunteer plants, and undesirable plants from the field.

Rouging is carried out at different growth stages. During flowering, off-type plants are identified based on flower colour and plant characteristics. During pod formation, plants are removed based on differences in pod length, pod width, shape, and colour. At harvest stage, rouging is done based on seed colour, seed size, and lustre.

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Harvesting and Processing

Pea seed crop should be harvested at proper maturity to maintain seed quality. The crop is usually ready for harvest when about 70 percent of the pods turn straw coloured. Delayed harvesting may lead to pod shattering, pest infestation, and deterioration of seed quality due to unfavorable weather conditions.

Harvesting is generally carried out by picking mature pods. Damaged, immature, and diseased pods are removed during harvesting. After harvest, pods are dried under sunlight until they become brown and start splitting. The dried pods are then beaten carefully using pliable sticks to separate seeds without causing mechanical injury.

After threshing, seeds are cleaned by winnowing to remove plant debris, broken seeds, and other impurities. The cleaned seeds are dried on tarpaulin until the moisture content is reduced to about 10 percent, which is considered safe for storage. Grading is carried out using suitable sieves to separate bold and healthy seeds from undersized and damaged seeds.

Seed Storage

Proper storage is essential for maintaining seed viability and vigour. Seed moisture content is one of the most important factors influencing storage life. Seeds with high moisture content are easily attacked by fungi and storage pests, resulting in rapid loss of viability.

For short-term storage, seed moisture content should be reduced to about 9 percent. Such seeds can be stored safely in cloth bags or gunny bags for about 6 to 8 months. For long-term storage, seeds should be dried to about 7 percent moisture and stored in polythene bags or moisture-proof containers.

Seeds are often treated with fungicides such as bavistin before storage to protect them from fungal infection. Seed bags should be stacked properly on wooden platforms or dunnages to allow aeration and prevent moisture absorption from the floor. Proper storage practices help maintain seed quality and prolong storage life.

Seed Certification

Seed certification is an official process carried out to ensure that the seed produced meets prescribed quality standards. Certified seed should possess high genetic purity, physical purity, germination percentage, and seed health.

The certification process includes verification of source seed, field inspections, maintenance of isolation distance, rouging, harvesting supervision, processing, and laboratory testing. Seed samples are tested for purity, germination, and moisture content before certification tags are issued. In pea seed certification, the maximum permissible limit for off-types is very low to maintain varietal purity.

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Certified seed should generally possess minimum germination percentage and required physical purity standards for successful cultivation.

Activities

Activity: Visit Nearby Seed Production Farm to Demonstrate Seed Production of Pulse Crops

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

Procedure:
Write the following information:

- Visit a nearby seed production farm of pulse crops.
- Identify and write the name of the pulse crop grown for seed production.
- Observe and record the different stages of seed production followed in the farm.
- Note the field preparation, sowing method, and crop management practices adopted.
- Record the isolation distance and rouging practices followed to maintain seed purity.
- Collect information about harvesting, processing, and storage of pulse crop seeds.

Check Your Progress

Fill in the Blanks

1. Black gram is commonly known as _____ bean.
2. Black gram improves soil fertility through _____ fixation.
3. The suitable soil pH for black gram cultivation is _____ to _____.
4. Black gram seeds are generally sown at a depth of _____ cm.
5. Pea is mainly a _____ pollinated crop.

Multiple Choice Questions

1. Which soil is ideal for black gram cultivation?

   a) Clay soil

   b) Waterlogged soil

   c) Sandy loam soil

   d) Saline soil

2. What is the suitable temperature range for black gram growth?

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a) 10°C–20°C

b) 15°C–25°C

c) 25°C–35°C

d) 35°C–45°C

3. Which nutrient encourages root growth and nodulation in black gram?

a) Nitrogen

b) Phosphorus

c) Potassium

d) Calcium

4. At what stage should black gram pods be harvested?

a) When pods are green

b) When 80% pods are black

c) When 50% pods are black

d) After complete drying

5. Which bacteria is commonly used for seed treatment in pea?

a) Rhizobium

b) Azospirillum

c) Bacillus

d) Pseudomonas

6. What is the isolation distance for foundation seed production of pea?

a) 5 m

b) 8 m

c) 10 m

d) 15 m

7. Which insect pest commonly damages developing pea seeds inside pods?

a) Whitefly

b) Aphid

c) Thrips

d) Pod borer

8. Pea crop is usually harvested when about _____ of the pods turn straw coloured.

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a) 50%

b) 60%

c) 70%

d) 90%

Match the Columns

Column A	**Column B**
A. Black Gram	1. Self-pollinated crop
B. Nitrogen Fixation	2. Urd bean
C. Roguing	3. Improves soil fertility
D. Pea	4. Removal of off-type plants
E. Rhizobium	5. Enhances nitrogen fixation

Descriptive Questions

1. Discuss the climate and soil requirements for black gram seed production.
2. Write a short note on isolation and roguing in black gram seed production.
3. Explain the floral characteristics and pollination in pea.
4. Describe the pest and disease management practices in pea seed production.

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Session 3: Seed Production of Vegetable Crops

Seed Production of Onion

Onion is one of the most important vegetable crops cultivated throughout the world. It is widely used in daily cooking because of its characteristic flavour, aroma, and nutritional value. Onion is rich in carbohydrates, minerals, vitamins, and certain medicinal compounds. It is consumed in raw, cooked, dehydrated, and processed forms and also serves as an important export commodity in many countries.

Floral Characteristics and Pollination

Onion is a cross-pollinated crop in which pollination occurs mainly through insects. The inflorescence of onion is called an umbel, which consists of many small flowers borne on a long flower stalk known as a scape. The flowers are bisexual and contain both male and female reproductive organs.

Onion exhibits protandry, meaning the anthers release pollen before the stigma becomes receptive. This condition encourages cross-pollination between plants. Honey bees and other insects play a major role in transferring pollen from one flower to another. Flowering generally starts several months after bulb planting and continues for a considerable period depending on the variety and environmental conditions. Since onion is highly cross-pollinated, contamination from neighboring varieties is very common. Therefore, maintenance of proper isolation distance and regular rouging are essential for preserving varietal purity during seed production.

Methods of Seed Production

Onion seed production is generally carried out by two methods known as the seed-to-seed method and the bulb-to-seed method.

In the seed-to-seed method, seeds are directly sown in the field, bulbs are allowed to remain in the soil during winter, and seed production occurs in the following season without lifting the bulbs. This method is simple and economical but is not commonly preferred because proper selection of bulbs is difficult.

In the bulb-to-seed method, bulbs are first produced during the initial season and then carefully selected for desirable characteristics before replanting for seed production. This method is widely followed because it allows selection of healthy, true-to-type bulbs and helps maintain varietal purity. Bulbs selected for seed production should be uniform in size, shape, colour, and free from diseases and mechanical injury.

Climate and Soil Requirement

Onion grows well under cool and dry climatic conditions. Cool weather during vegetative growth promotes healthy bulb formation, while warm and dry weather during flowering and seed maturation favors good seed production. Excess rainfall

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and high humidity during flowering and seed development adversely affect pollination and increase disease incidence.

The Soil selected for onion seed production should be fertile, well drained, and rich in organic matter. Waterlogged soils are unsuitable because they encourage bulb rotting and fungal diseases. The field should be free from volunteer onion plants and should not have been cultivated with another onion variety in the previous season to avoid contamination.

Proper Soil preparation is essential for healthy root growth and bulb establishment. The soil is ploughed thoroughly and brought to a fine tilth before planting. Organic manures such as farmyard manure or compost are incorporated during Soil preparation to improve soil fertility and structure.

Isolation Distance

Generally, an isolation distance of about 1000 meters is maintained for foundation seed production and 500 meters for certified seed production. Proper isolation helps prevent unwanted cross-pollination and ensures that the seed produced retains the true characteristics of the variety. Maintenance of isolation distance is also necessary for meeting seed certification standards.

Selection and Planting of Bulbs

Bulb selection is one of the most important operations in onion seed production. Only healthy, true-to-type bulbs should be selected for planting. The bulbs should be uniform in shape, size, colour, and maturity and should be free from diseases, pest damage, doubles, bolters, and mechanical injury.

Selected bulbs are generally medium-sized because extremely large or small bulbs may produce poor quality seed stalks. Before planting, bulbs are sometimes treated with fungicides to protect them from fungal diseases during storage and early growth stages. Bulbs are planted in rows with proper spacing to ensure good aeration and healthy growth. Adequate spacing facilitates intercultural operations, rouging, and field inspection. After planting, light irrigation is provided to encourage sprouting and establishment.

Nutrient and Irrigation Management

Balanced nutrient management is essential for obtaining healthy plants and good seed yield. Onion requires adequate nitrogen, phosphorus, and potassium for proper vegetative growth, flowering, and seed development. Organic manures improve soil fertility and water-holding capacity, while chemical fertilizers provide essential nutrients for crop growth. Nitrogen fertilizers are generally applied in split doses because excess nitrogen at later stages may delay maturity and reduce seed quality. Phosphorus encourages root development and flowering, while potassium improves seed filling and overall plant health.

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Irrigation management is equally important in onion seed production. Adequate moisture should be maintained during bulb establishment, flowering, and seed development stages. Water stress during flowering may reduce pollination and seed setting. However, excessive irrigation should be avoided because it increases disease incidence and causes lodging of seed stalks.

Weed Management

Weeds compete with onion plants for nutrients, water, sunlight, and space, thereby reducing seed yield and quality. Onion seedlings grow slowly during the initial stages and are poor competitors against weeds. Therefore, effective weed management is essential for successful seed production. Weeds are controlled through hand weeding, intercultural operations, and herbicide application. Pre-emergence herbicides are commonly used to suppress weed growth during the early stages of crop development. Regular hand weeding is also necessary to maintain a clean field and facilitate healthy growth of seed stalks. Proper weed management improves aeration, reduces pest and disease incidence, and promotes better flowering and seed development.

Pest and Disease Management

Onion seed crops are attacked by several pests and diseases that reduce both seed yield and quality. Important insect pests include thrips, onion maggot, and mites. Thrips are the most destructive pests and feed on leaves and flower stalks, resulting in poor growth and reduced seed setting.

Diseases such as purple blotch, downy mildew, basal rot, and stemphylium blight are common in onion seed production fields. These diseases damage leaves, flower stalks, and umbels, thereby reducing seed yield and seed quality.

Proper plant protection measures are necessary to control pest and disease incidence. Suitable insecticides and fungicides are applied at recommended stages to protect the crop. Removal of infected plants and maintenance of field sanitation also help reduce disease spread and maintain healthy crop growth.

Rouging

Rouging is an important operation in onion seed production because it helps maintain genetic purity and improve seed quality. It involves the removal of off-type plants, diseased plants, volunteer plants, and undesirable bulbs from the field. Rouging begins at the bulb selection stage itself. Bulbs that differ in shape, colour, size, maturity, or pungency are removed before planting. During vegetative growth and flowering stages, plants are examined carefully and off-type plants are removed based on leaf characteristics, flower stalks, and umbel shape.

Plants showing symptoms of diseases or abnormal growth are also removed immediately from the field. Regular rouging throughout the crop growth period

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helps maintain varietal purity and ensures compliance with seed certification standards.

Harvesting and Processing

Onion seed crop is ready for harvest when the seed heads or umbels turn brown and black seeds become visible. Harvesting should be carried out carefully because mature seeds shatter easily and may lead to heavy seed loss.

The umbels are cut along with a portion of the flower stalk and dried under shade or mild sunlight for several days. After proper drying, threshing is carried out carefully to separate seeds from the umbels. Seeds are then cleaned by winnowing to remove chaff, dried flower parts, and other impurities.

After cleaning, seeds are dried further until the moisture content is reduced to about 6 to 8 percent for safe storage. Proper drying is essential because onion seeds lose viability rapidly under high moisture conditions. Grading is carried out to remove undersized and damaged seeds and to obtain bold and healthy seeds suitable for storage and marketing.

Seed Storage

Onion seed has comparatively shorter storage life than many other vegetable seeds. Therefore, proper storage conditions are extremely important for maintaining seed viability and vigour. Seeds should be stored under cool and dry conditions with low moisture content.

Seeds are usually packed in moisture-proof containers such as polythene-lined bags or airtight containers to prevent absorption of atmospheric moisture. Storage rooms should be free from insects, rodents, and excessive humidity. Fungicidal seed treatment before storage helps protect seeds from fungal infection. Under proper storage conditions, onion seed can maintain good germination for about one year. However, prolonged storage under unfavorable conditions leads to rapid deterioration and reduction in germination percentage.

Seed Certification

Seed certification is carried out to ensure that onion seed produced meets prescribed quality standards. The certification process includes verification of source seed, field inspections, maintenance of isolation distance, rouging, harvesting supervision, processing, and laboratory testing.

Certified onion seed should possess high genetic purity, physical purity, germination percentage, and seed health. Seed samples are tested for moisture content, purity, and germination before certification tags are issued. Maintenance of proper isolation distance and regular rouging are particularly important in onion because of its highly cross-pollinated nature.

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Seed Production of Tomato

Tomato is one of the most important vegetable crops cultivated throughout the world. It is widely grown for fresh consumption as well as for processing into products such as ketchup, puree, sauce, soup, and juice. Tomato is rich in vitamins, minerals, carbohydrates, and antioxidants, particularly lycopene, which contributes to its nutritional and medicinal value. The crop occupies an important place in vegetable cultivation because of its high economic returns and wide adaptability to different climatic conditions.

The botanical name of tomato is *Solanum lycopersicum* (formerly *Lycopersicon esculentum*) and it belongs to the family Solanaceae. Tomato is predominantly a self-pollinated crop. Self-fertilization is favored by the position of the stigma within the anther cone and the pendulous nature of the flower. Although natural cross-pollination occurs to a limited extent, proper seed production practices are necessary to maintain varietal purity and produce high-quality seed.

Floral Characteristics and Pollination

Tomato is a typical day-neutral plant and can flower under a wide range of day lengths. The flowers are bisexual, containing both male and female reproductive organs. Self-pollination occurs naturally because the stigma is usually enclosed within the anther cone. Fertilization generally takes place before the flower fully opens, which minimizes the chances of cross-pollination.

Tomato performs best for fruit setting under temperatures ranging from 15°C to 20°C. Extremely high or low temperatures adversely affect pollen viability and fruit set. Since the crop is mainly self-pollinated, maintenance of varietal purity is comparatively easier than in cross-pollinated crops. However, proper isolation and rouging are still necessary to avoid contamination and maintain seed quality.

Climate and Land Requirement

Tomato grows well under tropical and subtropical climatic conditions. Moderate temperature and adequate sunlight favor healthy plant growth, flowering, and fruit development. Excessive rainfall and humidity during flowering and fruit ripening are undesirable because they increase disease incidence and reduce seed quality.

The field selected for seed production should be fertile, well-drained, and free from volunteer tomato plants. The previous crop should not be the same tomato variety because volunteer plants may cause contamination and reduce varietal purity. Proper land preparation is essential to create favorable conditions for seedling establishment and crop growth. The field should be ploughed thoroughly and brought to a fine tilth before transplanting.

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Isolation Distance

Isolation distance is maintained to prevent contamination from other tomato varieties and to preserve genetic purity. Although tomato is predominantly self-pollinated, a small amount of natural cross-pollination may occur through insects. For varietal seed production, an isolation distance of 50 meters is maintained for foundation seed and 25 meters for certified seed. In hybrid seed production, larger isolation distances are required because parental lines must be protected from foreign pollen. An isolation distance of 200 meters is maintained for foundation seed of parental lines and 100 meters for certified hybrid seed production. Proper isolation ensures that the seed produced remains true to type and meets certification standards.

Nursery Management and Seed Rate

Healthy seedlings are essential for successful tomato seed production. Seeds are sown in raised nursery beds approximately 20 cm high. The seeds are sown in rows at a spacing of about 5 cm and covered lightly with sand. Raised nursery beds provide good drainage and reduce the incidence of seedling diseases.

Approximately eight to ten nursery beds are sufficient to produce seedlings for one acre of cultivation. Application of diammonium phosphate before pulling out seedlings promotes vigorous growth and healthy transplanting material. The seed rate for varietal seed production is about 300–400 grams per hectare. In hybrid seed production, the seed requirement is lower, with approximately 25 grams per hectare for the male parent and 100 grams per hectare for the female parent.

Transplanting and Crop Management

Tomato seedlings are generally transplanted when they are 20–25 days old. Transplanting should preferably be carried out during evening hours to reduce transplanting shock and improve establishment. Healthy seedlings with well-developed roots should be selected for planting.

The recommended spacing for varietal seed production is 60 × 45 cm. In hybrid seed production, wider spacing is maintained for the female parent, generally 90 × 60 cm, while the male parent is planted at 60 × 45 cm spacing. Proper spacing ensures good aeration, efficient sunlight penetration, and easier field operations such as rouging and harvesting.

Before transplanting, about 25 tonnes of farmyard manure per hectare are incorporated into the soil. Balanced fertilization with nitrogen, phosphorus, and potassium is essential for healthy vegetative growth, flowering, and fruit development. Proper irrigation should be maintained throughout the crop growth period, particularly during flowering and fruit formation stages.

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Weed Management

Weeds compete with tomato plants for nutrients, moisture, sunlight, and space, resulting in reduced plant growth and seed yield. They may also harbor insect pests and disease-causing organisms. Therefore, effective weed control is necessary throughout the crop growth period. Weed management is achieved through a combination of hand weeding, intercultural operations, and herbicide application when necessary. Early removal of weeds is particularly important because tomato seedlings are sensitive to competition during the initial growth stages. Maintaining a clean and weed-free field improves crop growth, facilitates field inspection, and enhances seed production.

Pest and Disease Management

Several insect pests and diseases affect tomato seed crops and can significantly reduce seed yield and quality. Important insect pests include leaf-eating caterpillars and fruit borers. These pests damage leaves, flowers, and fruits, reducing seed recovery and marketable yield.

Major diseases affecting tomato include early blight and tomato mosaic virus. Early blight causes leaf spots, defoliation, and reduced fruit production, while mosaic virus causes stunted growth and mottled leaves. Disease management involves the use of healthy seed, field sanitation, removal of infected plants, and application of recommended fungicides such as Benlate or Dithane M-45. Timely pest and disease management helps maintain healthy crop growth and improves seed quality.

Rouging

Rouging is one of the most important operations in tomato seed production because it helps maintain varietal purity. It involves the removal of off-type plants, diseased plants, and undesirable plants from the seed production field. Rouging is carried out based on characteristics such as plant growth habit, leaf shape, branching pattern, fruit size, fruit shape, and fruit colour. Plants affected by diseases such as early blight, leaf spot, and tomato mosaic virus should also be removed immediately from the field. Regular rouging throughout the crop growth period ensures that only true-to-type plants contribute to seed production and helps maintain certification standards.

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Fig. 3.3: Rouging in Tomato

Harvesting and Seed Extraction

Tomato fruits intended for seed extraction should be harvested only after reaching full maturity and developing their characteristic red colour. Fruits from the first and last one or two harvests are generally avoided because they may contain immature or poor-quality seeds. Fruits collected from the middle harvests usually produce seeds of superior quality.

Before seed extraction, fruits are graded and only true-to-type, healthy, medium to large-sized fruits are selected. Proper fruit selection improves seed recovery and seed quality.

The acid extraction method is considered the best method for tomato seed extraction. In this method, ripe fruits are crushed into pulp and collected in plastic or cement containers. Commercial hydrochloric acid is added at the rate of about 30 ml per kilogram of pulp and mixed thoroughly. The mixture is allowed to stand for about thirty minutes with occasional stirring. During this period, seeds separate from the pulp and settle at the bottom. The floating pulp is removed and the seeds are washed several times with clean water.

Seeds extracted by the acid method possess better colour, higher vigour, improved germination, and reduced seed-borne pathogens compared to seeds extracted by fermentation methods.

Drying, Grading, and Storage

After extraction, tomato seeds should be dried carefully under shade. Direct drying under hot sunlight should be avoided because excessive heat may damage seed viability and vigour. The seeds are dried until the moisture content reaches about 8–9 percent, which is considered safe for grading and storage.

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After drying, seeds are graded to remove undersized, damaged, and immature seeds. Grading improves seed uniformity and market value. Properly graded seeds possess higher germination and better field performance.

For storage, seeds are treated with fungicides such as captan or thiram at the rate of 2 g per kilogram of seed. Seeds stored in moisture-pervious containers can maintain viability for about fifteen months, while storage in moisture-proof containers may extend viability up to thirty months. Storage rooms should be cool, dry, and protected from insects and rodents to maintain seed quality.

Seed Certification

Seed certification ensures that tomato seed meets prescribed standards of genetic purity, physical purity, and germination. A minimum of three field inspections are conducted during the crop growth period. The first inspection is carried out before flowering to verify isolation and volunteer plants. The second inspection is conducted during flowering to check off-types and isolation requirements. The third inspection is performed before harvest to verify varietal purity and crop condition.

Certified tomato seed should possess at least 98 percent pure seed, a minimum germination percentage of 70 percent, and moisture content not exceeding 8 percent. These standards ensure that farmers receive high-quality seed suitable for cultivation.

Seed Yield

Seed yield in tomato depends on variety, climatic conditions, nutrient management, irrigation, pest and disease control, and harvesting practices. Healthy plants producing well-developed fruits contribute to higher seed recovery and better seed quality.

Under favorable environmental conditions and proper management practices, tomato seed production yields approximately 100 to 120 kilograms of seed per hectare. Proper seed extraction, drying, grading, and storage further help in maintaining seed quality and reducing post-harvest losses.

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Activities

Activity: Visit Nearby Seed Production Farm to Demonstrate Seed Production of Vegetable Crops

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

Procedure:
Write the following information:

- Visit a nearby seed production farm of vegetable crops.
- Identify and write the name of the vegetable crop grown for seed production.

- Observe and record the different stages of seed production followed in the farm.
- Note the field preparation, sowing/transplanting method, and crop management practices adopted.
- Record the isolation distance and rouging practices followed to maintain seed purity.
- Collect information about harvesting, seed extraction, processing, and storage of vegetable crop seeds.

Check Your Progress

Fill in the Blanks

1. Onion is a _____ pollinated crop.
2. Tomato belongs to the family _____.
3. Tomato is predominantly a _____-pollinated crop.
4. Tomato seedlings are generally transplanted when they are _____ days old.
5. The inflorescence of onion is called an _____.
6. The long flower stalk in onion is known as a _____.
7. In the _____ method, bulbs are selected and replanted for seed production.
8. For foundation seed production, an isolation distance of _____ meters is maintained.

Multiple Choice Questions

1. Which insect mainly helps in onion pollination?

   a) Ants

   b) Honey bees

   c) Grasshoppers

   d) Beetles

2. Which disease commonly affects tomato seed crops?

   a) Downy mildew

   b) Purple blotch

   c) Early blight

   d) Basal rot

3. Which method is widely followed for onion seed production?

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a) Seed-to-seed method

b) Bulb-to-seed method

c) Broadcasting method

d) Nursery method

4. Which weather condition is ideal during onion flowering and seed maturation?

a) Warm and dry weather

b) Cold and wet weather

c) Heavy rainfall

d) High humidity

5. What is the isolation distance for certified onion seed production?

a) 100 m

b) 250 m

c) 500 m

d) 1000 m

6. Which nutrient encourages root development and flowering in onion?

a) Nitrogen

b) Potassium

c) Sulphur

d) Phosphorus

7. Which pest is considered the most destructive in onion seed production?

a) Aphid

b) Thrips

c) Pod borer

d) Whitefly

8. What is the minimum pure seed standard for certified tomato seed?

a) 90%

b) 95%

c) 97%

d) 98%

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Match the Columns

Column A	Column B
A. Umbel	1. Insect pollinator
B. Scape	2. Flower stalk
C. Honey Bee	3. Onion inflorescence
D. Protandry	4. Removal of off-types
E. Rouging	5. Pollen released before stigma is receptive

Descriptive Questions

1. Describe the seed-to-seed and bulb-to-seed methods of onion seed production.
2. Explain the importance of isolation distance in onion seed production.
3. Describe the pest and disease management practices in onion and tomato seed production.
4. Explain the acid extraction method of tomato seed extraction.
5. Write briefly about seed certification in tomato.

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Glossary

Abiotic Stress: Adverse environmental conditions caused by non-living factors such as drought, salinity, flooding, extreme temperatures, nutrient deficiency, or water scarcity that negatively affect plant growth, development, and productivity.

Aeration: The process by which air circulates through the soil, allowing oxygen to reach plant roots and soil microorganisms while enabling carbon dioxide to escape. Good soil aeration promotes healthy root growth and nutrient uptake.

Band Placement of Fertilizer: A method of fertilizer application in which nutrients are placed in narrow bands near seeds or roots to improve nutrient uptake and reduce losses.

Biotechnology: The application of living organisms, cells, genes, or biological processes to develop useful agricultural products and technologies.

Booting Stage: The stage in rice growth when the developing panicle remains enclosed within the leaf sheath before emergence.

Breeding Institute : A scientific organization involved in developing improved crop varieties through plant breeding and genetic research.

Bund: A raised embankment of soil constructed around fields to conserve water, facilitate irrigation, and reduce soil erosion.

Bund Maker: An agricultural implement used to construct field bunds and divide fields into smaller irrigation units.

Carbon Steel: A type of steel containing carbon as its main alloying element, commonly used in agricultural machinery because of its strength and durability.

Carryover Disease : A disease that survives from one cropping season to the next through infected plant residues, soil, seeds, or volunteer plants.

Cash Crop: A crop cultivated primarily for commercial sale and profit rather than direct household consumption.

Certification Agency: An authorized organization responsible for inspecting, testing, and certifying seed quality according to established standards.

Chaff: The dry outer coverings of grains separated from seeds during threshing and cleaning operations.

Climate-Resilient Variety: A crop variety specifically developed to tolerate adverse climatic conditions such as drought, heat, flooding, or salinity.

Climatic Conditions: Long-term patterns of temperature, rainfall, humidity, wind, and other weather factors that influence crop growth.

Clod: A compact lump of soil formed after ploughing or drying that must be broken down to create a suitable seedbed.

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Compaction : The compression of soil particles that reduces pore space, restricting water movement, aeration, and root growth.

Composite Sample : A representative soil sample prepared by combining several soil samples collected from different parts of a field.

Controlled Cross-Pollination : The deliberate transfer of pollen from a selected male parent to a selected female parent under controlled conditions to produce desired offspring.

Cultivar : A cultivated plant variety that has been selected and maintained for specific desirable characteristics.

Dormancy : A temporary condition in which viable seeds do not germinate even when environmental conditions are favorable.

Earhead Bug : An insect pest that damages developing rice grains by sucking their contents during grain formation.

Emasculation : The removal of male reproductive parts from a flower before pollen release to facilitate controlled hybridization.

Endosperm : The food storage tissue within a seed that supplies nutrients to the developing embryo during germination.

Environmental Stress : Any unfavorable environmental condition that negatively affects plant growth and productivity.

Farmyard Manure (FYM) : Decomposed organic material consisting of animal dung, urine, bedding materials, and farm waste used to improve soil fertility.

Field Sanitation : Agricultural practices aimed at removing weeds, volunteer plants, diseases, and contaminants from a field.

Fine Tilth : A well-prepared soil condition characterized by small, loose, and uniform soil particles suitable for sowing.

First-In-First-Out (FIFO) : A storage management principle in which the oldest seed lots are used before newer ones.

Floral Parts : The reproductive structures of a flower, including sepals, petals, stamens, and pistils.

Flowering Period : The duration during which flowers are open and capable of pollination and fertilization.

Food Security : A condition in which all people have access to sufficient, safe, nutritious, and affordable food at all times.

Furrow : A narrow trench created in the soil by a plough for planting seeds or applying fertilizers.

Furrow Slice : The strip of soil cut, lifted, and turned over during ploughing.

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Genetic Contamination : The unintended introduction of foreign genetic material into a seed crop through cross-pollination or mixing.

Genetic Diversity : The variation in genes and genetic characteristics among individuals within a species.

Genetic Engineering : The direct modification of an organism's DNA to introduce or alter specific traits.

Genetic Identity : The unique genetic constitution of a variety that distinguishes it from others.

Genetic Improvement : The enhancement of crop characteristics through breeding, selection, or biotechnology.

Genetic Material : The hereditary material, primarily DNA, that contains information responsible for inherited traits.

Genetic Potential : The maximum performance capability of a plant determined by its genetic makeup.

Genetic Purity : The degree to which a seed lot contains only seeds of the intended variety without contamination.

Genetic Purity Standard : The minimum percentage of plants or seeds that must conform to the characteristics of a specific variety for certification.

Germination Capacity : The ability of seeds to sprout and develop into healthy seedlings under suitable conditions.

Godown : A warehouse used for storing seeds, grains, and agricultural commodities.

Grading : The process of separating seeds according to size, weight, shape, and quality characteristics.

Grain Filling Stage : The stage during which nutrients accumulate in developing grains, determining final grain weight and quality.

Green Manure : A crop grown specifically to be incorporated into the soil to improve fertility and organic matter content.

Grow-Out Test : A field test used to determine the genetic purity and varietal identity of a seed lot.

Heterosis (Hybrid Vigor) : The superior performance of hybrid offspring compared to their parents in traits such as growth, yield, or resistance.

Hybridization : The process of crossing genetically different parent plants to produce hybrid offspring.

Improved Seed Variety : A variety developed through scientific breeding to possess superior traits such as high yield and disease resistance.

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Inflorescence : The arrangement or cluster of flowers on a plant. In rice, it is called a panicle.

Isolation Distance : The minimum prescribed distance maintained between a seed crop and related crops to prevent unwanted cross-pollination.

Kharif Season : The monsoon cropping season in India, generally extending from June to October.

Mechanical Injury : Physical damage caused to seeds during harvesting, handling, processing, or storage.

Mechanical Mixture : Unintentional mixing of seeds of different varieties or species.

Mechanization : The use of machinery and equipment to perform agricultural operations efficiently.

Metabolic Activities : Biochemical processes occurring within living seeds, including respiration and energy utilization.

Morphological Traits : Observable physical characteristics such as plant height, leaf shape, flower color, and seed size.

Nursery Bed : A specially prepared area where seedlings are raised before transplanting.

Panicle : The branched flower cluster of rice that bears spikelets and grains.

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

Physiological Maturity : The stage at which seeds attain maximum dry weight, vigor, and viability.

Plant Breeding : The science of developing improved crop varieties through selection and hybridization.

Plant Protection Measures : Practices used to protect crops from pests, diseases, weeds, and other harmful factors.

PPE (Personal Protective Equipment) : Safety equipment such as gloves, masks, boots, and goggles used during agricultural operations.

Productivity : The efficiency with which agricultural resources are converted into crop output.

Pulverization : The process of breaking soil into fine particles suitable for seed germination and plant growth.

Quartering Method : A standard sampling procedure used to obtain representative soil or seed samples by repeated division and mixing.

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Relative Humidity : The amount of moisture present in the air expressed as a percentage of the maximum moisture the air can hold.

Respiration : The biological process through which living seeds consume oxygen and stored food to release energy.

Rotavator : A tractor-operated implement with rotating blades used for soil pulverization and seedbed preparation.

Salinity : The concentration of soluble salts in soil or water that may adversely affect crop growth.

Seed Aging : The gradual decline in seed quality, vigor, and viability during storage.

Seed-Borne Diseases : Diseases transmitted through infected seeds and capable of affecting crop growth.

Seed Deterioration : The irreversible decline in seed quality caused by aging, pests, diseases, or unfavorable storage conditions.

Seed Lot : A specific quantity of seed produced and handled under uniform conditions and identified by a unique number.

Seed Multiplication : The systematic increase of seed quantity through successive classes of seed production.

Seed Processing : Operations such as cleaning, grading, drying, treating, and packaging performed to improve seed quality.

Seed Rate : The quantity of seed required for sowing a specific area of land.

Seed Vigor : The overall strength and ability of a seed to germinate rapidly and establish healthy seedlings.

Shattering : The premature shedding of mature seeds or grains before harvesting.

Standing Water : Water maintained on the soil surface during rice cultivation to support growth and suppress weeds.

Stubble : The lower portion of crop stems left in the field after harvest.

Surface Runoff : Water flowing over the soil surface rather than infiltrating into the ground.

Stress Tolerance : The ability of plants to survive and remain productive under adverse environmental conditions.

Threshing : The process of separating grains or seeds from harvested plants.

Traceability : The ability to track the origin, production history, processing, storage, and distribution of a seed lot.

Uniform Crop Stand : A crop population in which plants emerge and grow evenly throughout the field.

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Uniformity : Consistency among plants of a variety in growth, maturity, size, and other characteristics.

Varietal Identity : The assurance that a seed lot belongs to the specific variety claimed by the producer.

Viability : The ability of a seed to remain alive and germinate successfully under favorable conditions.

Volunteer Plants : Unwanted plants that emerge from seeds left in the field from a previous crop.

Waterlogging : A condition in which soil becomes saturated with excess water, reducing oxygen availability to roots.

Weed Control : The management and elimination of unwanted plants that compete with crops for resources.

Winnowing : The process of separating lighter materials such as chaff from heavier grains using air movement.

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Answer Keys

Unit 1 Session 1

Fill in the Blanks

1. Seeds
2. Cross
3. Heterosis
4. Varieties
5. Biotechnology

Multiple Choice Questions

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

Unit 1 Session 2

Fill in the Blanks

1. Ovule
2. Embryo
3. Genetic
4. Variety
5. Roguing

Multiple Choice Questions

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

Match the Columns

A → 2, B → 1 , C → 3, D → 4, E → 5

Unit 2 Session 1

Fill in the Blanks

1. volunteer
2. zigzag
3. quartering
4. Nucleus
5. Breeder
6. blue

Multiple Choice Questions

1-C, 2-B, 3-C, 4-D, 5-C, 6-B, 7-D

Match the Columns

A → 2, B → 4 , C → 3, D → 1 , E → 5

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Unit 2 Session 2

Fill in the Blanks

1. Tillage
2. Primary
3. Retention
4. Secondary
5. 30–45

Multiple Choice Questions

1-B, 2-C, 3-B, 4-D, 5-C, 6-A

Match the Following

1 – B, 2 – C, 3 – A, 4 – D

Unit 3 Session 1

Fill in the Blanks

1. Poaceae
2. Panicle
3. 3
4. Cross
5. Tassel
6. 400
7. Dehusking

Multiple Choice Questions

1-B, 2-A, 3-C, 4-D, 5-C, 6-B, 7-C

Unit 3 Session 2

Fill in the Blanks

1. Urd
2. Nitrogen
3. 6.0, 7.5
4. 3–4
5. Self

Multiple Choice Questions

1-C, 2-C, 3-B, 4-B, 5-A, 6-C, 7-D, 8-C

Match the Columns

A → 2 , B → 3 , C → 4 , D → 1 , E → 5

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Unit 3 Session 3

Fill in the Blanks

1. Cross
2. Solanaceae
3. Self
4. 20–25
5. Umbel
6. Scape
7. Bulb-to-seed
8. 1000

Multiple Choice Questions

1-B, 2-C, 3-B, 4-A, 5-C, 6-D, 7-B, 8-D

Match the Columns

A → 3, B → 2, C → 1, D → 5, E → 4

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