CROP PRODUCTION LEVEL- IV
Based on March, 2022 Version 4 Occupational standard



Module Title: Seed multiplication and quality control

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Introduction to the Module

This module covers the knowledge, skills and attitude required in the selection of quality seed or planting materials, multiplication of improved crop seeds and other planting materials. It includes planning and preparing for seed multiplication, preparing land and sowing, maintaining the field, managing weeds and pests, harvesting, grading of seeds processing/post-harvest seed treatments of seeds and storage.

LG #40	LO #1: Select quality seed/ planting materials

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Identification of crop types and seed class (E.G)
- Quality seed assessments parameters
- Causes of quality seed deterioration
- Seed quality standards
- Seed selection and measurement
- Seed treatment application and detrimental environmental impacts
- Relevant legislation and regulations relating to OHS (E.G)

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Identify crop types and seed class (E.G)
- Assess quality seed parameters
- determine causes of quality seed deterioration
- Identify seed quality standards
- Select and measure seed
- Seed treatment application and detrimental environmental impacts
- Relevant legislation and regulations relating to OHS (E.G)

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet 1

Introduction

Seed is a mature ovule consisting of an embryonic plant together with a store of food, all surrounded by a protective coat. It is any plant part used for the purpose of further propagation or multiplication.it is also termed as propagule. A seed, stands for any of the following used for sowing or planting,

Types of Planting Materials

- Seeds (seasoning herbs, legumes, corn)
- Seedlings (most vegetable crops)
- Cuttings (cassava, potato, yam, ginger, dasheen, tannia, eddoes)
- Suckers (banana, plantain)
- Budded/ grafted plants (fruit trees)
- Corms
- Bulbs.

Quality seed must be high in germination, relatively free from insect or mechanical damage, pure for the crop variety, and contain little or no inert matter or weed seeds. For maximum profit quality seed must be used in conjunction with good cultural practices, correct fertilizer rates, and adequate control of plant pests.

There are several factors to consider when selecting the seed type to plant in the crop production unit as follows:

- Fertilizer requirements on improved seed will be higher than for native lines
- Save their own seed shall be the one saved from cropping season to next by the farmer
- Seed storage and handling.

Difference between seed and crop production

Seed production

- Basic seed should be from an authentic source.
- Seed plot should be selected carefully for better performance, as per edaphic and environmental requirement.
- Needs isolation from other varieties.

- Needs technical skill for maintenance of quality
- Maintenance of genetic purity is importance
- Rouging is compulsorily practiced
- Harvesting should be done at physiological/ harvestable maturity
- Resultant seed should be vigorous and viable
- Importance is given to seed quality rather than the yield

Crop production

- Any seed material can be used
- Can be grown in any area
- Isolation is not necessary
- Special technical skill is not required
- Genetic purity is not required
- Roguing is not required
- Harvested at field maturity
- Question of viability does not arise
- Importance is given more to yield

1.1 Identify crop types and seed class (E.G)

A crop is a plant or plant product that can be grown and harvested for profit or subsistence. By use, crops fall into six categories: food crops, feed crops, fiber crops, oil crops, ornamental crops, and industrial crops. Food crops, such as fruit and vegetables, are harvested for human consumption. Grains, such as corn, wheat, and rice, are the world's most popular food crops.

1.1.1. Identify crop types

A crop is a plant or plant product that can be grown and harvested for profit or subsistence. By use, crops fall into six categories: food crops, feed crops, fiber crops, oil crops, ornamental crops, and industrial crops.

Food crops, such as fruit and vegetables, are harvested for human consumption. Grains, such as corn, wheat, and rice, are the world's most popular food crops. Food crops were the first crops to

be harvested through agriculture. Agricultural development and the growth of civilizations led to the diversity of other types of crops.

Feed Crops: Feed crops such as oats and alfalfa are harvested for livestock consumption. These crops contain nutrients that animals need to develop. Animals feed directly on forages, such as grasses. Forages that are cut and fed to livestock while they are still fresh are called green chop. Alfalfa is a popular crop fed to livestock as green chop.

Fiber Crops: Fiber crops, such as cotton and hemp, are harvested for textile and paper products. Textiles, or cloth, are made from the dried and processed fibers of certain plants. Most fibers used to make textiles are taken from the stem or roots of plants such as flax. Flax is used to make linen.

Oil Crops: Oil crops, such as canola and corn, are harvested for consumption or industrial uses. Oil crops are harvested for use in cooking, such as olive oil and corn oil. Oil crops are also harvested for industrial use, such as oil paints, soaps, and lubrication for machinery.

Fuel made from oil crops is called biofuel. The demand for biofuels has grown in recent years. Rising gas prices, concerns about global warming, and a desire for energy self-sufficiency have led governments and businesses to invest in biofuel research.

There are two main types of biofuel that use oil crops: bioethanol and biodiesel. Bioethanol is an alcohol made from fermented materials that come from sugar and starch crops. These crops include sugar cane, corn, and wheat. Bioethanol can be used as a fuel for vehicles, but it is usually used as a gasoline additive to improve vehicle emissions. Bioethanol is used widely in the United States and Brazil, where an abundance of corn and sugar cane crops facilitate its production.

Ornamental Crops: Ornamental crops, such as dogwood and azalea, are harvested for landscape gardening. Ornamental crops are most often grown in nurseries, where they are purchased for residential or commercial settings

Industrial Crops: Industrial crops, such as rubber and tobacco, are harvested for their products' use in factories or machines. Industrial crops include all crops used in the production of industrial goods, such as fiber and fuel products.

1.1.2. Identify seed classes

- Seed is the basic and most important input for sustained agricultural production.
- At the time of release of a variety, small quantity of seed normally known as **Nucleus seed** is available with the plant breeder. It is the initial number of pure seed of improved variety or parental lines of a hybrid produced under supervision of the plant breeder who has evolved that variety of hybrid.
- Commercial quantity of seed is produced after a series of multiplication steps. Starting from maintenance programme in which nucleus seed is multiplied in a generation system of multiplication as breeder, foundation and certified seed.

There are four classes recognized by the International Crop Improvement Association. These are briefly described here.

A. Breeder Seed

- It is also known as **nucleus seed** and is produced directly under the supervision of plant breeder and possessed all the required genetic characters.
- Such seeds have high genetic value and due to very little in quantity possess high cost.
- Breeder seed is used to produce foundation seed.
- In case of self-pollinated species, mass selection may be regularly practiced to retain the genetic purity of the variety.
- Tag color is yellow.

B. Foundation seed

- It is also known as **mother seed** because such seeds are the source of all other certified seed classes either directly or through registered seed.
- Such seeds are produced from breeder seed by State National Seed Corporation (NSC), State seed Corporation under technical guidance of qualified plant breeders or research scientists.

- White tag denotes foundation seed.

C. Registered seed

- It may be produced from foundation seed or registered seed itself and its production is supervised and approved by certification agency.
- It has satisfactory genetic value and purity and is usually produced by progressive farmers on their field under supervision of SSC and or NSC.
- It has purple tag.

D. Certified seed

- Such seeds may be progeny of foundation seed or registered seed or certified seed itself.
- Its production is supervised and approved by state seed certification agency.
- The seed of this class is normally produced by the State and National Seeds Corporation and Private Seed companies on the farms of progressive growers.
- This is the commercial seed which is available to the farmers for commercial crop production and its genetic purity should be 99%.
- It has blue tag.

1.2 Quality seed assessments parameters

Seed testing is required to assess the seed quality attributes of the seed lots which have to be offered for sale. These quality attributes are seed moisture content, germination and vigor, physical and genetic purity, freedom from seed borne diseases and insect infestation. The quality of seeds is assessed based on various parameters to ensure their suitability for planting. Some essential seed quality assessment parameters include.

- Purity: is an expression of how clean the seed lot is indicating the absence of impurities such as other crop seeds, weed seeds and inert matter
- The moisture content: it is a critical parameter as it affects their storability and longevity. High moisture content can lead to seed deterioration and loss of viability.
- Germination and viability: These parameters determine the percentage of seeds that are likely to germinate and produce normal seedlings under favorable conditions. It is a key indicator of seed quality.

- Vigor: Seed vigor tests are used to assess the seed's potential for rapid, uniform emergence and establishment of normal seedlings under a wide range of field conditions.
- Genetic purity: This refers to the genetic composition of the seed lot, ensuring that it is true to its declared variety or cultivar.
- Seed health: The absence of infection or infestation with seed-borne pests such as fungi, bacteria, viruses, nematodes, and insects is crucial for ensuring seed quality and a healthy crop.

1.3 Causes of quality seed deterioration

Seed deterioration can be defined as "deteriorative alterations occurring with time that increase the seed's exposure to external challenges and decrease the ability of the seed to survive". Seed deterioration causes loss of seed quality with time.

Deterioration of seed starts with its formation on the mother plant till the development of seedling by the seed in the next generation. Deterioration is evident as a decrease in percentage germination, while those seeds that germinate produce weak seedlings. Losses in seed quality occur during field weathering, harvesting and storage.

Seed deterioration is a natural process that involves cytological, physiological, biochemical, and physical changes in seeds, which reduce viability and ultimately cause death of the seed. The exact finite reasons for seed deterioration are not known, but many factors contribute to it. The major causes of seed deterioration include environmental conditions prior to harvest, abuse (mechanical damage), temperature, and humidity. Seeds that have been broken, cracked, or bruised due to handling deteriorate more rapidly in storage than undamaged seeds. Cracks in seeds serve as an entrance to pathogens causing consequent deterioration.

Seeds that have been developed under environmental stress conditions (such as drought, nutrient deficiency, and high temperatures) become more susceptible to rapid deterioration. High temperature hastens the rate of biochemical processes, triggering more rapid deterioration that

results in the loss of seed quality. Field weathering, harvest and post-harvest deterioration, and storage are other factors that contribute to seed deterioration.

1.4 Seed quality standards

The primary aim of the seed testing is to obtain accruable and reproducible results regarding the quality status of the seed samples submitted to the Seed Testing Laboratories. The seed samples received in the Seed Testing Laboratories are analyzed and results are communicated to the concerned. The following tests are conducted: Germination, Physical purity, O.D.V.(Other Distinguishable Variety) and Moisture.

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

Table 1.1 Minimum seed standards

Sl.No	Crop	Submitted sample (in gm)		Working sample	Phy. purity %	Germi-nation %	Moisture %	O.D.V.	
		CS	SS					FS	C
I	**Cereals &Millets**								
1.	Paddy	400	50	40	98	80	13	0.05	0.2
2.	Sorghum- Hy & var	900	100	90	98	75	12	10/kg	20/kg
3.	Maize – inbreds	1000	500	900	98	80	12	0	5/kg
	Maize – others	1000	500	900	98	90	12	5/kg	10/kg
4.	Barley	1000		120	98	85	12	10	20
5.	Oats	1000		120	98	85	12	10	20
6.	Wheat	1000		120	98	85	12	0	0
II	**Pulses**								
7.	Redgram-Hy &var	1000	150	300	98	75	9	10	20
8.	Black gram	1000	100	150	98	75	9	10	20
9.	Green gram	1000	100	120	98	75	9	10	20
10.	Cowpea	1000	150	400	98	75	9	5	10
11.	Horse gram	500	100	500	98	80	9	5	10

12.	Peas	1000	250	900	98	75	9	5	10
13.	French bean	1000	450	700	98	75	9	5	10
14.	Field bean	1000	450	600	98	75	9	0	0
III	**Oil seeds**								
14.	Ground nut	1000	500	1000	96	70	9	0	0
15.	Sunflower-V/Hy	1000/250	100	250/125	98	70	9	0	0
16.	Castor	1000	250	1000	98	70	8	5	10
17.	Soybean	1000	150	500	98	70	12	10	20
	Fibre crops								
18.	Cotton (Hy)	350-L 250-DL	200 100	35 25	98	65	10	0	0
19	cotton (var)	1000-L 350-DL	350 150	350 35	98	65	10	0	0
IV	Vegetable crops								
20.	Ash gourd	700	100	70	98	60	7	0	0
21.	Bittergourd V/Hy	1000	250	450	98	60	7	5	10
22.	Bottle gourd	700	100	70	98	60	7	0	0
23.	Ridgegourd Hy/var	1000	150	400	98	60	7	5	10
24.	Snakegourd	1000	250	250	98	60	7	0	0
25.	Watermelon V/Hy	1000	100	250	98	60	7	5	10
26.	Cucumber V/hy	150	100	70	98	60	7	0	0
27.	Pumpkin V/Hy	350	100	180	98	60	7	0	0
V	**Fruit vegetables**								
28.	Brinjal V/Hy	150	10	15	98	70	8	0	0
29.	Chillies	150	10	15	98	60	8	0	0
30.	Bhendi	1000	100	140	99	65	10	10	20
31.	Tomato V/Hy	7(hy),70	10	7	98	70	8	0	0
32.	Greens	70	50	7	95	70	8	10	20
VI	**Cole crops**								
33.	Cabbage	100	10	10	98	70	7	0	0
34.	Caulliflower	100	10	10	98	65	7	0	0
VII	**Bulb crops**								
35.	Onion V/Hy	80	10	80	98	70	8	0	0
VIII	**Root crops**								

36.	Carrot V/Hy	30	10	3	95	60	8	5	10
37.	Beet root	500	50	50	96	60	9	0	0
38.	Radish V/Hy	300	50	30	98	70	6	0	0
39.	Turnip V/Hy	70	10	7	98	70	6	0	0
40.	Cluster bean	1000	100	100	98	70	9	10	20
VIIII	**Forage crops**								
41.	Sunhemp	700	50	70	98	80		0	0
42.	Daincha	900	25	90	98	70		0	0
43.	Lucerene	50	25	5	98	80	10	0	0
44.	Cenchrus	25		3	80	30	10	0	0
45.	Stylosnathus	70		7	90	40	10	10	20
46.	Kolinji			90		70		0	0
X	**Miscellaneous**								
47.	Palak	250	25	25	96	60	9	0	0
48.	Spinach	250	25	25	98	70		0	0
49.	Papaya	400		40	98	60	12	0	0
50.	Moringa	1000		750	96	70	8	0	0
51.	Coriander	400		40	95	65		0	0

The quality assurance program defines procedures for: seed receival, seed cleaning, seed treatment, seed storage, documentation, packaging and labeling and seed dispatch. Seed net has extensive practical experience in seed processing and is familiar with the standards of the various seed processors.

Seednet is selective in its use of seed processors and will use only those facilities, which meet, or exceed, our standards. These seed processors must comply with our full range of Quality Assurance (QA) procedures and must be able to supply the relevant documentation to demonstrate QA compliance.

1.5 Seed selection and measurement

The seeds selected for cultivation should be of uniform size, age and free of contaminants. They should also have good germination capacity. To separate good seed from bad, soak them in water: the unviable seeds will float on the surface of water. These seeds can be easily removed and the seeds that sink can be used for cultivation. By this method, damaged seeds are easily removed.

Another method is used when there is an excess of chaffy grain in the seed stock. Take some water in a vessel and drop an egg in it. Keep adding salt slowly till the egg reaches the surface. When the seeds are dropped into the water, the good quality seeds will sink. Remove the unviable seeds that float on the surface of the water. Wash the selected seeds in good water 2–3 times to remove the salt deposits. If this is not done, the germination capacity of the seeds will be affected.

Seed rate is the number of seeds to be planted in a specified surface or area to achieve an adequate stand. The correct plant population is an important factor in maximizing yield of crops. It will help the overall health of the plant and vigor of the plant. To obtain the targeted population it is necessary not only to have quality sowing seed but also be able to accurately calculate seeding rates. It is surprising the difference a slight variation in seed size or germination makes to the seeding rate required to achieve a target plant density. Seed size, quality and germination vary between varieties, from year to year, from field to field and should be checked for each seed line to be used.

Use the following formula to calculate

Seed rate $Planting\ Rate = Target\ population\ (\ ha\ )\ Seed\ per\ kg\ X\ Establishment\ \%\ X\ Germination\ \%$

Seed rates can be determined by the following formula:

A. Seed rate (kg ha^{-1}) = $\frac{10\left(DPP + \frac{DPP \times PSA}{100}\right)}{PP \times PG \times 1000} \times WTS\ (g)$

B. Seed rate (lb ac^{-1}) = $\frac{10\left(DPP + \frac{DPP \times PSA}{100}\right)}{PP \times PG \times 453.6} \times WTS\ (lb)$

The above formulae have many limitations and are seldom used.

C. SR (g ha^{-1}) = $\frac{DPP/ha \times NS/H \times ISW \times MF}{PP \times PG \times FF}$

D. For dibbling and discontinuous line sowing of vegetative planting materials:

SR_{ddp} (g ha^{-1}) = $\frac{DNH/ha \times NS/H \times ISW\ (g)}{PP}$

E. For transplanting system:

SR_t (g/ha) = $\frac{DNH/ha \times NS/H \times ISW\ (g)}{PP \times PG \times FF}$

F. For broadcasting or continuous line sowing:

SR_{bc} (g/ha) = $\frac{DPP/ha \times ISW\ (g) \times MF}{PP \times PG \times FF}$

Where,

DPP = Desired plant population
PSA = Percentage of safety allowance

Activate Windows

PP = Purity percentage
PG = Germination percentage
WTS = Weight of thousand seeds
ISW = Individual seed weight
DNH/ha = Desired number of hill/ha
NS/hill = Number of seedling/hill
MF = Method factor

1.6 Seed treatment application and detrimental environmental impacts

1.6.1. Apply seed treatment

Seed treatment refers to the application of fungicide, insecticide, or a combination of both, to seeds so as to disinfect and disinfect them from seed-borne or soil-borne pathogenic organisms and storage insects. It also refers to the subjecting of seeds to solar energy exposure, immersion in conditioned water, etc. It can improve seed germination, seedling emergence, plant vigour, stand establishment and total yield, helping to ensure the crop or pasture is on its way to reaching its full genetic potential.

The first four to six weeks after sowing is a critical period in the life of a new plant, as seedlings emerge and develop their physical make up. Sowing treated seed provides protection during the germination and establishment stages when emerging seedlings are most vulnerable to attack from invasive insect pests and disease pathogens.

Benefits of Seed Treatment

- Agronomic benefit**:** Seedlings protected by seed treatment are in a better position to withstand environmental stresses, including pest and disease pressure.
- Targeted protection**:** Seed-applied chemicals are targeting specific against a range of economically damaging insect pests and diseases during the plant establishment period.
- Improves sowing accuracy**:**
- User-friendly: Reduces the need to handle chemicals on farm. It also allows more flexibility when weather conditions make it difficult to apply broad acre crop protection products.
- Low dose: Small amounts of pesticides are used in seed treatments compared to broadcast sprays. This reduces the environmental impact.
- Precision targeting: Very little insecticide is applied to non-target sites, or to non-target organisms' e.g. beneficial insects. Soil insects and insects that attack the seedlings as they are emerging can be controlled or deterred.

Disadvantages of seed treatment

- Limited protection under high pest pressure: Under high pest pressure, significant crop damage may occur. Even through pests are killed when they feed on the treated seedling,
- Duration of protection: Seed treatment may not provide protection for long enough to provide complete protection to the establishing crop. Pesticide breakdown is most rapid under warm, moist conditions.
- Limited shelf life of treated seed: Surplus treated seed cannot be sold for grain. This is a particularly serious limitation for seeds such as soybean, where seed germination and vigour decline relatively quickly.

- Phytotoxicity: Some seed treatments may be phytotoxic when applied at high rates. Cracked, sprouted, and scuffed seeds are particularly susceptible to toxic effects.

1.6.2. **Detrimental environmental impacts on seed multiplication**

Temperature is the most dominant signal across species, and even small differences in temperature can have important consequences for seed dormancy. Environment during seed production can affect seed dormancy, germination, and other traits, and these effects can cross whole generations. Climate change can also have detrimental impacts on seed production. Adverse climatic factors can result in a loss of quality and quantity of seeds, leading to lower market value and non-availability.

Overall, environmental factors such as temperature, climate change, and weather aberrations can have detrimental impacts on seed multiplication, affecting seed dormancy, germination, and other traits. It is important to consider these factors when planning seed production and to take measures to mitigate their negative impacts.

1.7 Relevant legislation and regulations relating to OHS (E.G)

Ethiopia has had a regulation on Occupational Safety and Health (OSH) since the 1940s, and the Ministry of Labor and Social Affairs (MOLSA) is the state organ that regulates workers' safety both in private and state-owned sectors. Ethiopia has ratified about 20 ILO conventions, including core conventions such as Occupational Safety and Health Convention, 1981 (No. 155). The national level policy on Occupational Safety and Health (OSH) has recently been developed, and Ethiopia is expected to develop a local OSH Policy that harmonizes the relationship.

The Ethiopian OSH Directive-2008 provides guidelines for employers to comply with safety and health measures. The directive includes standards, codes, and guidelines that employers must follow. The Ministry of Labor and Social Affairs of Ethiopia is the organ charged with the responsibility to inspect labor administration, labor conditions, occupational health, and safety. The Carter Center provides a lecture note on the legal framework of Ethiopia, including labor regulation and occupational health and safety.

Self-check 1	Written test

Directions: Answer all the questions listed below.

Part I. Write true if the statement is correct false if not

1. Quality seeds or planting materials significantly impact the overall crop yield.
2. The germination rate is an important factor to consider when selecting quality seeds or planting materials.

Part II. Choose the correct answer from the following alternatives

1. Which of the following factors should be considered when selecting quality seeds or planting materials?
   a) Seed/Planting material source c) Price and availability
   b) Physical appearance only d) Color and fragrance
2. What is the importance of selecting quality seeds or planting materials?
   a) Quality seeds ensure uniform plant growth and higher yields
   b) Quality seeds have better resistance to pests and diseases
   d) Quality seeds enhance the aesthetic appeal of the garden
3. When selecting quality seeds, it is important to consider the:
   a) Expiration date c) Packaging color
   b) Seed germination rate d) Brand popularity

Part III: Short Answer Questions

1. What is the importance of selecting quality seed or planting materials in agriculture?
2. What is seed vigor, and why is it important in selecting planting materials?
3. What physical characteristics should be evaluated when assessing seed or planting material quality?
4. How does selecting high-quality seed or planting materials contribute to overall crop productivity and success?

Operation sheet – 1	Apply pre-planting seed treatments

Operation sheet 1.1: Physical seed treatment

Hot water treatment

Step 1 Place seeds to be treated in porous containers, leaving enough room for the seeds to move around freely. Label each porous container with the seed type.

Step 2 Preheat seeds: Preheat the first bath/pot to 100°F (38°C) and the second bath/pot to 120°F (49°C).

Step 3 Treat seeds: Place the seeds in the first bath/pot and heat them to 100°F (38°C) for 10 minutes, then transfer them to the second bath/pot and heat them to 120°F (49°C) for 10 minutes.

Step 4 Cool seeds: After treatment, place contained seeds in cold tap water for 5 minutes to stop heating action.

Step 5 Dry seeds: Take the seeds out of the container and spread them in a uniform layer on a screen to dry.

https://www.youtube.com/watch?v=Ie3H_icKWb4

Operation sheet 1.2: Chemical seed treatment

Step 1 Contain seeds: Place seeds to be treated in a jar or porous container, leaving enough room for the seeds to move around freely.

Step 2 Apply chemical: For small quantities of seeds, spread one to two teaspoons of the dry fungicide over the seed and shake or rotate the jar until each seed is thoroughly coated with the chemical. For larger quantities, use a dry fungicide and apply it to the seed according to the manufacturer's instructions.

Step 3 Dry seeds: Take the seeds out of the container and spread them in a uniform layer on a screen to dry.

https://www.youtube.com/watch?v=nax0F7t3VCQ

LAP TEST-1	Performance Test

Name……. ID……..

Date…….

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **1** hour. The project is expected from each student to do it.

Task-1 You are required to perform physical seed treatment

Task-2 You are required to perform chemical seed treatment

LG #41	LO #2- Plan and prepare land for seed multiplication

Instruction sheet 2

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Planting material requirements
- Seed multiplication production scheduled
- Employing proper seed multiplication site
- Selection, preparation and cultivation for crop establishment
- Assessing nutrient deficiency and soil toxicity problems
- Application of soil amendment practices.
- Preparing machineries, equipment and other farm inputs

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Identify planting material requirements
- Understand seed multiplication production scheduled
- Employ proper seed multiplication site
- Select, prepare and cultivate for crop establishment
- Assess nutrient deficiency and soil toxicity problems
- Apply of soil amendment practices.
- Prepare machineries, equipment and other farm inputs

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks

Information Sheet 2

2.1 Planting material requirements

Characteristics/qualities of a good seed for planting

- Seeds should be free of weed/other plant seeds.
- Seeds should be free of soil or seed borne diseases.
- Seeds should be free from insect or any other damage.
- Should be tolerant to temporary climatic variations.
- Should be from variety which is high yielding
- They should be uniform in shape, color and size
- They should be from a variety which is resistant to pests and diseases
- Should have long shelf life i.e. longevity
- Should be viable/high viability i.e. ability of a seed to germinate.

Success of the crop always depends on type of planting materials and climatic conditions. How favorable the climate might be, if you start with the poor planting materials, the result will be always disappointing. So select/purchase planting materials from recognized or trusted sources.

2.2 Seed multiplication production scheduled

Monitoring of seed production programmes: The targets with name of producing breeder and centre for the production of nucleus and breeder seeds. The monitoring of seed production programme is being done by internal monitoring teams, representatives of the respective Coordinator/Project Director, monitoring team constituted by respective Coordinator/Project Director, official monitoring team for breeder seed production.

Seed distribution: The breeder seed produced is being supplied against the indents. The surplus breeder seed is being made available to indenters on first cum first served basis. Seed is being supplied directly to the farmers/seed societies/private seed sectors through seed counters of the university.

Seed extension activities: Seed Village Scheme is operated in twenty two districts of the state located in the jurisdiction of the university. The surplus breeder/ Seed of improved varieties of various crops are also made available to the farmers/ private seed sectors to create seed demands.

Maintenance breeding: The maintenance of recommended and notified crop varieties is basic requirement for maintaining the genetic purity, seed chain and production of nucleus seed. Maintenance breeding is therefore in operation with help of dedicated team of crop breeders working in different research project at different centers. The genetic purity of parents of released hybrids in sorghum, maize, pigeon pea and caster was also maintained.

Nucleus seed production: Nucleus seed is produced from either single plant progenies or bulk seed of single plant progenies. It is starting point of seed multiplication chain. The target for production of nucleus seed is decided considering the demand and indent of breeder seed in different crops as well as demands of the varieties.

Breeder seed production: Breeder seed is the back bone of the quality seed production programme as quality seed is very crucial and essential for increasing the production and productivity of any crop.

Roughing: is the removal of individual plants which differ significantly from the normal type of the variety. The most important object of the seed production is to maintain genetic purity of the variety or hybrids seed plot. Rouging consists of removal of Off types Plant, Volunteer plants Pollen shedders in female (A) lines, Plants of noxious weeds and other crops, Diseased plants affected by seed borne diseases growing in the seed plot and Tassels from plants in the female rows of seed production of single hybrids and double hybrids in maize.

Field Inspection: As per provisions of seed certification, the seed plots offered for certifications are subjected to field inspection by the staff of seed certification agency.

- The number of field inspections is usually carried without prior intimation to the seed producer. It is the responsibility of the seed producer to follow the instructions given by the field inspector.
- Seed producer or his responsible representative remains present on the field during each inspection.

- During the field inspection, source of seed used with tag isolation planting rouging are checked and counts of off types, shedders etc are taken.

Harvesting, Threshing, Drying and Sealing of Raw Seed:

- Seed plot should be harvested at proper stage of maturity and only after permission is granted by the field inspector.
- After harvesting the crop, it should be brought to threshing yard for drying care should be taken to see that there will not be contamination with other varieties in the produce of seed plot.
- The seed produce be threshed and winnowed for removing major part of inert matter. i. e Stones, sand , dried twigs, leaves, husk etc.
- The cleaned seed produce should be bagged in the presence of the field inspectors who ill seal the entire bags ad issue threshing certificate.
- At the time of sealing, field inspector draw 3 kg sample from each lot. In case of F/S and certified cotton seed for F.T. The seed bags should be transported to authorized seed processing plant for processing along with threshing certificate.
- It may be noted that the seed will not be accepted for processing at seed processing plant unless it is brought in bags sealed by the field inspector and issued with threshing certificate.

Seed Processing: Seed lot accepted for processing is processed at the seed draws three samples and sends one sample to seed testing laboratory for testing, one sample kept at his disposal and one sample for concerned seed producer.

Bagging, Tagging: When the seed lot is passed by seed certification agency on the basis of seed testing laboratory report (STL), than after processed and treated seed is bagged and tagged with appropriate tags issued by seed certification officer.

Release of Seed Lot: The certified seed lot is released to the seed producer for sale. But foundation seed lot is released after getting FT report.

Generally field inspections would be carried out during the following growth stages of the crop.

- Pre flowering stage

- Flowering stage
- Post flowering and Pre harvest stage
- Harvest time

2.3 Employ proper seed multiplication site

Seed (certainly breeder seed) should be produced in areas:

- Where the variety is adapted
- Where soil conditions are optimal (to achieve a high multiplication ratio); and
- Where climatic conditions are reliable to avoid loss due to natural hazards (flooding, drought, frost, etc.)
- The crop should be planted on a field with a known history to avoid contamination from volunteer plants, noxious weeds and soil-borne diseases that are potentially seed transmitted.
- A wheat seed crop should never immediately follow wheat, unless the wheat crop in the previous season was of the same variety and of the same or higher generation.
- For basic seed, it is often recommended that the field should not have been planted with wheat or other small grain crops for at least two consecutive years.
- For certified seed, no wheat crop should have been grown in the previous year.
- Seed contaminated with weeds could be the means for introduction and dissemination of noxious weeds. Fields in many countries are infested with wild oats (*Avena fatua*, *A. sterilis* and *A. ludoviciana*), noxious weeds that are spread almost all over the world and are difficult to eradicate.

2.4 Select, prepare and cultivate crop establishment

Successful crop establishment involves a combination of careful planning, proper seed selection, suitable land preparation, and ongoing management practices to create optimal conditions for crop growth. It sets the stage for the rest of the growing season and significantly influences overall crop yield and quality. Here are key points to consider regarding crop establishment:

Preparation Land: The first step in crop establishment is preparing the land for planting. This involves tasks like plowing, harrowing, and tilling to create a suitable seedbed. Proper land preparation helps improve soil structure, aeration, and drainage.

Seed Selection: Choosing the right type of seeds is crucial. Farmers select seeds based on factors such as crop variety, quality, disease resistance, and adaptability to local conditions. High-quality seeds have a better chance of germination and producing healthy plants.

Sowing: It is the act of placing seeds in the soil and can be done manually, using traditional methods like broadcasting or dibbling, or with modern machinery like seed drills. Proper seed placement ensures even spacing and depth, which is essential for uniform crop emergence.

Seeding rate: determining the appropriate seeding rate or the number of seeds to be sown per unit area is important. This rate varies by crop type and local conditions, and it affects crop density and competition for resources.

Crop rotation and Crop diversity: rotating crops and diversifying plant species in a field can help reduce the risk of soil-borne diseases and pests. It also improves soil fertility by varying nutrient demands.

Weed management: Effective weed control is essential to prevent weeds from competing with crops for nutrients, sunlight, and water.

Monitoring and Management: Regular monitoring of crop establishment is essential to identify and address issues like uneven germination, pest infestations, or nutrient deficiencies. Adjustments may be needed to optimize crop growth.

2.5 Assess nutrient deficiency and soil toxicity problems

When plants suffer from malnutrition, they show symptoms of being unhealthy. Too little or too much of any one nutrient can cause problems. Both macro- and micronutrients are naturally obtained by the roots from the soil. Plant roots require certain conditions to obtain these nutrients from the soil. Knowledge of soil pH, texture, and history can be very useful for predicting what nutrients may become deficient.

Symptoms of nutrient Deficiency

Visual nutrient deficiency symptoms can be a very powerful diagnostic tool for evaluating the nutrient status of plants. Many of the classic deficiency symptoms such as tip burn, chlorosis and necrosis are characteristically associated with more than one mineral deficiency and also with other stresses that by themselves are not diagnostic for any specific nutrient stress.

However, their detection is extremely useful in making an evaluation of nutrient status. In addition to the actual observations of morphological and spectral symptoms, knowing the location and timing of these symptoms is a critical aspect of any nutrient status evaluation.

Basic Nutrient Deficiency Terminology

Below are common terms used to describe nutrient deficiency symptoms in plant.

***Chlorosis*:** a general yellowing or whitening of the plant tissue; a lack of chlorophyll.

***Necrosis*:** death of plant tissue; usually begins with the yellowing of plant tissue, eventually browning and then death.

***Interveinal Chlorosis*:** only plant tissue between the veins of the leaves exhibit chlorotic symptoms.

***Burning or Scorching*:** severe localized yellowing or browning, exhibiting a scorched appearance

***Mottling*:** a spotted irregular or inconsistent pattern

Diagnosing Nutrient Deficiencies in Crops

The three basic tools for diagnosing nutrient deficiencies and toxicities are

A. Soil testing; B. plant analysis; and C. visual observations in the field.

Within a plant, some nutrients are mobile, while others are immobile. Generally speaking, macronutrients tend to be mobile, while micronutrients tend to be immobile. The location of symptoms on a plant plays an important role in helping us narrow down and identify which specific nutrient deficiency the plant is exhibiting.

A plant can relocate mobile nutrients, usually moving them from the older leaves to the area of new growth. Plants do this to ensure that growth continues to happen, typically when a certain nutrient is deficient. In this case, deficiency symptoms will appear in the older growth, or lower

portion of the crop. Immobile nutrients are fixed and cannot be relocated within the plant. These nutrients are usually incorporated into the structural components of plants. For example, calcium is a component of cell walls, and remains in place. Deficiency symptoms of immobile nutrients will typically and initially be located in the new growth, near the top of the plant.

Other Symptoms Easily Confused with Nutrient Deficiencies

Disease Damage: Nutrient deficiency symptoms are often mistaken for viral, bacterial, or fungal diseases, because each of these results in a yellowing and necrosis of leaves. Nutrient deficiency can typically be distinguished from pest damage and disease by its symmetry. Disease symptoms are mottled, blotchy, or unevenly positioned on the plant or leaf, while nutrient deficiencies tend to be symmetrical and evenly dispersed in the plant or leaf.

Nematode Damage: Plants affected by nematodes show stress symptoms easily confused with a variety of nutrient deficiency symptoms. Nematode damage is especially easy to confuse with N deficiency from flooding and denitrification. The former can typically be distinguished by the presence of symptoms outside of low-lying areas (not a drainage issue) and wilting on only the tops of plants. If nematodes are suspected, pull up a few plants and examine the roots for "knots"; if possible, you can have a sample sent to a local lab for accurate identification. Correctly identifying the presence of nematodes in your field can be difficult, and should be confirmed with a microscope.

Herbicide Drift: Herbicide drift can occur when herbicides are applied on a windy day, or in close proximity with other crops. If the herbicide doesn't kill the unintended target crop, it can cause damage, leaving symptoms that can be easily confused with nutrient deficiency symptoms. Again, this can usually be distinguished by an irregularity of chlorosis or necrosis, rather than a symmetrical pattern. Depending on the chemical, it can leave symptoms of severe chlorosis or symptoms of 'scorching' on leaf tips. The symptoms will come on very suddenly, most likely within 24 to 48 hours of an herbicide application. Plants have the ability to outgrow smaller levels of damage due to herbicides.

A Plant Nutrient, or Essential Element, Is Not Considered Essential Unless:

- a deficiency of it makes it impossible for the plant to complete the vegetative or reproductive stage of its life cycle;
- such deficiency is specific to the element in question, and can be prevented or corrected only by supplying this element; and
- The element is directly involved in the nutrition of the plant quite apart from its possible effects in correcting some unfavorable microbiological or chemical condition of the soil or other culture medium.

Diagnosis of nutrient status

There are different ways to express concentration, but the most common are percent (%) and mg/kg (or part per million, or ppm). Percent is commonly used for the major nutrients – N, P, K, S, Mg and Ca – while ppm is used for the micronutrients.

There may be several fundamental relationships between yield and nutrient concentration in plant tissue. The curve comprises three basic segments: ascension, where yield increases as nutrient concentration increases; a plateau, where yield is constant with increasing nutrient concentration; and a descent, where yield decreases with increasing nutrient concentration. These three segments generally represent zones of deficiency, adequacy (sufficiency) and toxicity, respectively.

Concentration or ranges of the major elements and micronutrients in mature leaf tissue generalized as deficient, sufficient or excessive for various plant species (munson, 1998).

Table 2.1 General representation of essential nutrients zones of deficiency, sufficiency and toxicity

ESSENTIAL ELEMENTS	% DEFICIENT	% SUFFICIENT OR NORMAL	% EXCESSIVE OR TOXIC
Major Elements			
Nitrogen (N)	<2.50	2.50 - 4.50	>6.00
Phosphorus (P)	<0.15	0.20 - 0.75	>1.00
Potassium (K)	<1.00	1.50 - 5.50	>6.00
Calcium (Ca)	<0.50	1.00 - 4.00	>5.00
Magnesium (Mg)	<0.20	0.25 - 1.00	>1.50
Sulfur(S)	<0.20	0.25 - 1.00	>3.00
Micronutrients	ppm	ppm	ppm
Boron (B)	5 - 30	10 - 200	50 - 200
Chlorine (Cl)	<100	100 - 500	500 - 1,000
Copper (Cu)	2 - 5	5 - 30	20 - 100
Iron (Fe)	<50	100 - 500	>500
Manganese (Mn)	15 - 25	20 - 300	300 - 500
Molybdenum (Mo)	0.03 - 0.15	0.1 - 2.0	>100
Zinc(Zn)	10 - 20	27 - 100	100 - 400

2.6 Application of soil amendment practice

Soil amendments are used in agriculture to support plant growth and development, specifically by adding organic and inorganic nutrients to the soil, and improving soil tilth, organic matter, and water holding capacity. Soil amendments are not the same as chemical fertilizers. Fertilizers are added to soils specifically to add plant-available nutrients.

Soil amendments, on the other hand, are used primarily to correct adverse chemical, physical or biological soil properties other than low nutrient availability. The distinction between amendments and fertilizers is not always clear-cut. For example, organic matter can serve as both fertilizer and soil amendment. A number of common soil problems can be treated by adding soil amendments. Some of these problems are described below.

A. Acidic soils

The purpose of liming is primarily the neutralization of the cause of soil acidity (H^+ ions and Al^{3+} in very acid soils), thus raising the pH value. Ca and Mg compounds are mainly used for the amelioration of acid soils. Most liming materials are obtained from limestone deposits that were formed in seas of earlier geological periods. The resulting limestone may be from inorganic precipitates or from carbonate shells. It can range from physically very soft material to very hard rock. Limestone reserves are immense in the form of calcitic and dolomitic mountains.

Liming materials

Common liming materials are:

- Calcium carbonate.
- A magnesium carbonate ($MgCO_3$)
- Calcium magnesium carbonate (dolomite)

B. Alkali soils

Alkali soils can be amended by the following methods

- ferrous sulphate ($FeSO_4$), which yields acid after hydrolysis with water
- Elemental S, which yields acid after oxidation by bacteria to sulphate
- Iron pyrite (FeS_2), which yields sulphuric acid after decomposition (also used for alkali soils)
- Calcium sulphate or gypsum ($CaSO_4.2H_2O$), for alkali soils.

Organic amendments

There are a tremendous variety of organic amendments, including crop residues, manures, food or other wastes, organic fertilizers, biochar, compost, and others. One important property of organics is the carbon to nitrogen ratio (C: N). the carbon percentage of organics is fairly constant at 50-60% by weight.

On the other hand, N percentage varies from well below 1% to more than 6%. Therefore, the C: N ratio of organics can be as low as 8 to as high as 200. In general, organic materials that are easily decomposed in soils have low C: N (i.e., they contain a high proportion of nitrogen) and

are valuable as fertilizers. Manures, green crop residues, and food wastes are examples of such materials. When these materials are added to soils and microbial decomposition begins, they serve as nutrient sources for plant use. When these organic amendments decompose, the nutrients they provide are no more available or beneficial to plants than those from chemical fertilizers. However, the addition of organics to soils also includes the benefit of adding organic matter.

The rate of organic matter decomposition is highly variable and depends on the chemical composition of organic material, C: N ratio, soil moisture, pH and temperature, and microbial populations. In general, microbial decomposition of organic materials is most rapid in moist, warm, and slightly acid soils.

Organic materials resistant to microbial decomposition and with high C: N ratios can serve as soil amendments but do not make good fertilizers. Brown crop residues and woody materials are examples. When they are added to soils and start to decompose, they may actually "consume" available nutrients for several weeks or months. These materials with a high C: N ratio resists decomposition, so they will persist in soils for a long time. They become an important part of humus, which contains stored carbon and which helps give soil its structure. Forming humus also encourages storage or "sequestration" of carbon in soils.

2.7 Prepare machineries, equipment and other farm inputs

The basic objective of sowing operation is to put the seed and fertilizer in rows at desired depth and seed to seed spacing, cover the seeds with soil and provide proper compaction over the seed. Sowing and planting equipment includes **seed driller, seed metering device, furrow openers, earth auger, dibbler etc.**

A. Seed drill: Seed drill is a machine for placing the seeds in a continuous flow in furrows at uniform rate and at controlled depth with or without the arrangement of covering them with soil.
B. Seed cum fertilizer drill: Seed drills, fitted with fertilizer dropping attachment, distribute the fertilizer uniformly on the ground. It is called seed cum fertilizer drill. Such a drill has a large

seed box which is dividend lengthwise into two compartments, one for seed and another for fertilizers. Seed drill may be classified as (i) Bullock drawn (ii) Tractor drawn.

C. Furrow openers: The furrow openers are provided in a seed drill for opening a furrow. The seed tube conducts the seed from the feed mechanism into the boot from where they fall into the furrows. Furrow openers should be selected according to type of **soil and depth of seed placement**.

D. Earth auger: The earth auger is a manually operated hand tool and it consists of cutter head having semicircular blades connected to pipe with the help of clamp and flange. The handle and pipe are fabricated from galvanized steel. For operation the cutter head is placed on the moist soil and rotated manually which helps in penetration of the head. The auger is repeatedly lowered into the hole until desired depth is achieved.

E. Dibbler: The hand dibbler is made from mild steel flat or leaf spring by forging operation. The working end is flattened and edge made sharp for easy penetration in the soil. The cutting edge of the tool made from spring steel is hardened and tempered to desired hardness. The tool is used in squatting position by pushing/striking the cutting edge in the soil.

F. Planter: Are implements used to plant row crops (typically in row spacing ranging from 10 to 40 inches). Planters open a seed trench, meter seeds one-at-a-time, drop seeds into the seed trench, and gently cover the seed. Planter is normally used for those seeds which are larger in size and cannot be used by usual seed drills. A planter consists of:

i. Hopper
   - Feed metering device
   - Knock out arrangement
   - Cut-off mechanism
   - Furrow opener and
   - Other accessories

ii. Rice Transplanter

The rice transplanter consists of; -

- Air cooled gasoline engine
- Main clutch
- Running clutch

- Planting clutch
- Seeding table
- Float
- Star wheel
- Accelerator lever
- Ground wheel
- Handle
- Four bar linkage mechanism.

iii. **Ridge makers**

Self-Check – 2	Written test

Directions: Answer all the questions listed below.

Part I. write true if the statement is correct false if not

1. Planning and preparing land for seed multiplication is only necessary for large-scale agricultural operations.
2. Land preparation for seed multiplication involves removing weeds and other vegetation from the field.
3. Planning and preparing land for seed multiplication should be done shortly before the planting season.

Part II. Choose the correct answer from the following alternatives

1. Which of the following techniques is commonly used to control weeds during land preparation for seed multiplication?
   a. Hand weeding c. Mulching with plastic sheets
   b) Overwatering d. Using excessive chemical fertilizers
2. Why is it important to remove crop residues and debris from the field during land preparation for seed multiplication?
   a. To prevent the spread of diseases and pests c. To improve soil drainage
   b. To provide organic matter for seed germination d. To attract beneficial insects
3. Which of the following practices is recommended for soil preparation before seed multiplication?
   a) Adding excessive amounts of synthetic pesticides
   b) Deep tilling to break up compacted soil
   c) Planting seeds without any soil amendments
   d) Ignoring soil fertility testing

Part III: Short Answer Questions

1. What role does crop rotation play in land preparation for seed multiplication?
2. Explain the importance of timing in land preparation for seed multiplication.

LG #42 LO #3. Establish seed production

Instruction sheet 3

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Monitoring soil and weather conditions
- Calculation of seed/planting material
- Identification of parental lines and their maintaining methods
- Keeping certified seeds with appropriate isolation distance
- Method of pollination
- Conducting seeding and fertilizer applications
- Cleaning machinery and equipment

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Monitor soil and weather conditions
- Calculate seed/planting material
- Identify and maintain parental lines
- Keep certified seeds with appropriate isolation distance
- Understand Method of pollination
- Conduct seeding and fertilizer applications
- Clean machinery and equipment

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet 3

Introduction

Seed production is a process with many stages, including research, breeding, production, certification, post-harvest handling and, if done commercially, marketing. For most home garden managers, commercial seeds are out of reach, because of their cost or because of limited access. Seed multiplication and saving, therefore, is an important practice for many rural households.

3.1 Monitor soil and weather conditions

Climate is the dominant factor in determining the suitability of a crop for a given area. The components of climate are rainfall /precipitation/, temperature, humidity and light. Climatic differences are due to differences in latitude, altitude and distances from large bodies of water, ocean currents, and the direction and intensity of winds.

Rainfall: has a dominant influence in crop production in semi-arid regions, in regions of low rain fall. The deficiency may be partly overcome by moisture conserving tillage and rotation practices or by irrigation. The effectiveness in crop production of a given quantity of rainfall depends upon the time of year that it falls, and the rapidly and intensity of individual rains. Rainfall has its greatest value when it falls during the growing season. The critical period for most crops occurs just before or after flowering.

Temperature: It is influenced by latitude and altitude as well as by exposure each crop plant has its own approximate temperature range, i.e. it's minimum, optimum and maximum for growth, although they are subjected to a rather wide range of temperature. Crops may be classed broadly as warm weather or cool weather crops. The crops that make their best growth under relatively cool temperature with stands freezing temperature at any time up to about the flowering stage. Warm weather crop plants, after they reach appreciable size, are killed by temperatures slightly below freezing and sometimes at several degrees above freezing when exposed for prolonged periods.

Humidity: - It is water vapor in the air. Relative humidity is the vapor pressure in the air in terms of the percentage necessary to saturate the atmosphere at the particular temperature. A

saturated atmosphere that causes fog, dew, or rain has a theoretical relative humidity of 100 percent. Evapo-transpiration increases with increases in temperature and decreases in relative humidity.

Light: - It is necessary for the formation of chlorophyll in green plants and photosynthesis the process of manufacturing food essential to their growth. The life processes of many plants were influenced by the relative lengths of day and night which is called Photoperiodism. This led to the distinction between long day and short day plants. Long day plants require a relatively long day for the formation of inflorescences, but they increase in vegetative growth when the days are short. Short day plants are stimulated to vegetative growth with delayed flowering and maturity when the days are long, and produce flowers and fruits when the days are relatively short.

Soil factors: - soil physical properties influence how soils function in an ecosystem and how they can best be managed. The color, texture and other physical properties of soil are used in classifying soil profiles in the soil horizon and in making determinations about suitability for agriculture. The physical properties of soil are soil particles density, texture, structure and the nature of the system of its pore spaces.

3.2 Calculation of seed/planting material

There are two basic factors that must be determined in order to calculate a proper seeding rate. The first factor is determining the amount of desired seedling per square foot (density.) The second factor is the number of seed per pound of the species being planted.

Calculating Seeding Rates: To calculate the seeding rate in pounds per acre you need the following information:

- Desired plant density in plants per square foot
- Germination rate (%)
- Emergence mortality (%)
- Row spacing in inches
- 1000 kernel weight in grams

It is a good idea to make sure you have a value for the 1000 kernel weight (in grams). Otherwise, you will need to count out 1,000 seeds and weigh them (grams). The postal service has good

scales. Remember that *1 ounce equals 28.3 grams. So, if you weigh 1000 kernels in ounces, multiply by 28.3 to get grams of seed per 1000 kernels.*

One more simple conversion: Collect the seed that would be planted in 100 feet of row by placing a bag over one of the openers. Weigh the seed. The actual seeding rate can then be calculated as follows:

Seed calculations

$$\text{Seed required (kg)} = \frac{\text{Area (ha)}}{\text{Seed rate (kg/ha}}$$

$$\text{Seed rate} = \frac{\text{area*test weight of seed}}{\text{Spacing*1000*GP*PP}}$$

Where, GP=germination percentage, PP=purity percentage

Seed rate often depends on germination percentage and percent filled grains in a seed lot.

Calculating the area

$$\text{Area to be planted (ha)} = \frac{\text{seed requirement x \% germination}}{\text{Seed rate x \% of filled grains}}$$

$$\text{Area required (ha)} = \frac{\text{Seed production plan (t)}}{\text{Seed yield (t/ha)}}$$

3.3 Identify parental lines and their maintaining methods

Steps in Cultivar Development

Cultivar development is one of the four plant breeding projects (other three are genetic improvement, trait integrations and product placement) of many breeding programs. The end product depends on the specific objectives, the mode of propagation and commercial production, and like most other processes, specific steps need to be followed in succession (in parallel in certain cases) to ensure the set objectives are met.

Objectives

- Describe the basic steps in the development of clonal, inbred, synthetic, hybrid, multilines, and blended cultivars
- Distinguish among the different clonal types and source of variation
- Know the application of male sterility in hybrid crop development

Steps in Development of Self-Pollinated Cultivars

Pure Line Cultivars

Pure line cultivars are developed in self-pollinating species. Pure line cultivars are homogeneous and homozygous and, once created, can be maintained indefinitely by selfing. Inbred lines are different from pure lines, although sometimes people use the terms interchangeably.

Inbred lines are developed in cross-pollinated species through inbreeding and these lines are used as parents in the production of hybrid cultivars and synthetic cultivars. Inbred lines are not meant for commercial release to farmers for commercial production because inbred lines suffer from inbreeding depression (yield will be lower than in hybrid and even an open-pollinated variety (OPV). Inbred lines are homogenous and homozygous, similar to pure lines; however, artificial selfing needs to be done at each generation to maintain or increase seed. Sib-mating can be used to avoid severe inbreeding depression.

Summary of Steps in Development of Self-Pollinated Cultivars

Step 1: Define objectives
Step 2: Form the genetic base by creating segregating population(s)
Step 3: Perform selection to make pure lines
Step 4: Conduct Trials (testing of experimental lines) and Seed Multiplication

Steps in Development of Hybrid Cultivars

Hybrid Cultivars

Hybrid maize (*Zea mays* L.) is an example of a success story in cross-pollinated crops. A hybrid cultivar is the F_1 offspring of a planned cross between inbred lines, cultivars, clones, or

populations. The hybrids may be the product of a single cross, a three-way cross, or a double cross hybrid. One absolute requirement for a hybrid cultivar is its superior performance over the parents (heterosis) and an ability to economically generate the seed for commercial seed sale. In the case of maize, farmers moved from OPV to hybrids due to several advantages offered by hybrids which include higher yield, improved tolerance to stalk lodging (i.e. better standability), and improved response to drought.

Development of hybrids in maize was easier due to the ability to follow a configuration of males and females for seed production – female rows were detasseled and seed was only collected from female rows (in later years, male rows destroyed post-pollination to ensure no contamination). Therefore, the role of male rows is to serve as pollen source, with requirements that the male needs to be a good combiner to the female (higher SCA) and must possess good pollen shed, nicking well with the female, i.e, must have close flowering time to that of the female.

Cytoplasmic Male Sterility

Discovery of cytoplasmic male sterility (Figure 3.1) has also helped in the development of hybrid crops in those species. Plants with sterile cytoplasm plus nuclear non-restorer genes are male sterile; plants with sterile cytoplasm plus nuclear restorer genes produce fertile pollen (fertility restoration). In contrast to plants with sterile cytoplasm, plants with normal cytoplasm are male fertile when they carry either of the nuclear genes: restorer or non-restorer. Fertility restoration may not be needed for crop species in which the vegetative part is of economic value.

In addition to straight crossing (male or female) and male sterility, chemical agents have been used to create hybrid cultivars. An important consideration of hybrid cultivars is the expression of heterosis and efficiency (i.e., cost, labor, time) of seed production.

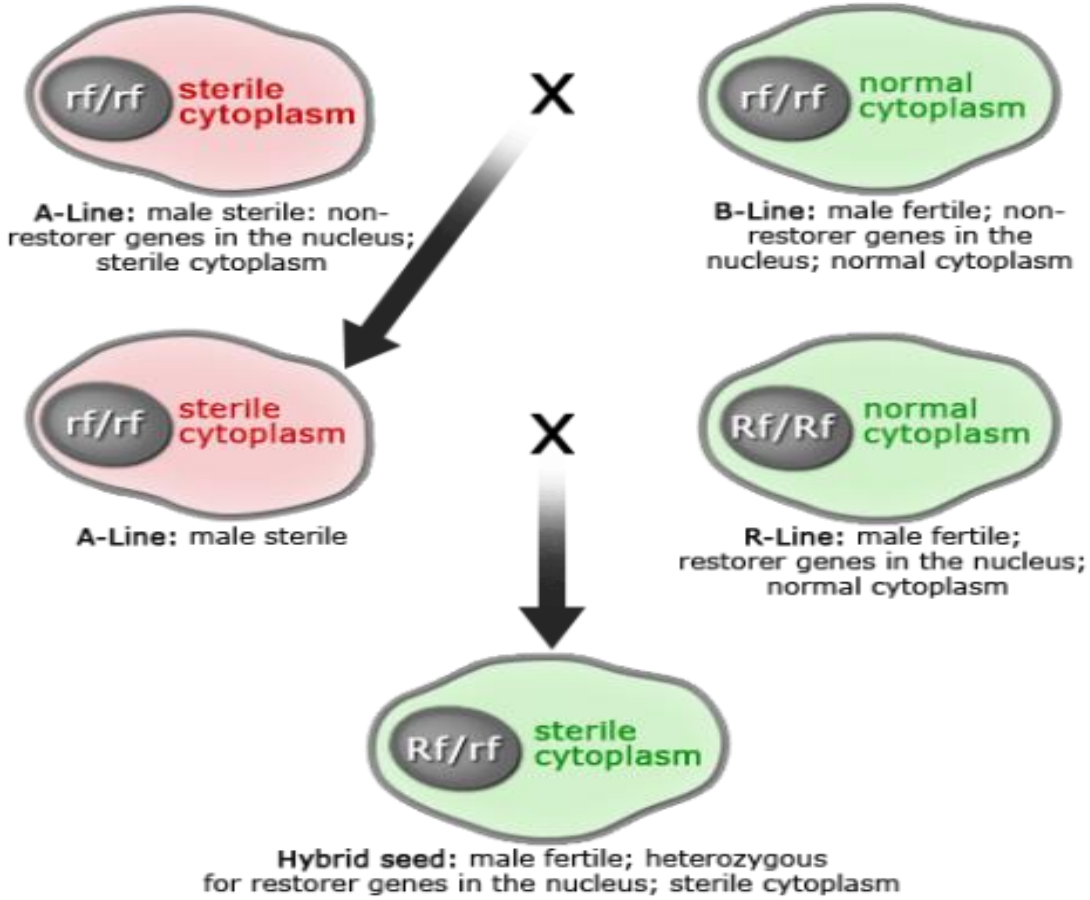


Figure 3.1: The CMS system used for hybrid seed production: **Rf** refers to fertility restorer genes in the nucleus and **rf** refers to nuclear genes that cannot restore the fertility of a plant with sterile cytoplasm.

Some practical considerations for hybrid systems:

- Farm production of field crops such as wheat, barley, rye, sunflower, grain sorghum requires large amounts of seed for planting the crop and return per unit area is relatively low compared to most horticultural crops or oilseed crops (such as canola), so expensive labor intensive methods of producing hybrid seed (such as hand emasculation) are not preferred. Cytoplasmic male sterility is one approach that is useful in field crops to develop hybridization techniques in which seed parents and pollinators could be grown on a field scale.
- Pollination also needs to be on a field scale, such as with wind or with bees. Successful hybridization via wind pollination requires that males shed abundant amounts of pollen and

female lines be receptive (e.g. florets should open at appropriate times). There is a need to synchronous flowering times between females and males.

- Female inbred line should generally be more productive and with a higher capacity to produce more seed. Male and female need to be chosen for their superior specific combining ability, and are generally distinct i.e. belonging to different heterotic groups as for example stiff stalk and non-stiff stalk in maize in North America, or origins as for example *indica* and *japonica* in rice.
- Expression of heterosis needs to be sufficient to overcome the cost of development and hybrid seed production. For example, in wheat heterosis is not sufficient to warrant development of a hybrid. Floral morphology also prevents easy pollinations.

3.4 Keep certified seeds with appropriate isolation distance

Growing a seed crop separate from all sources of contamination (genetic, physical and pathological), is one of the fundamental seed production techniques. In practice, such contamination can be reduced by not planting a seed crop in the vicinity of a similar crop that may contaminate it. The minimum distance required for a particular crop is usually prescribed by the national seed regulations and depends on the seed class. Minimum isolation distances are larger for the early than for the later generations.

Restricting the number of varieties grown for seed multiplication per farm will reduce the chances of contamination. Where the breeders' seed is produced in open-pollinated fields, it is essential that the crop is sufficiently isolated from potential contaminant crops to ensure that the breeders' seed is pure.

Two methods of isolation may be employed.

- The first is to **isolate by distance** from a contaminant crop. In this case the distance between the breeders' seed plot and other contaminant crop should be at least equal to the requirements for basic seed production.
- The second method is to **isolate by time** in which case the breeders' seed plot is planted in close proximity to, but either earlier or later than the contaminant crop by a time gap sufficient to avoid overlap of the flowering periods of the two crops.

Off-type variant and diseased plants are removed under supervision of the breeder prior to the flowering of the crop.

For example, maize plot may be laid out in two ways:

- Male and female rows may be identified, with the female plants de-tasseled prior to flowering to ensure cross-pollination from the male rows. The seed from the female rows is carefully selected from typical plants and desirable ears, with seed from at least 400 plants bulked for breeders' seed. The seed from the male rows may be discarded or used as basic seed.
- The plot is grown as an open-pollinated field, with no separation into male and female rows. At least 600 plants that are typical of the variety are selected from within the field, and the seed from the central portion of the cobs is bulked for breeders' seed. After shelling, a portion of the seed is kept for future breeders' seed production, while the remainder is passed onto the production of pre-basic or basic seed.

De-tasseling

In hybrid seed maize production, de-tasseling of the female plants must be up to standard and conducted in a timely fashion. Any delays in de-tasseling, or poor detasseling techniques that result in tassel-stubs or missed plants will seriously impact on genetic purity and might result in rejection for certification.

- The tassels on the female plants in hybrid seed maize production must be removed before they begin to shed pollen.
- De-tasseling must commence when the top 3–4 cm of the tassel is visible above the whorl.
- De-tasseling must continue on a daily basis until complete, come rain or sunshine!
- The de-tasseling period may be two to three weeks, depending on the uniformity of the crop.
- Six people can normally de-tassel one hectare of seed females per day.
- Individual workers may be allocated specific sections of the field to de-tassel, so as to give responsibility and accountability.

3.5 Methods of Pollination

What does pollination mean?

Pollination is the transfer of pollen grains from the male component of the flower, the anther, to the female part, the stigma. Fertilization is usually preceded by this procedure. It crucial is a step in plant reproduction that without the sexual reproduction would to impossible. It is a process that has evolved over time as plants and animals have coevolved, with the animals acting as pollinators or pollination agents. Plants and animals coexist in the same environment.

Importance of pollination

- Genetic variety, in a nutshell. The rule of thumb is that the more diverse the group, the better. A population with a lot of genetic diversity can withstand a lot more dangers and changes than a population with a lot of genetic diversity.
- Within high-diversity populations, there's a better probability that at least a few individuals have features that allow them to adjust to the new surroundings and reproduce, allowing the species to survive.
- Even when self-pollination occurs, flowering plants can reproduce asexually by producing clones of them. However, sexual reproduction, which involves pollination and the subsequent production of seeds and fruits, results in greater diversity.
- Cross-pollination adds to this diversity by combining genetic material from two different parent plants.

Pollination of the pollen grains can occur in the same flower or in two different flowers. Based upon the location of transfer of the pollen, pollination is of the following two types.

A. Self-Pollination
B. Cross-Pollination

What is Self-pollination?

Self-pollination happens on a single flower. It involves the transfer of pollen grains from the anther to the stigma part of the same flower. In this process, the pollen grains from the anther or the flower's male reproductive structure get transferred to the stigma or the female reproductive structure of the same flower or of another flower on the same plant. The pollen grains are carried by the wind, water, or animals.

Plants like orchids, oats, legumes, peas, sunflowers, peanuts, peaches, potatoes, and wheat follow self-pollination. In the case of self-pollination, the same plant's genetic material is used to form gametes, and finally, the zygote. Hence, self-pollination leads to the production of plants that do not have genetic diversity. Self-pollination occurs in flowers when both the reproductive parts, the stamen and the carpel, mature at the same time. This method does not require any pollinating agents or any nectar and pollen to attract insects or birds.

Types of Self-Pollination

Self-pollination consists of two types: autogamy and geitonogamy.
When the transfer of pollen is done to the stigma of the same flower, it is known as autogamy.
When the transfer of pollen happens from another of flower one to the stigma of flower two on the same flower with one gymnosperm, it is known as geitonogamy.

What is Cross-Pollination?

It occurs when there is a transfer of pollen grains from the anther of one flower to the stigma of another flower. The destination flower is a different flower of the same species. This method of pollination leads to an increase in genetic diversity. It is because the genetic information from different flowers gets shared and crossed. It results in the creation of unique offspring. In this case, the reproductive process takes place in different plants.

Cross-pollination is also known as heterogamy. It is types of pollination where pollen grains which are sperm-laden get transferred from the flowers of plant one to the second flowers which are egg-bearing. It is found in both flowering plants and cone-bearing plants. Cross-pollination can be carried out by wind as well as bees and other birds or animals. Insects cross-pollinate many fruit-bearing plants like apples, strawberries, raspberries, grapes, plums, and flowers like tulips and daffodils. Wind pollination can be observed in different grasses, maple trees, and dandelions.

Differentiate between Cross-pollination and Self-pollination

Feature	Self-Pollination	Cross-Pollination
Pollen transfer	Same or different flower of the same plant species	Different flower of a different plant
Flower type	Flowers that follow the same genetic pattern have this type of pollination.	Genetically different flowers have this pollination type.
Maturity Time	Simultaneous maturity for both the stigma and anther of the plant	The maturity of the stigma and anther is at different times on different plants.
Pollen Transfer	Limited	Large amounts
Offspring outcomes	Homogeneous genetic conditions	Heterozygous conditions in offspring
Genetic Variation	Nil or decreased	Increased
Breeding Type	Inbreeding	Outbreeding
Pollinators	Not required, as happens on the same flower	Requires pollinators like wind and insects

New Species	Cannot be created	New species can be generated.

3.6 Conduct seeding and fertilizer applications

3.5.1. Conduct seeding

Sowing is the placement of a specific quantity of seed in the soil at optimum position for germination and growth. Time of sowing is a very important factor for proper establishment, growth and yield of a crop. It varies with season and availability of irrigation facilities. In Ethiopia, the optimum time of sowing for most of the tropical crops is immediately after the onset of rainy season.

Methods of sowing

A. Broadcasting: the seeds are spread (which may or may not be covered with the soil) uniformly over well prepared land. Broadcasting may be done by hand, mechanical spreader or airplane.
B. Drilling: Drilling is the practice of dropping the seeds in rows or lines. Furrows at specified distance are made and the seeds are dropped at a definite depth and distance, covered with soil and are compacted. Seeds and fertilizers both can be drilled simultaneously.
C. Dibbling: This method consists of putting or placing individual seed in a hole or pit, made at pre-determined spacing and depth by manual labor or with the use of mechanical dibbler or planter.

3.5.2. Conduct fertilizer application

Fertilizer application to seed crops should be based on local recommendations. A well-balanced supply of N, P and K is essential for seed production as it has an influence on seed development and thereby on seed quality. P is essential for enhancing seed maturity and K for seed development. Seed nutrition combined with soil nutrition gave better yields and better seed quality.

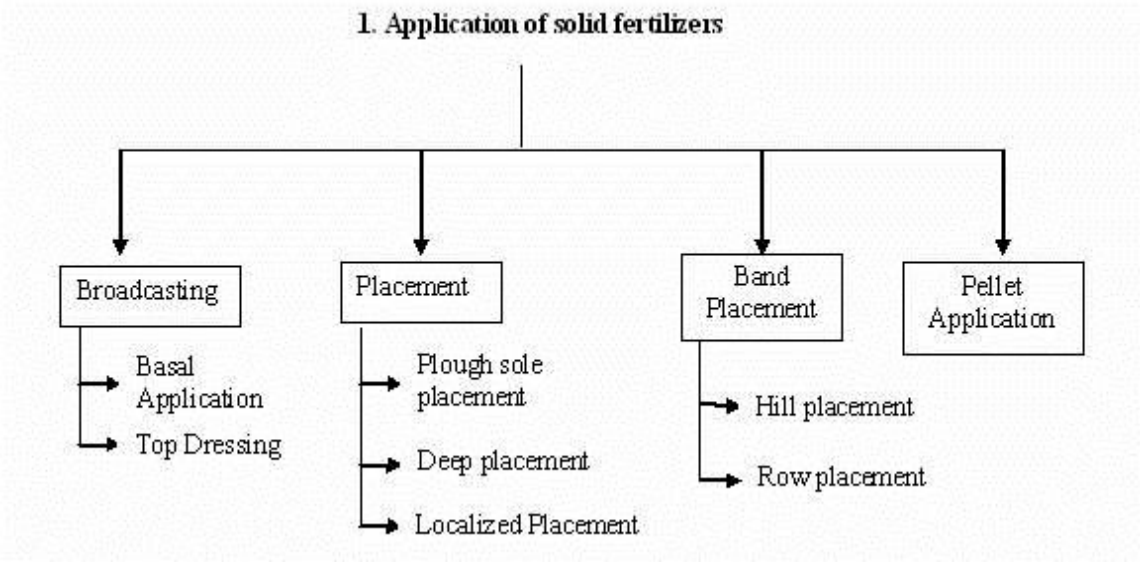
Timing Fertilizer Application

Fertilizers can be applied at pre-planting i.e. organic fertilizers at time of sowing i.e. DAP and after planting i.e. UREA. This is because timing of fertilizer application has a significant effect on crop yields. Proper timing of the fertilizer application increases yields, reduces nutrient losses, increases nutrient use efficiency and prevents damage to the environment.

Applying fertilizers at the wrong timing might result in nutrient losses, waste of fertilizer and even damage to the crop. Plants need different nutrient amounts and ratios at different growth stages. In order for the nutrients to be available when the plant needs them, fertilizers should be applied at the right timing. The optimum timing for fertilizer application is, therefore, determined by the Nutrient uptake pattern of the crop. For the same crop, each nutrient has an individual uptake pattern.

Methods of fertilizer application

The different methods of fertilizer application are as follows:



A. Broadcasting

i. It refers to spreading fertilizers uniformly all over the field.

ii. Suitable for crops with dense stand, the plant roots permeate the whole volume of the soil, large doses of fertilizers are applied and insoluble phosphatic fertilizers such as rock phosphate are used.

Broadcasting of fertilizers is of two types.

a. Broadcasting at sowing or planting (Basal application)

The main objectives of broadcasting the fertilizers at sowing time are to uniformly distribute the fertilizer over the entire field and to mix it with soil.

b. Top dressing**:** It is the broadcasting of fertilizers particularly nitrogenous fertilizers in closely sown crops like paddy and wheat, with the objective of supplying nitrogen in readily available form to growing plants.

B. Placement

i. It refers to the placement of fertilizers in soil at a specific place with or without reference to the position of the seed.

ii. Placement of fertilizers is normally recommended when the quantity of fertilizers to apply is small, development of the root system is poor, soil have a low level of fertility and to apply phosphatic and potassic fertilizer.

The most common methods of placement are as follows:

i) Plough sole placement

- In this method, fertilizer is placed at the bottom of the plough furrow in a continuous band during the process of ploughing.
- Every band is covered as the next furrow is turned.
- This method is suitable for areas where soil becomes quite dry upto few cm below the soil surface and soils having a heavy clay pan just below the plough sole layer.

ii) Deep placement**:** It is the placement of ammoniacal nitrogenous fertilizers in the reduction zone of soil particularly in paddy fields, where ammoniacal nitrogen remains available to the crop. This method ensures better distribution of fertilizer in the root zone soil and prevents loss of nutrients by run-off.

iii) Localized placement**:** It refers to the application of fertilizers into the soil close to the seed or plant in order to supply the nutrients in adequate amounts to the roots of growing plants. The common methods to place fertilizers close to the seed or plant are as follows:

a. Drilling**:** the fertilizer is applied at the time of sowing by means of a seed-cum-fertilizer drill. This places fertilizer and the seed in the same row but at different depths. Although

this method has been found suitable for the application of phosphatic and potassic fertilizers in cereal crops, but sometimes germination of seeds and young plants may get damaged due to higher concentration of soluble salts.

b. Side dressing**:** It refers to the spread of fertilizer in between the rows and around the plants. The common methods of side-dressing are

i. Placement of nitrogenous fertilizers by hand in between the rows of crops like maize, sugarcane, cotton etc., to apply additional doses of nitrogen to the growing crops and

ii. Placement of fertilizers around the trees like mango, apple, grapes, papaya etc.

c. Band placement**:** If refers to the placement of fertilizer in bands.

Band placement is of two types.

i) Hill placement

It is practiced for the application of fertilizers in orchards. In this method, fertilizers are placed close to the plant in bands on one or both sides of the plant. The length and depth of the band varies with the nature of the crop.

ii) Row placement**:** When the crops like sugarcane, potato, maize, cereals etc., are sown close together in rows, the fertilizer is applied in continuous bands on one or both sides of the row, which is known as row placement.

d. Pellet application

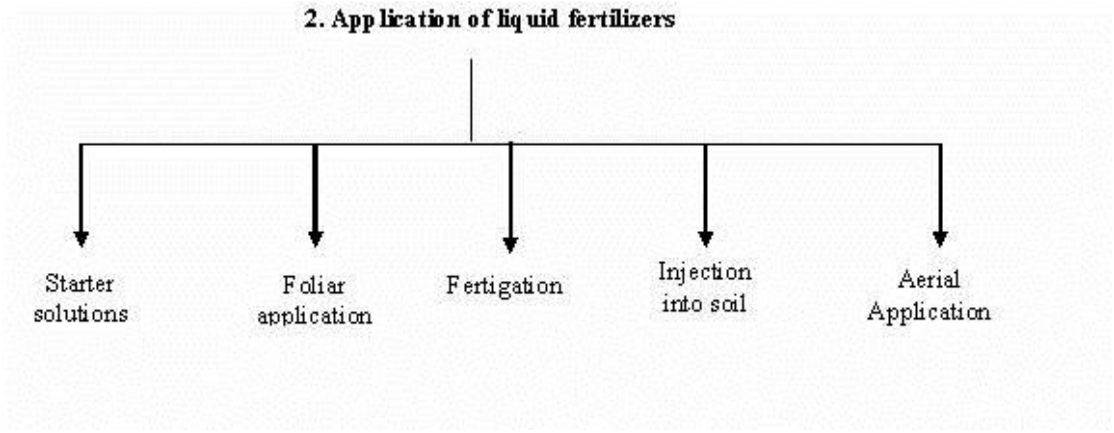
i. It refers to the placement of nitrogenous fertilizer in the form of pellets 2.5 to 5 cm deep between the rows of the paddy crop.

ii. The fertilizer is mixed with the soil in the ratio of 1:10 and made small pellets of convenient size to deposit in the mud of paddy fields.

Advantages of placement of fertilizers

- When the fertilizer is placed, there is minimum contact between the soil and the fertilizer, and thus fixation of nutrients is greatly reduced.
- The weeds all over the field cannot make use of the fertilizers.
- Residual response of fertilizers is usually higher.
- Utilization of fertilizers by the plants is higher.
- Loss of nitrogen by leaching is reduced.

- Being immobile, phosphates are better utilized when placed.



Following are the common methods of applying liquid fertilizers

A. Starter solutions**:** It refers to the application of solution of N, *P2O5 and* K2O in the ratio of 1:2:1 and 1:1:2 to young plants at the time of transplanting, particularly for vegetables. Starter solution helps in rapid establishment and quick growth of seedlings. The disadvantages of starter solutions are (i) Extra labor is required, and (ii) the fixation of phosphate is higher.

B. Foliar application

i. It refers to the spraying of fertilizer solutions containing one or more nutrients on the foliage of growing plants.
ii. Several nutrient elements are readily absorbed by leaves when they are dissolved in water and sprayed on them.
iii. The concentration of the spray solution has to be controlled, otherwise serious damage may result due to scorching of the leaves.
iv. Foliar application is effective for the application of minor nutrients like iron, copper, boron, zinc and manganese. Sometimes insecticides are also applied along with fertilizers.

C. Application through irrigation water (Fertigation)

i. It refers to the application of water soluble fertilizers through irrigation water.
ii. The nutrients are thus carried into the soil in solution.
iii. Generally nitrogenous fertilizers are applied through irrigation water.

D. Injection into soil

i. Liquid fertilizers for injection into the soil may be of either pressure or non-pressure types.

ii. Non-pressure solutions may be applied either on the surface or in furrows without appreciable loss of plant nutrients under most conditions.

iii. Anhydrous ammonia must be placed in narrow furrows at a depth of 12-15 cm and covered immediately to prevent loss of ammonia.

E. Aerial application**:** In areas where ground application is not practicable, the fertilizer solutions are applied by aircraft particularly in hilly areas, in forest lands, in grass lands or in sugarcane fields etc.

3.7 Clean machinery and equipment

Vacuum cleaner should also not be overlooked when maintaining cleaning equipment. One of the easiest ways to keep a vacuum cleaner up and running is to simply change the bag. As the bag fills, the machine becomes less effective and slows down the motor. The bag should be changed every day if the machine is used more than a few hours per day. Likewise, regularly clean the filters. Almost all high-end machines, as well as many of the new generation of vacuum cleaners, require the filters to be maintained on a regular basis for the vacuum to be effective and high performing.

Unless you have a wet/dry, you should not be vacuuming up liquid. Once moisture is absorbed into the machine, a variety of components, from motors to hoses, can be harmed. Moisture causes dirt and dust to cling to the sides of hoses, limiting the machine's performance. It can also cause odor problems, which can negatively impact the machine and the indoor environment. Always be aware of what you are picking up with your vacuum. Coins, paper clips, and other items can get stuck in the machine, cause a strain on the motor, or damage belts.

Listen for your vacuum getting louder, which is a signal that moisture or a foreign object are inside the machine. Or it can be a sign of motor wear, with more serious problems soon to come. If you notice your vacuum has become louder, stop, access what is user-accessible, and see if the problem can be detected and corrected in-house. If not, a service call may be required. Don't forget to regularly check and clean the beater bar. If it is covered with lint and debris, the machine cannot adequately perform and vacuuming efficiency will be negatively affected.

An often overlooked item is the user manual. This contains important information about how to use and maintain equipment in the best way possible, and could be worth the 15 minute read. Most manufacturers know their equipment well and can predict which parts may break down and advise whether they can be fixed by the user or require a service professional.

Instructing users to show more care for the machines, inspecting them regularly, and taking action at the first sign that a problem may be developing can prevent downtime, cut repair bills, and add years of useful life to the equipment.

Self-Check – 3	Written test

Directions: Answer all the questions listed below.

Part I. Write true if the statement is correct false if not

1. Establishing seed production requires selecting suitable plant varieties with desirable traits.
2. Seed production can be established using seeds from any source, regardless of their quality or origin.
3. Isolation distance is an important consideration in seed production to prevent cross-pollination between different varieties.
4. Establishing seed production involves regular monitoring and management to ensure seed quality and purity.

Part II. Choose the correct answer from the following alternatives

1. Which of the following factors is crucial for establishing seed production?
   a) Selecting suitable plant varieties c) Implementing advanced irrigation techniques
   b) Maximizing crop yield d) Introducing genetically modified organisms
2. What is the purpose of maintaining isolation distances in seed production?
   a) To prevent cross-pollination between different varieties
   b) To increase crop yield
   c) To reduce the need for pest control
   d) To enhance seed germination rate
3. What does the term "roguing" refer to in seed production?
   a) Selecting the best seeds for future planting
   b) Removing diseased or off-type plants from the field
   c) Using mechanical equipment for seed harvesting
   d) Applying growth hormones to enhance seed development

Part III. Short Answer Questions

1. What is seed production, and why is it important in agriculture?
2. What are the key factors to consider when selecting a suitable site for seed production?
3. What are some common methods used for establishing seed crops?

Operation sheet - 3	Conduct appropriate seed tests

Operation sheet 3.1 Seed sampling

Objectives of seed sampling revolve around ensuring seed quality, compliance with regulations, maintaining seed identity, supporting research and development, facilitating seed certification, enabling traceability, and promoting seed conservation and long-term storage.

Required materials:

- Clean sampling containers (bags, envelopes, or vials)
- Sampling tools (scoops, spoons, or trowels)
- Labels and markers
- Pen and notebook for recording information
- Gloves (if necessary)
- Sealable plastic bags (for packaging samples)

Procedure:

Step 1 Clearly identify the lot or batch of seeds from which the samples will be taken. Record any relevant information, such as lot number, seed variety, and supplier information.

Step 2 Determine the appropriate sampling plan based on the purpose and requirements of the seed analysis. This may include random sampling or targeted sampling from specific areas of the lot.

Step 3 Select the appropriate sampling method. This may include random sampling or targeted sampling from specific areas of the lot.

Step 4 Determine the required sample size based on the analysis requirements, industry standards, or regulatory guidelines.

Step 5 Sampling Procedure:

i. Use clean sampling containers for each sample to avoid cross-contamination. Label each container with a unique sample identifier.

ii. If applicable, wear gloves to prevent contamination or contact with hazardous seeds or substances.

iii. Collect samples from various locations within the lot, ensuring that they are representative of the entire batch.

iv. For each sample, record specific information such as the date, location, lot identification, and any relevant observations.

v. Seal each sample container securely to prevent seed leakage or contamination.

Step 6: Record all relevant information regarding the sampling operation

Step 7: Place each sample container in a sealable plastic bag to provide extra protection. Label the bag with the sample identifier, lot number, and any other required information.

Step 8: Store the samples in a suitable condition until they can be transported to the laboratory or testing facility. Ensure the samples are protected from excessive heat, moisture, and potential damage during transportation.

https://www.youtube.com/watch?v=IYBGrbI7XDQ

Operation sheet 3.2. Seed moisture testing

Objective: To determine the moisture content of seed samples for quality assessment and storage purposes.

Equipment Required:

- Moisture testing equipment (e.g., moisture meter or oven)
- Clean and dry sample containers
- Weighing scale
- Sample bags or containers
- Pen and notebook for recording information

Procedure:

Step 1 Identify the sampled seed

Step 2 Sample Preparation:

- Ensure that the seed samples are clean and free from debris or foreign materials.
- If necessary, separate the seeds from any chaff or other non-seed materials.

Step 3 Calibration (for moisture meter):

- If using a moisture meter, calibrate the equipment as per the manufacturer's instructions.
- Follow the calibration procedure to ensure accurate readings.

Step 4 Moisture Testing:

For moisture meter method:

a) Take a representative sample of seeds from each container and place it in the moisture meter tray.
b) Insert the tray into the moisture meter and wait for the reading to stabilize.
c) Record the moisture reading for each sample.

For oven drying method:

a) Weigh a clean and dry sample container.
b) Place a representative sample of seeds into the container, ensuring it is evenly spread.
c) Weigh the container with seeds and record the initial weight.
d) Place the container with the seeds in an oven set at a specific temperature (e.g., 105°C) for a predetermined period (e.g., 16-24 hours).
e) After drying, remove the container from the oven and allow it to cool in a desiccator.

f) Weigh the container with the dried seeds and record the final weight.

Step 5 Calculation of Moisture Content:

For moisture meter method:

a) Calculate the moisture content using the moisture meter reading directly.

For oven drying method:

a) Calculate the moisture content using the formula:

Moisture Content (%) = [(Initial Weight - Final Weight) / Final Weight] x 100

Step 6 Record the moisture content of each sample in the logbook or data sheet.

Step 7 Reporting

https://www.youtube.com/watch?v=iSpGZLVyMBk

https://www.youtube.com/watch?v=0ceLmfNde1w

Operation sheet 3.3. Germination testing

Objective: To assess the percentage of seeds capable of producing viable seedlings and evaluate seed quality for sowing or storage purposes.

Equipment Required:

- Clean and sterile germination containers (petri dishes, seed trays, or germination paper)
- Seeds to be tested
- Distilled water or appropriate germination media
- Thermometer
- Incubator or germination chamber
- Labels and markers
- Tweezers or forceps
- Light source (if applicable)
- Pen and notebook for recording information

Procedure:

Step 1 Identify sampled seed

Step 2 Pre-germination Treatment (if applicable):

If any pre-germination treatment is required, such as scarification or stratification, follow the specific treatment protocols and record the details.

Step 3 Germination Setup:

a) Prepare the germination containers:

- Clean and sterilize the germination containers to prevent contamination.
- Add a suitable germination medium, such as moistened germination paper or agar, to the containers. Alternatively, use distilled water for water germination tests.

b) Determine the appropriate temperature and lighting conditions:

- Consult seed-specific information or germination guidelines to determine the recommended temperature and lighting conditions for the seeds being tested.
- Set up the incubator or germination chamber to maintain the desired temperature and provide appropriate light conditions if necessary.

Step 4 Seed Placement:

- Place a predetermined number of seeds (based on the desired sample size) onto the germination medium in each container.
- Use tweezers or forceps to handle the seeds carefully and avoid damaging them.
- Ensure proper spacing between seeds to prevent overcrowding.

Step 5 Germination Period:

- Record the start date of the germination test.
- Place the germination containers in the incubator or germination chamber, maintaining the specified temperature and lighting conditions.
- Regularly monitor the seeds during the germination period, checking for any signs of germination, growth, or abnormalities.

Step 6 Germination Assessment:

- After the predetermined germination period (usually specified by seed type or guidelines), assess the germinated seeds.
- Count and record the number of seeds that have germinated, considering factors such as the emergence of the radicle or visible growth.
- Record any abnormal or malformed seedlings separately.

Step 7 Germination Calculation

- Calculate the percentage of germination using the formula:

Germination Percentage = (Number of Germinated Seeds / Total Number of Seeds Tested) x 100

Step 8 Record Keeping

Step 9 Reporting

https://www.youtube.com/watch?v=E0jzPVGiKHs

Operation sheet 3.4. Seed purity test

Objective: To determine the percentage of pure seeds in a sample and identify the presence of impurities, such as weed seeds, inert matter, or other crop seeds.

Equipment Required:

- Clean and sterile workspace
- Seed testing tray or white surface
- Hand lens or magnifying glass
- Seed forceps or tweezers
- Petri dishes or small containers
- Distilled water
- Labels and markers
- Pen and notebook for recording information

Procedure:

Step 1 Identify sampled seed

Step 2 Sample Preparation:

- Thoroughly mix the seed sample to ensure a representative portion is used for testing.
- If necessary, remove any large debris, such as stones, soil clumps, or plant material, from the seed sample.

Step 3 Workspace Setup

- Clean and sterilize the workspace to prevent contamination.
- Place a seed testing tray or a clean white surface on the workspace for better visibility of the seeds.

Step 4 Seed Separation

- Take a representative portion of the seed sample and spread it evenly on the seed testing tray or white surface.
- Use seed forceps or tweezers to separate the seeds from each other and any clumps.

Step 5 Visual Inspection

- Examine the seeds visually using a hand lens or magnifying glass.

- Look for impurities, such as weed seeds, other crop seeds, inert matter, or damaged/abnormal seeds.
- Separate any impurities from the pure seeds and place them in separate petri dishes or small containers.

Step 6 Recording

- Record the number and type of impurities found during the visual inspection.
- Note any observations or specific characteristics of the impurities or damaged seeds.

Step 7 Determining Purity Percentage

Calculate the percentage of pure seeds using the formula:

Purity %age = [(Weight of Pure Seeds / Weight of Total Sample)] x 100

Step 8 Packaging and Labeling

- Place the pure seed portion in a clean, labeled container for future use or storage.
- Seal the container securely to maintain seed purity.

Step 9 Record Keeping

- Record the purity percentage, impurity types, and any relevant observations in the logbook or data sheet for each sample tested.
- Include the sample identification and date of testing

Step 10 Reporting

- Prepare a summary report of the seed purity test results, including the purity percentage and impurity identification.
- Include additional information if required, such as acceptable purity standards for the specific seed type or regulatory guidelines.

https://www.youtube.com/watch?v=3GX1piaXem0

LAP TEST-3	Performance Test

Name……. ID……..

Date…….

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **1** hour. The project is expected from each student to do it.

Task-1: You are required to perform seed sampling

Task-2: You are required to perform seed moisture testing

Task-3: You are required to perform germination testing

Task-4: You are required to perform seed purity test

LG #43 LO #4. Maintain field

Instruction sheet 4

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Monitoring crop condition and growth
- Ensuring field inspection of certified seeds
- Application of agronomic practices
- Environmental issues of ploughing soil for planting
- Monitoring soil moisture content and irrigation
- Monitoring and maintaining field drainage

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Monitor crop condition and growth
- Ensure field inspection of certified seeds
- Apply agronomic practices
- Understand environmental issues of ploughing soil for planting
- Monitor soil moisture content and irrigation
- Monitor and maintain field drainage

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet 4

4.1 Monitor crop condition and growth

Crop management may be distilled down to three cardinal points, viz, timeliness, adherence to high standards and minimization of wastage of inputs Timeliness. Timeliness is of utmost importance in seed production. All seed crops develop in a certain sequence from sowing through to maturity, and management of the crop is determined by this growth pattern. Every management decision must be taken and every input applied at the most appropriate time for the crop.

The establishment of a crop is generally the most important stage in the whole cycle, since decisions taken at sowing impact on the whole of the life cycle of the crop. Most summer field crops, like maize, cotton and soybeans, yield more when planted early than late.in order to plant at the best and correct time, good plans need to be made. This involves setting deadlines for various operations, like land preparation, purchase of inputs, application of fertilizer, planting date and so on. This is best done on a calendar well ahead of the deadlines and the work scheduled to meet the deadlines, making sure everything needed is in place for the optimum planting date. However, the importance of timeliness extends beyond planting to all aspects of seed production.

Operations such as weeding, top dressing, pesticide applications, detasseling of females, male removal in hybrid seed and harvesting all have to be done at the right time where the work will bring forth the best results. It is an established fact that weed competition during the first four to six weeks of a crop's life is most detrimental to yield. Also, small weeds are much easier to control than large weeds. Thus, timely weeding, when the crop and weeds are small will be most effective and beneficial to good seed production.

Removal of the male plants in hybrid seed production as soon after pollination as possible reduces competition with the female plants and improves the yield of the adjacent female rows. The male plants may be destroyed or removed from the field and used for stock feed. Ensuring

the thorough removal of male plants avoids the possibility of mixing male and female seed at harvest.

Eliminating undesirable plants

Carefully examine your seed crop as it grows. You may find plants that look very different or flower much earlier or later than most other plants in the field. These plants are called off-types and they should be removed a process known as ***roguing*** before pollen hedding starts. Most farmers do not like to remove any maize plants from their field, but roguing is critical in maintaining varietal purity.

Quality control in seed production

A planting inspection is commonly conducted to determine that the seeds planted are genetically pure, of known origin, and an appropriate variety for the area. The field should be inspected to verify that it is properly isolated and free of volunteer plants.

The most important field inspections are made just before and during flowering. At this time, the seed field is most susceptible to genetic contamination from wind-blown pollen coming from off-type plants within the field or from other maize varieties in surrounding fields. Therefore, it is essential during the pre-flowering inspection to confirm that the seed field has been properly rogued and is sufficiently isolated. Plants that are off-type or diseased, along with harmful weeds, should be removed at this time.

Benefits of Effective Crop Monitoring

Improved yield prediction and planning in agriculture is achieved through the use of advanced technologies and data analytics.

- By leveraging historical data, weather patterns, and crop monitoring information, farmers can make more accurate predictions about potential crop yields for the upcoming season. This enables them to plan their resources and operations more efficiently, optimize planting schedules, and adjust cultivation practices to maximize productivity and profitability while minimizing risks associated with uncertain crop outcomes.

- In order to prevent extensive crop damage and the necessity for excessive pesticide use, early pest and disease detection is essential in agriculture. Farmers can immediately spot early symptoms of infestations and diseases by using remote sensing, IoT sensors, and other monitoring technology. The protection of crop health and the optimization of production potential are all made possible by timely detection, which also encourages more ecologically friendly and sustainable agricultural practices.
- Precision agriculture practices and data-driven decision-making enables efficient resource management in agriculture, including the use of fertilizers and water. Farmers can monitor soil moisture levels, crop nutrient needs, and weather conditions in real time with the use of IoT sensors, satellite imaging, and AI analytics. This information makes it possible to apply resources precisely and strategically, maximizing water efficiency and minimizing fertilizer waste.

4.1 Ensure field inspection of certified seeds

The field inspections are done to achieve the following objectives:

- To verify seed origin (source seed) and identity of the variety.
- To collect information on cropping history of the seed field, i.e. to verify whether the seed field meets the prescribed land requirements.

The inspection of a seed crop is done at different stages of crop growth so as to make various verifications and estimates of various impurities, off-types and diseases, etc.

i. Inspection at the time of sowing

Sowing time inspection is to educate the farmers participating in a certified seed production. Programme for the first time or at times when a new crop is introduced, are very helpful in maintaining good quality of seed.

ii. Inspection during pre-flowering/vegetative stage

The purpose of pre-flowering inspection is to educate growers regarding plants to be rogued and to suggest other corrective measures.

iii. Inspection during flowering stage

- Check whether various corrective measures, if suggested earlier, have been carried out.

- Check or re-check the land and isolation requirements, planting ratios and source seed.
- Take detailed counts for various contaminating factors.
- Advise the farmer to continue roguing during flowering season.

iv. Inspection during post-flowering and pre-harvest stage

The corrective isolation measures suggested earlier may also be checked to ensure whether these have been done.

v. Harvest time inspection

Harvest time inspection is the last inspection conducted on a seed crop. During this inspection detailed counts are taken for various factors, and isolation requirements are finally checked to confirm whether the seed crop has met the requisite field standards. The farmer should be given necessary instructions regarding precautions he should take during harvesting /threshing and supply of the material to processing plants.

vi. Contaminants to be observed during field inspection

- Off-types:

Plants of the same crop species as the seed crop, differing in the expression of morphological characters such as plant type, branching habit, pigmentation, etc., are classified as 'off-type'.

- Pollen shedder

In hybrid seed production involving use of cytoplasmic-genetic male sterility three different lines, namely, a male sterile line (A line), a maintainer line (B line) and a restorer(R line) are involved. While tacking field counts only those 'B' line ears which have 2 cm or more of the ear length shedding pollen or which have already shed pollen, are counted as pollen shedders. The grower must be informed, so that the whole b line plants can be completely removed before they commence shedding.

- Shedding tassel

Tassels on female parents plants found during field inspection to have come out but which have not commenced shedding are not counted, but special mention as ''not commenced shedding'' is made for subsequent inspections to be done sooner

- Inseparable other crop plants and objectionable weed plants

Inseparable other crop plants are plants of cultivated crops found in the seed field and whose seeds are so similar to the crop found in the seed field and whose seeds are so similar to the crop

seed that it is difficult to separate them economically by mechanical means. If its stage of growth is so widely different from that of the seed crop that it cannot bear seed by the time the seed crop matures, it need not be counted. However, the presence of an inseparable other crop plant in widely differing stages is made for verification during subsequent inspection

- Diseased plants

The plants affected by diseases should invariably be counted and roguing of these plants from the fields.

4.2 Apply agronomic practices

Agronomic factors required for seed production

The agronomic conditions refer to the crop management activities that are required for successful seed production. The availability of adaptable and high-quality seed variety is an important factor to consider in seed production. Different varieties of the same crop have been developed to adapt to different agro-ecological zones. Therefore, it is very important to know the specific varieties that are suitable in the region where the seed farm is located.

Also, land preparation must be properly done through ploughing and harrowing in order to ensure that planted seeds are able to germinate and grow very well. In a situation where there is poor drainage system, making of ridges may also be necessary for some crops.

In addition, it is very important to plant the right quantity of seeds (seed rate) at the right planting depth using the recommended plant spacing (crop-specific) at the right time (time of planting), while also considering the isolation distance for the specific class of seed being planted (e.g. Breeder seed: 400 – 600 meters; Foundation seeds: 300 – 500 meters; Certified seeds: 200 – 400 meters). It is also very important to ensure that weeding is done at the right time to prevent competition of seed crops with weeds. In other words, right timing is an important condition for successful seed production.

Furthermore, after the seed has been planted, it is very important to monitor the growth and development of the crops and carry out rogueing (removal of off-types and undesirable seed crop from the seed farm) whenever necessary. Other operations such as detasseling (as in the case of maize) are also necessary depending on the type of crop being cultivated.

4.3 Environmental issues of ploughing soil for planting

Plowing is a method of working the land which consists in turning and breaking up the soil with a plough, a hoe, or even a simple spade. Plowing is used in agriculture for several purposes, including:

- prepare the soil for planting, creating a bed for plant germination;
- remove weeds and residues of previous crops;
- Incorporate fertilizers or other organic matter into the soil to increase its fertility.

Intensive ploughing and harrowing can have negative environmental impacts, like pesticide and nutrient runoff soil erosion, soil compaction and loss of organic matters. Damage caused by plowing to soil, biodiversity and pollinating insects. Plowing is an agricultural practice as widespread as it is harmful. In this article, we want to explain to you what are the negative effects that this technique causes on the health of the soil and on the delicate natural balances, and the possible solutions to limit its environmental impact.

In addition to erosion, plowing can also cause soil compaction, reducing its porosity. Compact soil limits the correct penetration of plant roots into the soil and therefore becomes unsuitable for their luxuriant growth, causing a decrease in crop productivity**.** Furthermore, it is not surprising that plants born in poor, eroded and compact soil are weak and therefore also more vulnerable to disease, to the attack of harmful microorganisms or insects, as well as to unfavorable environmental conditions.

4.4 Monitor soil moisture content and irrigation

Methods and techniques for soil moisture monitoring

Combining effective irrigation management strategies with more efficient irrigation systems and soil moisture monitoring can lead producers to use water more efficiently and reduce energy used for irrigation. Excessive irrigation not only increases the cost of production from additional pumping and electricity use but also causes excessive fertilizer loss to runoff and leaching, without an economic increase in production. Excessive runoff can also increase the topsoil erosion and can be harmful to the environment if fertilizers and pesticides move to sensitive environments. By subjecting soil and plant canopies to frequent and prolonged wet conditions,

excessive irrigation can decrease harvestable yield due to greater occurrence and severity of disease, anaerobic soil conditions, nutrient deficiencies, and inability to operate farm machinery in the fields. On the other hand, providing insufficient water for the crop limits transpiration and photosynthesis and, in turn, hinders crop growth and reduces yield and crop quality.

Wiser irrigation scheduling methods can achieve efficient irrigation management. Methods range from monitoring crop water use (crop evapotranspiration) based on weather data, monitoring soil moisture status, to monitoring crop indicators such as canopy temperature. A combination of the above is best to accurately determine when to irrigate and how much water to apply; however, to schedule irrigation, producers need to know how to interpret sensor readings, which requires an understanding of basic soil water concepts, available soil moisture sensors, sensor technology and their installation procedures.

Soil moisture monitoring

Soil moisture monitoring is divided into two broad categories – direct and indirect monitoring. Direct methods measure soil volumetric water content. These methods are destructive, tedious, time-consuming, and non-continuous. In contrast, indirect soil moisture monitoring methods measure volumetric water content using related properties based on a calibration equation. Various factors such as soil physical and chemical properties, soil temperature, and the accuracy of the factory calibration equation can affect the performance of indirect sensors. Depending on the sensor's technology (such as sensor response time, sensing volume, operational range, etc.) different soil moisture monitoring devices respond differently in different soil environments.

Feel and appearance method

This method includes the collection of soil samples at different locations and depths in the field to view and feel the soil by crumbling the sample into small pieces and then squeezing it by hand to form a ball. The soil is then ribboned between thumb and the forefinger. The cohesiveness of the ball is an indication of soil wetness, with ribbon length positively correlated to the soil water content.

This method requires a great deal of judgment and experience to make a good estimate of soil water content. In general, this is the least accurate method as it provides a subjective assessment of soil moisture. Nevertheless, the method is widely used.

This method is low cost, as it requires only a soil hand probe or auger to remove the soil sample from different depths. Considering the spatial variability of soil in a field, this method can be used for irrigation management, especially if measurements are validated against a more accurate method periodically. This method becomes more challenging when working with layered soil (different soil texture at different depths) due to the difference in soil physical properties among layers. Another disadvantage of this method is the needed experience before confidence is gained and accuracy achieved.

Gravimetric method

This is a direct measure of soil moisture and does not require sensors. It involves collecting soil samples at different locations and depths using a soil probe or soil auger. The soil is then sealed in an airtight container or plastic bag so moisture is not lost before weighing. After determining wet weight, the soil is placed in an oven for 24 hours at 220ºF, and the dry soil sample is reweighed to determine the amount of water lost. This method also requires the use of bulk density of the soil to covert the gravimetric water content to volumetric water content.

While fairly simple, this method is also accurate and is a standard method for measuring soil moisture content, meaning it is often used to validate or calibrate other methods. The method can give an accurate measure of volumetric water content within 1 percent if the **bulk density** is known and a reliable balance is used for weighing. However, because of its high labor requirement and time-consuming nature, producers do not use the method on a regular basis. Another limitation is measurements are not instantaneous, since it takes 24 hours to completely dry the soil.

Tensiometer

A tensiometer measures the soil matric potential, which is also referred to as soil water suction or soil water tension (negative pressure). Tensiometers are mostly used in horticultural crops and consist of an airtight, water-filled cylindrical tube with a porous cup attached on the lower end and a vacuum gauge at the top.

The tension measured by tensiometer is equivalent to the force or energy that a plant has to overcome to extract water from the soil, and the force that determines the moisture distribution and transport within the soil. The porous cup must be in good contact with the soil at the desired depth. If installed this way, water in the porous cup will form equilibrium with water in the soil, and water.

Will be drawn into or pulled out of the porous cup as the soil becomes wetter or drier. This process creates and releases the suction force in the cup. The force is transmitted through the water column inside the plastic tube and causes a tension reading on a vacuum gauge (recorded manually or automatically using a pressure transducer connected to a data logger).

In general, the operational suction scale on the vacuum gauge of most commercial tensiometers ranges from 0 to 80 centi bar (cbar, which is 1/100 of a bar) of tension. However, a higher range is required for silt and clay soils as compared to sandy soils. For silt loam soils, the suggested irrigation trigger point ranges from 80 to 110 cbar, this is at or above the operating range of tensiometers as compared to fine sandy soils, with irrigation trigger points ranging from 20 to 30 cbar.

4.5 Monitor and maintain field drainage

Irrigation and drainage are complementary practices the necessity for drainage being increased by low efficiencies in the conveyance and application of irrigation water. Adequate drainage improves soil structure and increases the productivity of the soil. Drainage benefits irrigation agriculture in many ways such as: - facilitating early plowing and planting, lengths the crop growing season, provide more available moisture, decreases soil erosion, helps in soil aeration, leaches excess salts from the soil.

Self-Check – 4	Written test

Directions: Answer all the questions listed below.

Part I. writes true if the statement correct false if not

1. Maintaining the field during seed multiplication involves regular monitoring for pests and diseases.
2. Quality control in seed multiplication is not necessary since the focus is on quantity rather than seed quality.

Part II. Choose the correct answer from the following alternatives

1. Which of the following practices is essential for maintaining the field during seed multiplication?
   a) Implementing proper irrigation and drainage systems
   b) Applying excessive amounts of chemical fertilizers
   c) Ignoring weed control measures to allow natural competition
   d) Avoiding regular field inspections
2. What is the purpose of rouging in maintaining the field during seed multiplication?
   a) Removing off-type or diseased plants to maintain seed purity
   b) Promoting hybridization for increased seed diversity
   c) Reducing the need for irrigation and water usage
   d) Enhancing the soil fertility for better seed germination
3. Which of the following is a common practice for quality control during seed multiplication?
   a) Regular seed sampling and testing for germination rates
   b) Applying excessive amounts of chemical pesticides
   c) Mixing seeds from different varieties for increased genetic diversity
   d) Ignoring seed storage conditions and temperature control
4. What is the purpose of seed cleaning and processing during seed multiplication?
   a) Removing impurities and debris to ensure seed purity
   b) Increasing seed weight for higher market value

c) Enhancing seed color and appearance

d) Promoting seed dormancy for extended storage life

5. What is the significance of seed sampling and testing during quality control in seed multiplication?

a) To assess seed germination rates and viability

b) To determine seed weight and market value

c) To enhance seed color and appearance

d) To promote seed dormancy for extended storage life

Part III. Short answer question

1. What is the importance of crop monitoring?
2. Mention the contaminants to be observed during field inspection

Operation sheet - 4	Roughing and field inspection

Objective: To assess the field conditions, identify any weed, disease, or pest infestations, and determine the need for corrective actions or treatments.

Materials and Equipment Required:

- Field notebook or data sheet
- Pen or pencil
- Plant identification guide or resources
- Measuring tape or ruler
- Camera or smartphone (optional)
- PPE (Personal Protective Equipment) as required (e.g., gloves, boots, hat, etc.)

Procedure:

Step 1 Field Identification:

- Record the field identification information, including the field name, location, crop type, and any other relevant details.

Step 2 Pre-inspection Preparation:

- Familiarize yourself with the crop and its growth stages to identify any abnormalities or signs of pest or disease infestation.

Step 3 Roughing Inspection:

- Walk through the field in a systematic pattern, covering the entire area.
- Observe the crop canopy, growth patterns, and overall health.
- Identify and record any visible signs of pest infestation, disease symptoms, or weed presence.
- Take note of any other field conditions that may affect crop health or productivity, such as nutrient deficiencies, waterlogging, or soil erosion.

Step 4 Weed Assessment:

- Identify and record the types of weeds present in the field.
- Take note of their abundance, distribution, and potential impact on the crop.
- Determine if any weed management strategies or treatments are required.

Step 5 Disease and Pest Inspection:

- Examine the crop plants carefully for any signs of disease symptoms, such as leaf spots, wilting, discoloration, or abnormal growth patterns.
- Look for evidence of pest infestations, including insect damage, eggs, larvae, or adult pests.
- Use plant identification guides or resources to identify specific pests or diseases if necessary.
- Record the types of diseases or pests observed and their severity.

Step 6 Sample Collection (if necessary):

- Collect plant samples or specimens, including infected plant parts or pest samples, for further analysis or identification if required.
- Ensure proper labeling and handling of samples for accurate diagnosis or laboratory testing.

Step 7 Documentation and Reporting:

- Record all observations, findings, and measurements in a field notebook or data sheet.
- Take photographs (if applicable) to document visual evidence of field conditions, pests, diseases, or weed infestations.
- Prepare a detailed report summarizing the field inspection findings, including recommendations for necessary actions, such as pest control measures, disease management strategies, or weed control options.

https://www.youtube.com/watch?v=s-ygoMFvstM

LAP TEST-4	Performance Test

Name……. ID……..

Date…….

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **1** hour. The project is expected from each student to do it.

Task-1 you are required to perform roughing and field inspection

LG #44 LO # 5. Control weeds, pests and diseases

Instruction sheet 5

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Weed infestation and crop pest occurrences
- Implementing weed and pest control methods
- Environmental thresholds for a range of weeds and pests
- Identifying side effects of pest control methods
- Assessing effectiveness of pest control methods
- Monitoring and controlling late growing weeds

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Manage weed infestation and crop pest occurrences
- Implement weed and pest control methods
- Understand environmental thresholds for a range of weeds and pests
- Identify side effects of pest control methods
- Assess effectiveness of pest control methods
- Monitor and control late growing weeds

Learning Instructions:

3. Read the specific objectives of this Learning Guide.
4. Follow the instructions described below.
5. Read the information written in the information Sheets
6. Accomplish the Self-checks

Information Sheet 5

5.1 Weed infestation and crop pest occurrences

Weed infestation

- Weeds are plants that grow where they are not wanted and compete with crops for water, nutrients, light, and space.
- Weeds can contaminate products at harvest, harbor pest insects, mites, vertebrates, or be a source of plant disease agents.
- Weeds can cause more yield loss and add more to farmers' production costs than insect pests, crop pathogens, root-feeding nematodes, or warm-blooded pests.

Crop pest occurrences

- Crop pests can include insects, diseases, and nematodes that can damage or destroy crops.
- Crop pests can cause significant yield loss and increase production costs for farmers.

Weed infestation and crop pest occurrences can have a significant impact on crop yield and quality. Effective weed control and crop pest management strategies are essential to maintain crop productivity and quality. These strategies may include hand pulling, hoeing, cultivation, crop rotation, seed cleaning, herbicides, pesticides, and integrated pest management strategies.

5.2 Implement weed and pest control methods

General categories of weed control methods are:
Preventative Weed Control: refers to any control method that aims to prevent weeds from being established in a cultivated crop, a pasture, or a greenhouse. Examples of preventative weed control would be using certified weed free seed, only transporting hay that is weed free, making sure farm equipment is cleaned before moving from one location to another, and screening irrigation water to prevent weed seeds from traveling along irrigation ditches.

Cultural weed control: refers to any technique that involves maintaining field conditions such that weeds are less likely to become established and/or increase in number. Examples of cultural

weed control would be crop rotation, avoiding overgrazing of pastures or rangeland, using well-adapted competitive forage species, and maintaining good soil fertility.

Mechanical weed control: refers to any technique that involves the use of farm equipment to control weeds. The two mechanical control techniques most often used are tillage and mowing.

Biological weed control: refers to any technique that involves the use of natural enemies of weed plants to control the germination of weed seeds or the spread of established plants. This is a rapidly expanding area of weed control with many examples. Examples of biological weed control include sheep to control tansy ragwort or leafy spurge, cinnabar moth and the tansy flea beetle to control tansy ragwort, the chrysolira beetle to control St. John's Wort, and the use of goats to control brush on rangeland.

Chemical weed control: refers to any technique that involves the application of a chemical (herbicide) to weeds or soil to control the germination or growth of the weed species. In economic terms, chemical control of weeds is a very large industry and there are scores of examples of chemical weed control products. Common examples of chemicals used to control weeds in forages are 2,4-DB; EPTC; bromoxynil; and paraquat.

5.3 Environmental thresholds for a range of weeds and pests

Terms to Know

Host: A plant or animal on or in which a pest lives.

Juvenile hormones: Natural insect chemicals that keep the earlier stages of an insect from changing into the normal adult form.

Labeling: The pesticide product label and other accompanying materials that contain directions that pesticide user are legally required to follow

Mycoplasmas: The smallest known living organisms that can reproduce and exist apart from other living organisms. They obtain their food from plants.

Nematodes: Small, usually microscopic, eel-like roundworms.

Non target organism: Any plant or animal other than the pest that is being controlled.

Parasite: An organism living on, in, or with another living organism for the purpose of obtaining food.

Pathogen: An organism that causes disease in other organisms.

Pheromones: Chemicals emitted by an organism to influence the behavior of other organisms of the same species.

Predator: An organism that attacks, kills, and feeds on other organisms.

Scouting: Regularly searching for, identifying, and assessing numbers of pests and the damage they are causing.

An economic threshold is the insect's population level or extent of crop damage at which the value of the crop destroyed exceeds the cost of controlling the pest. Economic thresholds can be expressed in a variety of ways including the number of insects per plant or per square meter, the amount of leaf surface damage, etc.

The Economic Injury Level and the Economic Threshold in IPM

Economic injury level: The smallest number of insects (amount of injury) that will cause yield losses equal to the insect management costs.

Economic threshold: The pest density at which management action should be taken to prevent an increasing pest population from reaching the economic injury level.

EILs are usually expressed as a pest density and are developed from yield-loss relationships derived from field research studies. The EIL has been described as the break-even point, the level of pest a plant can tolerate, among other things. The main thing is that we want to manage the pest population before it reaches the EIL. That is where the ET comes in.

The ET is the practical rule used to determine when to take management action. In fact, some refer to the ET as the action threshold. It is essentially a prediction of when a pest population is going to reach the EIL. It is assumed that once the ET is reached, there is a high probability that the pest population will reach the EIL if no management action is taken.

Establishing an ET is complex. It incorporates the EIL as well as other factors which require a thorough understanding of the pest's population dynamics in the specific crop. Pest and crop

phenology, pest population growth and injury rates, and the practical aspects of management tactics all have to be considered when establishing ETs.

Unfortunately, a complete understanding of the pest and crop biology and ecology is rarely available, and a certain level of subjectivity is part of establishing ETs. For example, sometimes the ET is simply set at 80% of the EIL, as it is with bean leaf beetle on soybean. In this case the ET is relatively close to the EIL. On the other hand, for an insect such as the soybean aphid that has an exponential population growth rate, the ET is well below the EIL and at a level where no damage occurs.

Because ET development is complex and dependent on the specific agro-ecosystem, one should have an understanding of how ETs are determined before altering them. Simply raising or lowering ETs to account for changes in the market may not be appropriate.

Principles of Pest Control

A pest is anything that:

- competes with humans, domestic animals, or desirable plants for food or water,
- injures humans, animals, desirable plants, structures, or possessions,
- spreads disease to humans, domestic animals, wildlife, or desirable plants,
- Annoys humans or domestic animals.

Types of Pests

Types of pests include:

- Insects, such as roaches, termites, mosquitoes, aphids, beetles, fleas, and caterpillars.
- insect-like organisms, such as mites, ticks, and spiders,
- microbial organisms, such as bacteria, fungi, nematodes, viruses, and mycoplasmas,
- weeds, which are any plants growing where they arc not wanted,
- mollusks, such as snails, slugs, and shipworms, and
- Vertebrates, such as rats, mice, other rodents, birds, fish, and snakes.

Pest Identification

Accurate identification is the first step in an effective pest management program. Never attempt a pest control program until you are sure of what the pest is. The more you know about the pest

and the factors that influence its development and spread, the easier, more cost-effective, and more successful your pest control will be. Correct identification of a pest allows you to determine basic information about it, including its life cycle and the time that it is most susceptible to being controlled.

As a certified applicator, you must be familiar with the pests you are likely to encounter in the type of work in your certification category. To be able to identify and control pests, you need to know:

- The physical features of the pests likely to be encountered.
- characteristics of the damage they cause,
- their development and biology,
- Whether they are continuous, sporadic. or potential pests, and
- What your control goal is.

Pest Control

Any time you are considering whether pest control is necessary, remember:

- Control a pest only when it is causing or is expected to cause more harm than is reasonable to accept.
- Use a control strategy that will reduce the pest numbers to an acceptable level.
- Cause as little harm as possible to everything except the pest.
- Even though a pest is present, it may not do very much harm. It could cost more to control the pest than would be lost because of the pest's damage.

Pest Control Goals

Whenever you try to control a pest you will want to achieve one of these three goals. or some combination of them:

- Prevention - keeping a pest from becoming a problem.
- Suppression - reducing pest numbers or damage to an acceptable level, and .
- Eradication - destroying an entire pest population.

Threshold Levels

Thresholds are the levels of pest populations at which you should take pest control action if you want to prevent the pests in an area from causing unacceptable injury or harm. Thresholds may

be based on esthetic, health, or economic considerations. These levels, which are known as "action thresholds," have been determined for many pests.

A threshold often is set at the level where the economic losses caused by pest damage, if the pest population continued to grow, would be greater than the cost of controlling the pests. These types of action thresholds sometimes are called "economic thresholds." In some pest control situations, the threshold level is zero: even a single pest in such a situation is unreasonably harmful. For example, the presence of any rodents in food processing facilities forces action. In homes, people generally take action to control some pests, such as rodents or roaches, even if only one or a few have been seen.

Integrated Pest Management

Integrated pest management is the combining of appropriate pest control tactics into a single plan (strategy) to reduce pests and their damage to an acceptable level. Using many different tactics to control a pest problem tends to cause the least disruption to the living organisms and nonliving surroundings at the treatment site. Relying only on pesticides for pest control can cause pests to develop resistance to pesticides, can cause outbreaks of other pests, and can harm surfaces or non-target organisms. With some types of pests, use of pesticides as the only tactic will achieve very poor control.

To solve pest problems you must:

- Identify the pest or pests and determine whether control is warranted for each.
- Determine your pest control goal(s).
- Know what control tactics are available.
- Evaluate the benefits and risks of each tactic or combination of tactics.
- Choose a strategy that will be most effective and will cause the least harm to people and the environment.
- Use each tactic in the strategy correctly.
- Observe local, State, and Federal regulations that apply to the situation.

The strategy you choose will depend on the pest you have identified and the kind and amount of control you need.

Control measures must be used. Those available include:

a. Host resistance

Some plants, animals, and structures resist pests better than others. Some varieties of plants, wood, and animals are resistant to certain pests. Use of resistant types, when available, helps keep pest populations below harmful levels by making conditions less favorable for the pests.

Host resistance works in three main ways:

i. Chemicals in the host repel the pest or prevent the pest from completing its life cycle.
ii. The host is more vigorous or tolerant than other varieties and thus less likely to be seriously damaged by pest attacks.
iii. The host has physical characteristics that make it more difficult to attack.

b. Biological control

It involves the use of natural enemies: parasites, predators, and pathogens. You can supplement this natural control by releasing more of a pest's enemies into the target area or by introducing new enemies that were not in the area before. Biological control usually is not eradication. The degree of control fluctuates. There is a time lag between pest population increase and the corresponding increase in natural controls. But, under proper conditions, sufficient control can be achieved to eliminate the threat to the plant or animal to be protected.

Biological control also includes methods by which the pest is biologically altered, as in the production and release or large numbers of sterile males and the use of pheromones or juvenile hormones.

Pheromones can be useful in monitoring pest populations. Placed in a trap for example they can attract the insects in a sample area so that pest numbers can be estimated. Pheromones also can be a control tool. Sometimes a manufactured copy of the pheromone that a female insect uses to attract males can be used to confuse males and prevent mating, resulting in lower numbers of pests. Applying juvenile hormones to an area can reduce pest numbers by keeping some immature pests from becoming normal, reproducing adults.

c. Cultural control

Cultural practices sometimes are used to reduce the numbers or pests that are attacking cultivated plants. These practices alter the environment, the condition of the host plant, or the behavior of the pest to prevent or suppress an infestation. They disrupt the normal relationship between the pest and the host plant and make the pest less likely to survive, grow, or reproduce. Common cultural practices include rotating crops, cultivating the soil, varying time or planting or harvesting, planting trap crops, adjusting row width, and pruning, thinning, and fertilizing cultivated plants.

d. Mechanical (physical) control

Devices, machines, and other methods used to control pests or alter their environment arc called mechanical or physical controls. Traps, screens, barriers, fences, nets, radiation, and electricity sometimes can he used to prevent the spread or pests into an area.

Lights, heat, and refrigeration can alter the environment enough to suppress or eradicate some pest populations. Altering the amount or water, including humidity, can control some pests, especially insects and disease agents.

e. Chemical control

Pesticides are chemicals used to destroy pests, control their activity, or prevent them from causing damage. Some pesticides either attract or repel pests. Chemicals that regulate plant growth or remove foliage also are classified as pesticides. Pesticides are generally the fastest way to control pests. In many instances, they are the only tactic available.

5.4 Identify side effects of pest control methods

Chronic poisoning from pesticide symptoms may occur gradually, after repeated exposures over a period of time, and may include: muscle weakness.

General pesticide safety

Suggestions when using pesticides at home include:

- Don’t stock up on pesticides. Buy only as much as you need.
- Read the manufacturer’s instructions carefully and always use the product strictly as directed. Do not use more than the recommended amount and make sure that you follow all safety precautions.

- Do not mix pesticides. You risk an unexpected and potentially dangerous chemical reaction.
- Store the pesticide in its original container with the lid firmly sealed and keep out of the reach of children, for example, locked in a high cupboard in the garage. Never transfer pesticides into containers that children might mistake for food or drink.
- Do not set traps or place baits in areas that are accessible to children, pets or native animals.
- Wear the protective clothing suggested in the manufacturer's instructions whenever you handle or use the pesticide, for example, rubber gloves.
- Do not eat, drink or smoke while using a pesticide.
- Wash your hands after use.

Safety suggestions for indoor use of pesticides

When you use pesticides indoors you should always:

- Cover or remove bird cages and fish tanks, and relocate other pets before using aerosol (spray) pesticides. Many pesticides are extremely toxic to birds and fish.
- Remove (or cover) food, cooking utensils and other personal items from the area to be treated. Thoroughly clean kitchen benches before preparing food.
- Avoid applying surface sprays to areas commonly touched by family members, such as furniture. Only use surface sprays in out-of-the-way areas like along skirting boards.
- Leave the room while the pesticide (such as fly spray) is taking effect. When you come back, open the windows to clear the air.
- Make sure pesticides are used in the right place. For example, mice tend to run along skirting boards and under floors. If you put traps or baits out in the open, they may fail to attract the pest and may pose a health risk to family members or pets.
- Clear up any food debris or scraps if you use baits, so that the pest is drawn only to the bait. This means you will need less bait.

Safety suggestions for outdoor use of pesticides

When you use pesticides outdoors, you should always:

- Make sure all doors and windows are closed before using the pesticide
- Avoid using pesticide outdoors on rainy or windy days. The weather can influence the effectiveness of the pesticide and cause damage to other animals, people and the environment
- Cover fish ponds, barbeques and vegetable gardens before using the pesticide
- Relocate pets and remove their bedding, food and water bowls
- Avoid watering your garden after using a pesticide. Check the manufacturer's instructions for a guide to how long you should wait
- Observe plants and birds for a few days afterwards to make sure that the pesticide isn't causing unwanted harm
- Advise your neighbours if you use any external pesticide treatments
- If you have a rainwater tank, take care to prevent overspray onto guttering and the roof area. If there is any risk of pesticide residue washing into the tank, you should divert the collection pipe away from the rainwater tank until after the next rainfall.

Pesticides and harm to the environment

Some pesticides, like space sprays, are fast acting. They knock down the pest, and then break down quickly. Other pesticides, like surface sprays and termite treatments, linger in the environment for days, weeks or even longer after application.

While most pesticides are designed to only affect the target pest, other insects or animals may sometimes be harmed. For example, a bird may be poisoned if it eats a spider killed by insecticide. That's why it's important to select pesticides that are designed for the pest you wish to treat, follow the label instructions carefully and use the least amount possible.

Pesticides and your health

Pesticides can take the form of a solid, liquid, powder or spray. The form will influence the way in which the pesticide can enter your body and potentially affect your health.

Pesticides can enter your body if you:

- swallow a pesticide, eat, drink or smoke after handling pesticide, or consume food or drink that was exposed to a pesticide

- have skin contact with pesticides – directly, through pesticide-soaked clothing, or by touching pesticide-treated surfaces
- inhale pesticide vapors, sprays or dust
- Rub your eyes after handling pesticides or cause pesticides to come into direct contact with your eyes.

If you minimize your exposure and take care when you come into contact with pesticides, you will reduce the chance of damaging your health.

Pesticide poisoning

Poisoning by exposure to pesticides may occur shortly after a single exposure (acute poisoning) or gradually after repeated exposures over a period of time (chronic poisoning).

Acute poisoning from pesticides

Symptoms of acute poisoning from pesticides may begin shortly after exposure and may include:

- headache
- dizziness
- nausea
- vomiting
- stomach cramps
- diarrhoea
- blurred vision
- excessive eye watering
- sweating
- Excess saliva.

More severe poisoning may also lead to changes in heart rate, chest tightness, muscle weakness and twitching, difficulty breathing and walking, constricted pupils and incontinence. In very severe cases of poisoning, seizures and unconsciousness may occur.

Chronic poisoning from pesticide

Symptoms may occur gradually, after repeated exposures over a period of time, and may include:

- muscle weakness

- fatigue
- difficulty concentrating and remembering things
- Generally feeling unwell.

The type of symptoms you have, how long they last and how severe they are may vary depending on factors such as:

- the type and concentration of the pesticide used
- the degree of exposure
- The health and age of the person exposed.

Many of the potential symptoms are not specific to pesticide poisoning – they may be due to other conditions, such as illness or allergy. You should always consult your doctor for an accurate diagnosis of symptoms.

Risk factors for pesticide poisoning

Although anyone may be affected by exposure to pesticides, certain groups of people are particularly susceptible including:

- unborn babies and young children
- pregnant and nursing women
- Elderly people.

5.5 Assess effectiveness of pest control methods

Factors Affecting Pest Control Effectiveness

Several factors can affect the effectiveness of pest control measures. Understanding these factors is essential for manufacturers to develop effective pest control solutions. Here are some common elements:

i. Type of Pest:

Different pests have unique behaviors, life cycles, and environmental requirements. Therefore, other pest control methods may be required to control different pests effectively.

ii. Environmental factors**:**

Such as temperature, humidity, and lighting can significantly impact the effectiveness of pest control measures. For example, some pests thrive in warm and humid environments, while others prefer cooler

and drier conditions. Here are some ways in which environmental conditions can affect pest control effectiveness:

- Temperature**:** The temperature can influence the behavior and reproductive cycles of pests. For example, cockroaches and other warm-blooded insects are more active in warmer temperatures, while rodents are more active in cooler temperatures. Thus, it is essential to consider the temperature when developing pest control solutions to ensure that the chosen method is effective for the specific type of pest.
- Humidity**:** The level of humidity can also impact pest behavior. Some pests, such as silverfish and booklice, thrive in high humidity environments, while others, such as termites, require a certain level of moisture to survive. This means that pest control solutions must take into account the humidity levels in the environment where the pests are present.
- Weather conditions**:** Weather conditions such as rain, wind, and snow can also impact pest behavior and the efficacy of pest control measures. For example, rain can wash away pesticides, making them less effective, while strong winds can disperse insecticide sprays, reducing their efficacy.
- Habitat**:** The habitat of pests can also impact the effectiveness of pest control measures. For example, some pests, such as rats and mice, are known to burrow and nest in walls and other hidden areas. This means that pest control solutions must be tailored to the specific habitat of the pests to ensure their effectiveness.

iii. Type of Pesticide:

The type of pesticide used can impact its effectiveness in controlling pests. Some pesticides are more effective against specific types of pests, while others may have broader efficacy. Additionally, some pests may have developed resistance to certain pesticides, rendering them ineffective. Here are some ways in which the type of pesticide can affect pest control effectiveness:

- Target pest**:** Different types of pesticides are designed to target specific types of pests. For example, insecticides are used to control insect pests, while rodenticides are used to control rodents. Using the wrong type of pesticide can be ineffective in controlling the target pest.
- Mode of action**:** Pesticides work by interfering with the biological processes of pests. Some pesticides work by disrupting the nervous system of pests, while others work by interfering

with their reproductive systems or metabolism. The mode of action of the pesticide can impact its effectiveness in controlling pests.

- Residual activity**:** Some pesticides have longer residual activity than others. Residual activity refers to the length of time that the pesticide remains active after it has been applied. Pesticides with longer residual activity can provide longer-term control of pests.
- Pesticide resistance**:** Pests can develop resistance to certain types of pesticides over time. If a pest population has developed resistance to a particular pesticide, it may be ineffective in controlling the pest. Manufacturers must be aware of the potential for pesticide resistance and use alternative pesticides or methods when necessary.

iv. Application Method and Timing:

The method and timing of pesticide application can affect its effectiveness. For example, applying pesticides during periods of high pest activity or in the early stages of pest infestation may be more effective than waiting until the infestation is severe.

v. Expertise of Pest Control Personnel

The skills, knowledge, and experience of pest control personnel can impact the effectiveness of pest control measures. Proper training and education can help ensure that personnel are equipped with the knowledge and skills necessary to implement effective pest control solutions.

By taking these factors into consideration, manufacturers can ensure that their pest control solutions are effective in controlling pests and minimizing the risk of infestations.

Common Metrics for Measuring Pest Control Effectiveness

Measuring pest control effectiveness is essential for ensuring that the pest control measures being implemented are working as intended. There are several common metrics for measuring pest control effectiveness, including:

- Pest Population Density

Measuring pest population density before and after implementing pest control measures can provide insight into the effectiveness of the measures. If the pest population density has decreased significantly after implementing pest control measures, it is an indication that the measures are effective.

- Pest Activity

Measuring pest activity, such as the number of pests caught in traps, can also provide insight into the effectiveness of pest control measures. If the number of pests caught in traps has decreased after implementing pest control measures, it is an indication that the measures are effective.

- Damage caused by Pests

Measuring the damage caused by pests before and after implementing pest control measures can also provide insight into their effectiveness. If the amount of damage caused by pests has decreased after implementing pest control measures, it is an indication that the measures are effective.

- Pesticide Use

Measuring pesticide use before and after implementing pest control measures can also provide insight into their effectiveness. If pesticide use has decreased after implementing pest control measures, it is an indication that the measures are effective in controlling pests.

- Customer Satisfaction

Measuring customer satisfaction with pest control services can also be an indicator of their effectiveness. If customers report fewer pest problems after implementing pest control measures, it is an indication that the measures are effective.

- Compliance with Regulations

Compliance with pest control regulations can also be a metric for measuring effectiveness. If pest control measures are in compliance with regulations and standards, it is an indication that the measures are effective in controlling pests.

Conducting Pest Control Effectiveness Evaluations

Evaluating the effectiveness of pest control measures is important for ensuring that they are working as intended and for identifying any potential issues that may need to be addressed. Here are some steps you can take to conduct a pest control effectiveness evaluation:

- Set clear goals**:** Before beginning the evaluation, it is important to establish clear goals for what you hope to achieve. This might include reducing the number of pests in a particular area, preventing the spread of disease, or reducing the need for chemical pesticides.
- Choose appropriate metrics**:** Depending on your goals, you will need to choose appropriate metrics to measure the effectiveness of your pest control measures. This might include tracking the number of pests caught or killed, monitoring changes in the population over time, or conducting surveys to assess pest activity.

- Establish a baseline**:** To evaluate the effectiveness of your pest control measures, it is important to establish a baseline level of pest activity before any treatments are applied. This will provide a point of comparison for measuring changes in pest activity after treatment.
- Conduct regular monitoring**:** Regular monitoring is essential for assessing the effectiveness of pest control measures over time. This might involve conducting regular inspections, setting up traps or bait stations, or using other monitoring methods to track pest activity.
- Analyze data and adjust treatments**:** As you collect data on pest activity and the effectiveness of your control measures, it is important to analyze this data and make adjustments to your treatments as needed. This might involve changing the type of treatment used, adjusting the frequency or intensity of treatments, or making changes to the environment to reduce pest activity.

The Most Effective Methods of Pest Control

The first step in effective pest control is identifying the exact problem. By identifying the type of problem you're facing, you'll be able to work out the best control strategy. Using the wrong control method can, at best, delay the resolution of your pest problem. At worst it can actually cause unnecessary damage and put you and your family at risk. Using the best control strategy for your pest problem will reduce your exposure to harmful chemicals and allow savings in time and money. Once you've identified what you're up against – be it rats, mice, flies, mosquitoes, fleas or bedbugs – make sure you read the rest of this blog to learn more about the five most effective methods of pest control that you have at your disposal to remedy it.

A. Pesticides: Pesticides can be used to control a variety of pests. They are effective for controlling a wide variety of insect and rodent infestations. Although they're one of the most commonly used and effective ways to eliminate your pest problem, they do have drawbacks. Exposure to these chemicals can be hazardous for you, your family and your pets. They can also harm beneficial insects such as bees and butterflies. This is why it's always vital that you carefully read and follow the instructions on any pesticides you purchase.

B. Organic Pesticides: There are a range of organic pesticides and home pest control remedies out there for those that wish to avoid exposing themselves to potentially harmful chemicals or harming any beneficial insects. That being said, they often aren't as effective as industrial

pesticides, so make sure you attempt to use them before your pest problem gets too bad (or as a deterrent to keep pests away in the first place).

C. Fumigation: This common method is great for terminating several types of pests in the home at all stages of their lifecycle. However, for an effective treatment, your home needs to be sealed or covered for at least 24 hours. It's important to understand that the fumigation process may require several sessions to deal with your pest problem, so it could represent a serious disruption to your lifestyle.

D. **Baiting**: For chemical-sensitive individuals, baiting provides a more specific and targeted approach to pest control. Baiting is also a cost-effective way to significantly lower the number of hidden pests around the home. Bait stations allow for the containment of poison and thus reduces the chance of exposure. However, baiting can be hazardous for homes with pets and small children, so it's important to take all the right safety precautions if you're going down this route.

E. **Traps**: Traps provide an option for resolving a wide range of pest problems – from insects to rodents – without the use of chemicals or poisons. However, certain traps (such as those for rats and mice) can also be hazardous for pets and small children, so it's important to consider this before you deploy them.

5.6 Monitor and control late growing weeds

Late Season Perennial Weed Control

Producers struggle with a few troublesome perennial weeds, such as johnsongrass and bindweed. These weeds typically emerge in the same spots year after year due to their resilient root systems or rhizomes. Some herbicides are reasonably effective on these weeds during the growing season. But typically, these weeds are tough to completely eradicate from a field.

One thing to consider is a post-harvest herbicide treatment. Later in the growing season, perennial plants begin to store food reserves in their roots, rhizomes or tubers for the winter. We can take advantage of that downward flow of nutrients from the leaves to the roots by applying an herbicide that will translocate down to the roots. This can result in a significantly better kill of the entire plant.

When an herbicide is applied to a perennial plant early in the growing season, a good portion of the herbicide will translocate to the above ground growing points. This may kill the vegetative portion of the plant, but not necessarily kill all the roots or the rhizomes.

A late season application allows significantly more herbicide to move toward the below ground portions of the plant. This gives you a much better chance of killing the entire plant. This becomes very noticeable the next season as there is typically a significant reduction in plants that emerge the next year. The same principal can be taken with the dandelions in your lawn. We tend to treat this perennial when we see those yellow flowers in the spring, but the plant rarely dies. Consider a fall treatment in your lawn to reduce next year's dandelion population.

Self-Check – 5	Written test

Directions: Answer all the questions listed below.

Part I. write true if the statement is correct false if not

1. Mulching with organic materials is an effective method for weed control during seed multiplication.
2. Integrated Pest Management aims to minimize pesticide use and promote ecological balance.
3. Crop rotation is a strategy used to break disease cycles and manage diseases during seed multiplication.
4. Regular scouting and monitoring of fields are important for early detection and identification of pests and diseases during seed multiplication.

Part II. Choose the correct answer from the following alternatives

1. Which of the following methods is commonly used to control weeds during seed multiplication?
   a) Mulching with organic materials
   b) Applying excessive chemical fertilizers
   c) Ignoring weed control measures to promote natural diversity
   d) Planting seeds at a shallow depth to suppress weed growth
2. Integrated Pest Management focuses on:
   a) Minimizing pesticide use and promoting ecological balance
   b) Maximizing pesticide use for better pest control
   c) Eliminating all pests from the field to ensure seed purity
   d) Applying excessive chemical pesticides to control pests effectively
3. What is the purpose of implementing crop rotation during seed multiplication?
   a) To disrupt the life cycle of pests and diseases
   b) To increase weed growth for better competition with the desired plants
   c) To promote cross-pollination between different crop varieties
   d) To reduce the need for irrigation and water usage

4. Which of the following is an effective method for managing pests during seed multiplication?
   a) Biological control using natural predators
   b) Applying excessive chemical pesticides
   c) Ignoring pest control measures to allow natural population growth
   d) Using only physical barriers like nets or fences
5. What is the significance of disease monitoring and early detection during seed multiplication?
   a) To implement timely control measures and prevent disease spread
   b) To encourage disease development for better seed resistance
   c) To promote cross-pollination and genetic diversity among plants
   d) To reduce the need for irrigation and water usage

Part III. Short answer questions

1. Why is it important to control weeds, pests, and diseases in crop production?
2. What are some cultural practices that can help prevent and manage pests and diseases?
3. How can crop rotation contribute to the control of weeds, pests, and diseases?

LG #45	LO #6. Harvest crop

Instruction sheet 6

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Coordinating and conducting internal and external inspections
- Evaluating and determining crop maturity
- Taking and determining moisture content of standards samples
- Preparing harvesting equipment, operations and transportation
- Identifying hygiene standards
- Maintaining quality seed
- Seed storage principles and treatments
- Field storage and laboratory standards of seed

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Coordinate and conduct internal and external inspections
- Evaluate and determine crop maturity
- Take and determine moisture content of standards samples
- Prepare harvest equipment, operations and transportation
- Identify hygiene standards
- Maintain quality seed
- Understand seed storage principles and treatments
- Understand field storage and laboratory standards of seed

Learning Instructions:

a. Read the specific objectives of this Learning Guide.
b. Follow the instructions described below.
c. Read the information written in the information Sheets
d. Accomplish the Self-checks

Information Sheet 6

6.1 Coordinate and conduct internal and external inspections

Field inspection, that is, inspection of standing seed crops is an essential step in verifying conformity of seed crops to prescribed certification standards.

General principles

- All field inspections must be made by well-trained and qualified personnel. The inspector has to know the prerequisites and standards.
- The prescribed procedures and techniques of field inspection and the minimum number of inspections specified in the certification standards should be strictly adhered to.
- The inspections should be made without prior notice.
- The seed inspector should achieve full co-operation from the seed growers, even in the case of the rejection of a field.
- Upon arrival at the seed farm, the inspector should check all information about species, variety, seed origin, cultivated area, class of seed, cropping history of the field to be inspected, and known adjacent fields of the same species, which may be dangerous from isolation point of view.
- Each field and its boundaries must be pointed by the seed grower.
- During the walk in the field, the inspector must make estimates of other varieties and impurities, diseased plants, general condition of the crop, applied farm practices and possible yield.
- If the direction of plant rows permits, the inspector should walk through his side or back.

The inspection of a seed crop is done at different stages of crop growth so as to make various verifications and estimates of various impurities, off-types and diseases, etc.

Crop stage of inspection

A. Inspection at the time of sowing

Sowing time inspections is to educate the farmers participating in a certified seed production. Programme for the first time, or at times when a new crop is introduced, are very helpful in

maintaining good quality of seed. In biennial crops the main objective is to verify the purity of roots/stem at the time of transplanting.

B. Inspection during pre-flowering/vegetative stage

The purpose of pre-flowering inspection is to educate growers regarding plants to be rogued and to suggest other corrective measures.

C. Inspection during flowering stage

- Check whether various corrective measures, if suggested earlier, have been carried out.
- Check or re-check the land and isolation requirements, planting ratios and source seed.
- Take detailed counts for various contaminating factors.
- Advise the farmer to continue roguing during flowering season.

D. Inspection during post-flowering and pre-harvest stage

The corrective isolation measures suggested earlier may also be checked to ensure whether these have been done.

E. Harvest time inspection

Harvest time inspection is the last inspection conducted on a seed crop. During this inspection detailed counts are taken for various factors, and isolation requirements are finally checked to confirm whether the seed crop has met the requisite field standards. The farmer should be given necessary instructions regarding precautions he should take during harvesting / threshing and supply of the material to processing plants.

6.2 Evaluate and determine crop maturity

Time of harvesting

The optimum time of harvest is when the seed is fully mature, when weather damage has just begun and the seed is easily harvested and cleaned resulting in minimum harvest losses. Harvesting at earlier stages makes combining difficult and relative losses due to threshing and cleaning are greater. Similarly harvesting at a late stage may result in increased weather damage to seeds and losses due to shattering seeds and lodging of plants in the field. The optimum harvest time is somewhere between these two extremes.

Early harvesting of seed crops is not always possible because of the nature of the seed. For example, at physiological maturity of soybeans, the seed and plant is difficult to harvest and thresh, and if attempted will cause much damage to the seed. On the other hand, maize cobs may be harvested (but not shelled) at a seed moisture content of 25% to 30%, dried at moderate air temperatures (<35°C) and shelled when the seed moisture is less than 14%.

Assessing the crop maturity

Cereal seed reaches physiological maturity between 35 to 45% moisture content, but it needs to dry down to safer moisture content for harvesting and storage. The seed moisture content can be used as an indicator of when the crop is ready for harvest. Electric moisture meters or the crop characteristics can be used to decide when to harvest.

For example, maize at physiological maturity of the crop, the seed has high moisture content (between 30 and 38 % in maize) and the crop will still have some vestiges of green in the stems and leaves. From physiological maturity onwards, the seed dries as the natural environment allows.

6.3 Take and determine moisture content of standards samples

Evaluation of seed moisture content is an extremely important determination in seed testing. Knowledge of the seed moisture content is useful because it provides information regarding the potential for harvesting, cleaning, and plant injury as well as the likely hood for successful long term storage. Seed moisture content is conducted by first weighing the seeds to determine their wet weight. Then, the seeds are placed into an oven set for 100 ^{0}c for grass, legume, and cereal seeds for 24 hours except for large or thick coated pine seeds and oil seeds such as brassica species in which 48 hours at 85 ^{0}c is required. After the drying period the seeds are removed from the oven, placed in a desiccator for 15 minutes to cool, and the dry weight of the seed is determined or directly determined in the field by moisture tester.

How to determine seed moisture content?

Step 1: Determine how many seeds are available for the test

- The lower the weight of seed used, the more accuracy is required to achieve a true result.

- The submitted sample is only accepted if it is in an intact, moisture-proof container and as much air as possible has been excluded (sealed for official purposes).

Step 2: Determine if pre-drying is required

Step 3: Determine if grinding is necessary

Step 4: Decide which method is appropriate to use

Step 5: Proceed with the determination of moisture content

Step 6: Use the results of the weighing to calculate moisture content

Two methods are used to express seed moisture content and calculated in the following ways.

Wet weight basis

$$\frac{\text{Weight before drying – weight after drying}}{\text{Weight before drying}} \times 100 = \%\ \text{moisture content}$$

Dry weight basis

$$\frac{\text{Weight before drying – weight after drying}}{\text{Weight after drying}} \times 100 = \%\ \text{moisture content}$$

6.4 Prepare harvesting equipment, operations and transportation

In preparation for harvesting, an assessment is done of the tools and equipment required. This is done taking into account the size of the farm, the crop and/or cultivars, the period during which the harvesting must be completed, and the capacity of storing facilities, where applicable.

Once this information has been gather a decision can be made as to the number and size of picking teams, which in turn determines the equipment requirements. In the case of mechanical harvesting such assessments will determine when a harvester should be booked, if the farmer does not own a harvester, and the number of harvesters that may be required. In addition, the numbers of back-up equipment such as tractors and trailers used for transporting harvested goods can be decided upon.

6.5 Identify hygiene standards

Agricultural crops are grown and harvested under a wide range of climatic and diverse geographical conditions, using various agricultural inputs and technologies, and on farms of varying sizes. In each primary production area, it is necessary to consider the particular agricultural practices that promote the production of safe products, taking into account the conditions specific to the primary production area, type of products, and methods used. Procedures associated with primary production should be conducted under good hygienic conditions, avoid physical mixing of different varieties to minimize contamination of the seeds.

Where possible potential sources of contamination from the environment should be identified Production should not be carried out in areas where the presence of potentially harmful substances would lead to an unacceptable level of such substances in or on after harvest. Where possible, growers should evaluate the previous uses of the sites (indoor and outdoor) as well as adjoining sites in order to identify potential microbial, chemical and physical hazards. The potential for other types of contamination (e.g., from agricultural chemicals, hazardous wastes, etc.) should also be considered.

6.6 Maintain quality seed

Seed quality begins to deteriorate after physiological maturity, and this is an inextricable process that cannot be stopped. Furthermore, seed deterioration is an irreversible process bad seed cannot be turned into good seed. However, the rate of deterioration varies with the crop, and also within and between seed lots of a crop. And, through good management of the seed, the rate of deterioration may be slowed. Therefore, every effort must be made to reduce the rate of seed deterioration. Low quality seed will deteriorate faster than high quality seed, whereas high quality seed will store for longer than low quality seed.

The quality of the seed will decline if environmental conditions become adverse, with high air temperatures, high moisture (or high relative humidity), seed diseases and grain borers having the most negative impact on seed quality. Thus, harvesting of the crop must be timed to ensure

that the seed has the highest possible quality, which basically means that the crop should be harvested as soon after physiological maturity as possible and feasible.

6.7 Seed storage principles and treatments

Seed storage may be defined as the conservation of seeds obtained from the harvest until they are planted for successful crop production. The seeds are required to be conserved through proper storage for a short or long period. During the storage of seeds, moisture is appropriately controlled for the protection of deterioration.

Condition of Storage

- Seed storage aims to maintain its germination capacity; more stringent conditions are required than those to conserve the seed's nutritional or industrial quality.
- During storage, some of the germination capacity is lost slowly or rapidly, depending on storage conditions.
- The store temperature and moisture will be low for dry seed storage at 10°C and relative humidity at 50%.

Principles of Seed Storage

The following principles emerge as necessary for good storage because of the various factors affecting storage's seed viability.

- Seed storage conditions should be dry and cool.
- Effective storage pest control.
- Proper sanitation in seed stores.
- Before placing seeds into storage, they should be dried to safe moisture limits, appropriate for the storage system.
- Storing high-quality seed only, i.e., well cleaned, treated, and high germination with vigour and good pre-storage history.
- Determine seed storage needs because of the period or length of storage time and prevailing climate of the area during the storage period.

Stages of Seed Storage

The seeds are considered stored when they reach physiological maturity until they germinate or throw away because they are dead or otherwise worthless. The entire storage period can be conveniently divided into the following stages.

- Storage on plants (Physiologically maturity until harvest).
- Harvest until processed and stored in a warehouse.
- In storages (Warehouses).
- In transit (rail wagons, trucks, carts, railway sheds, etc.).
- In retail stores.
- On the user's farm.

6.8 Field storage and laboratory standards of seed

Seed analyses laboratory

Seed plays a vital role in the potential crop yield of each small grain producer. Small grain seed must comply with legal requirements with regard to the purity and germination percentage before it can be marketed. Tests that can be done by the laboratory include the following:

Genetic purity analysis: The determination of the cultivar purity is determined visually according to kernel characteristics. Mixed seed lots, netiquette seed lots or carry-over seed can be identified on cultivar level.

Physical purity: Seed must be free of seed of other crops as well as weed seed. Pure seed is then tested to determine the percentage germination.

Germination percentage: It gives an indication of the percentage seed that forms normal seedlings under favorable conditions. Seed purchased has a germination percentage above the minimum of 80%.

Coleoptile length tests: Coleoptile lengths are especially used in the dryland production areas, because planting depths are often deep and emergence problems can occur. Especially certain seed treatments influence the coleoptile length and therefore it is tested to ensure that the minimum requirements are met.

Grading of small grains: Grading of small grains can also be done for the producer to determine the class and grade of the harvest

Self-Check – 6	Written test

Directions: Answer all the questions listed below.

Part I. **writes true if the statement is correct and false if not**

1. Harvesting the crop involves the collection of mature crops from the field.
2. Crop harvesting is typically done during the planting stage of agricultural practices.
3. Harvesting is the final step in the crop production cycle before processing or storage.

Part II. Choose the correct answer from the following alternatives

1. What is the primary objective of proper timing during crop harvesting?
   a) Maximizing crop yield c) Promoting soil fertility
   b) Minimizing labor requirements d) Reducing post-harvest losses
2. Which of the following factors should be considered when determining the harvesting method?
   a) Crop type and maturity c) Availability of farm equipment
   b) Weather forecast for the next season d) Market demand for the crop
3. Which of the following is a common method used for harvesting grains?
   a) Combining c) Pruning
   b) Handpicking d) Transplanting

Part III. Short Answer Questions

1. What are some common methods used for harvesting different types of crops?
2. What factors should be considered when choosing the appropriate harvesting equipment?
3. What role does post-harvest handling play in maintaining crop quality?
4. How can farmers minimize losses during the harvesting process?

LG #46	LO #7. Process seed and treatments

Instruction sheet 7

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Application of seed treatments
- Grading, packaging and labeling seeds
- Selection and application of post-harvest treatments
- Collecting and forwarding seed samples

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Apply seed treatments
- Grade, package and label seeds
- Select and apply of post-harvest treatments
- Collect and forward seed samples

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets
4. Accomplish the Self-checks
5. Perform Operation Sheets
6. Do the “LAP test”

Information Sheet 7

7.1 Apply seed treatments

Seed treatment refers to the application of fungicide, insecticide, or a combination of both, to seeds so as to disinfect and disinfect them from seed-borne or soil-borne pathogenic organisms and storage insects. It also refers to the subjecting of seeds to solar energy exposure, immersion in conditioned water, etc. The seed treatment is done to achieve the following benefits.

Benefits of Seed Treatment:

- Prevents spread of plant diseases
- Protects seed from seed rot and seedling blights
- Improves germination
- Provides protection from storage insects
- Controls soil insects.

Types of Seed Treatment

A. Seed disinfection: Seed disinfection refers to the eradication of fungal spores that have become established within the seed coat, or i more deep-seated tissues. For effective control, the fungicidal treatment must actually penetrate the seed in order to kill the fungus that is present.

B. Seed disinfestation: Seed disinfestation refers to the destruction of surface-borne organisms that have contaminated the seed surface but not infected the seed surface. Chemical dips, soaks, fungicides applied as dust, slurry or liquid have been found successful.

C. Seed Protection: The purpose of seed protection is to protect the seed and young seedling from organisms in the soil which might otherwise cause decay of the seed before germination.

Conditions under which seed must be treated

- Injured Seeds: Any break in the seed coat of a seed affords an excellent opportunity for fungi to enter the seed and either kills it, or awaken the seedling that will be produced from it. Seeds suffer mechanical injury during combining and threshing operations, or from being dropped from excessive heights. They may also be injured by weather or improper storage.

- Diseased seed: Seed may be infected by disease organisms even at the time of harvest, or may become infected during processing, if processed on contaminated machinery or if stored in contaminated containers or warehouses.
- Undesirable soil conditions: Seeds are sometimes planted under unfavorable soil conditions such as cold and damp soils, or extremely dry soils. Such unfavorable soil conditions may be favorable to the growth and development of certain fungi spores enabling them to attack and damage the seeds.
- Disease-free seed: Seeds are invariably infected, by disease organisms ranging from no economic consequence to severe economic consequences. Seed treatment provides a good insurance against diseases, soil-borne organisms and thus affords protection to weak seeds enabling them to germinate and produce seedlings.

Precautions in Seed Treatment:

Most products used in the treatment of seeds are harmful to humans, but they can also be harmful to seeds. Extreme care is required to ensure that treated seed is never used as human or animal food. To minimize this possibility, treated seed should be clearly labeled as being dangerous, if consumed. The temptation to use unsold treated seed for human or animal feed can be avoided if care is taken to treat only the quantity for which sales are assured.

Care must also be taken to treat seed at the correct dosage rate; applying too much or too little material can be as damaging as never treating at all. Seed with very high moisture content is very susceptible to injury when treated with some of the concentrated liquid products.

If the seeds are to be treated with bacterial cultures also, the order in which seed treatments should be done shall be as follows

- Chemical treatments
- Insecticide and fungicide treatments
- Special treatments

Chemical treatments to improve germination and vigor potential

Soaking / treating the seeds with nutrients, vitamins and micronutrients *etc*.

Examples: Paddy: Seeds can be soaked in 1% KCL solution for 12 hours to improve the germination and vigor potential. Sorghum: Seeds could be soaked in $NaCl_2$ (1%) or KH_2PO_4 (1%) for 12 hours for improving the germination and vigor potential. Pulses: Seeds can be soaked in $ZnSO_4$, $MgSO_4$ and $MnSO_4$ 100ppm solution for 4 hours to improve the germination and vigor potential.

7.2 Grade, package and label seeds

7.2.1. Grade seeds

Seed grading is a process that helps to sort and improve the quality of seeds. It involves separating seeds by size, shape, and other characteristics. The principal operations in a seed-processing plant are reception, drying, cleaning and grading, treatment, and weighing, packaging, and storage. Grading requires different types of separators to remove weed and broken and undesirable seeds.

The different types of grading equipment are as follows: indented cylinder, gravity separator, spiral separator, velvet roller, disc separator, electromagnetic separator, and color sorting machine. The sorting process removes any damaged or defective seeds, making sure you're left with high-vigorous seed. Graded seed has a higher crop health, vigor, and yield.

Grading also helps to maintain the quality of the seed from one season to the next. The specific procedures for grading seeds may vary based on the type of seed and the grading machine being used. Always refer to reliable sources and follow the recommended guidelines for the particular seed grading process being applied.

7.2.2. Package and labeling seeds

Proper packaging and labeling of seeds are essential for maintaining seed quality, ensuring regulatory compliance, and providing necessary information to end-users. Adhering to labeling requirements and utilizing appropriate packaging solutions are critical aspects of the seed industry.

Here are some key points related to packaging and labeling seeds:

a. Labeling requirements:

The Federal Seed Act and State Seed laws dictate the information found on the seed tag. This includes the name of each kind and variety of seed in the package, lot number, name and address of the distributor, and percent of germination along with the test date.

b. seed certification

Seed certification is essential to preserve genetic purity and identity. It is a program enabling seed companies to market genetically pure seed.

c. Significance of labeling

Labeling on agricultural seed bags provides essential information about the seed variety, origin, and any special handling instructions. This is integral to ensuring seed viability, protecting crop quality, and adhering to regulatory standards.

d. packaging solutions

Various packaging solutions, such as booklet labels, multi-ply labels, and durable signage labels, are available for the seed industry. These solutions are designed to provide necessary information and ensure regulatory compliance.

e. Organized seed storage

Proper labeling is essential for organized seed storage, especially when gathering, sharing, or swapping seeds. It helps in providing specific planting information and maintaining user-friendly seed storage

7.3 Select and apply post-harvest treatments

Postharvest treatments generally consist in cleaning, selecting, grading, and packing of the fresh produce. However, some crops necessitate special handling or treatments. Root crops, such as potatoes and some tropical root crops may require having their roots cured prior to long-term storage.

Basic conditions for postharvest treatments are

- Only fresh produce can be preserved
- Produce should be free from defects

A basic principle in shelf life enhancement process is to control or minimize the respiration rate and spoilage.

Following are post-harvest treatments in handling and storage of horticultural commodities

- Pre- cooling (Low temperature)
- Cleaning, washing and trimming
- Sorting, grading and sizing
- High temperature – curing/drying/hot water treatments /vapour heat
- treatments/vapor heat treatment/degreening
- Chemical treatment - Disinfestations/ Sprout suppressants/mineral
- application/ethylene inhibitors(1-MCP)
- fruit coating (waxing)
- Astringency removal
- Irradiation
- Regulation of ripening -Control/ethylene scavenging/degreening
- Pulsing and tinting
- Minimal/ Light processing
- Cold storage
- Packing

7.4 Collecting and forwarding seed samples

When collecting and forwarding seed samples for testing, it is essential to follow specific procedures to ensure the samples are representative and maintain their integrity. Here are the general procedures for collecting and forwarding seed samples.

a. Sampling procedures
    - To secure a representative sample, equal portions should be taken from evenly distributed parts of the seed quantity to be sampled. Access should be had to all parts of that quantity.
    - For free-flowing seed in bags or bulk, a probe or trier long enough to sample all portions of the bag or bulk should be used. For non-free-flowing seed, such as chaffy

grass seed, which is difficult to sample with a probe or trier, specific sampling methods should be employed.

- Composite samples should be obtained to determine the quality of a seed lot, such as the percentages of pure seed, other crop seed, weed seed, inert matter, etc.

b. Sample size

- The size of the submitted sample required for testing should be small and representative of the seed lot.

c. Packaging and forwarding

- Specialized seed collection kits are available to allow seed collection directly into an extraction-capable receptacle for easy stackable storage and shipping.
- After drawing the sample, the sample container or bags must be properly sealed and identified corresponding to that of the lot certificate.
- Detailed instructions for shipping seed samples, including packaging and labeling, are provided by relevant organizations and agencies.

Self-Check – 7	Written test

Directions: Answer all the questions listed below.

Part I. write true if the statement is correct false if not

1. Processing seed involves removing impurities and undesirable materials from the seed lot.
2. Seed treatment is primarily done to enhance the physical appearance of the seeds.
3. Seed treatments are used to protect seeds from pests, diseases, and environmental stresses.

Part II. Choose the correct answer from the following alternatives

1. What is the purpose of seed priming as a seed treatment?
   a) To enhance seed germination and early seedling growth
   b) To increase seed weight and market value
   c) To improve seed color and appearance
   d) To promote seed dormancy for extended storage life
2. Which of the following is a common seed processing method used to remove chaff and other debris?
   a) Winnowing c) Cold stratification
   b) Seed coating d) Soil sterilization
3. Which of the following seed treatments is commonly used to control fungal diseases?
   a) Seed disinfection c) Seed vernalization
   b) Seed scarification d) Seed inoculation

Part III. Short answer questions

1. What is the purpose of seed cleaning during seed processing?
2. Name two common methods used for seed treatment and briefly explain their purposes.
3. What are the key factors to consider when selecting a seed treatment method for a specific crop?
4. Explain the importance of seed drying in the seed processing and treatment process.

Operation sheet: 7	Grade seeds based on the criteria

Objective: To classify seeds into different grades based on specific criteria, such as size, weight, purity, germination rate, or other quality parameters.

Equipment Required:

- Clean and sterile workspace
- Seed grading trays or sieves of different sizes
- Seed cleaning equipment (e.g., air aspirator, gravity separator, or specific cleaning machinery)
- Digital scale or seed counter
- Seed moisture tester (if moisture content is a grading criterion)
- Seed purity testing equipment (if purity is a grading criterion)
- Germination testing equipment (if germination rate is a grading criterion)
- Labels and markers
- Pen and notebook for recording information

Procedure:

Step 1 Sample Identification:

- Label each seed sample container with a unique identifier and record the sample identification information in a logbook or data sheet.
- Note down the seed type, variety, lot number, and any other relevant details.

Step 2 Sample Preparation:

- Thoroughly mix the seed sample to ensure a representative portion is used for grading.
- If necessary, remove any large debris, such as stones, soil clumps, or plant material, from the seed sample.

Step 3 Workspace Setup:

- Clean and sterilize the workspace to prevent contamination.
- Set up the necessary equipment, including grading trays, sieves, seed cleaning machinery, and testing equipment.

Step 4 Grading Criteria Selection:

- Determine the specific grading criteria based on the quality parameters required or the grading standards applicable to the seed type.
- Common grading criteria include size, weight, purity, germination rate, moisture content, or other quality attributes.

Step 5 Grading Process:

i. Select a representative sample from the seed lot for grading.
ii. Based on the chosen criteria, perform the following tasks:
iii. Size grading: Pass the seeds through appropriate sieves or grading trays to separate them into different size categories. Record the percentage of seeds falling into each size category.
iv. Weight grading: Use a digital scale or seed counter to determine the weight or count of seeds in a given sample. Classify the seeds into different weight categories according to the grading standards.
v. Purity grading: Conduct a seed purity test using specific equipment or methods to identify and separate impurities. Determine the percentage of pure seeds and record the results.
vi. Germination grading: Perform germination tests on a representative sample to determine the germination rate. Classify the seeds into different germination rate categories based on the grading standards.
vii. Moisture content grading: Use a seed moisture tester to measure the moisture content of the seeds. Categorize the seeds into different moisture content ranges according to the grading standards.
viii. Record

Step 6 Packaging and Labeling:

- Place the graded seeds into separate, labeled containers or packaging for each grade.
- Clearly mark the grade and any relevant information on the containers or packaging.

Step 7 Record Keeping

Step 8 Reporting

https://www.youtube.com/watch?v=JJkP8THKJuY

LAP TEST-7	Performance Test

Name……. ID……..

Date…….

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within **1** hour. The project is expected from each student to do **it.**

Task-1 you are required to perform grading seed

LG #47	LO #8- Store seeds and evaluate the stored seed

Instruction sheet 8

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Selecting and maintaining storage facilities
- Maintaining quality and germination capacity storing seeds
- Conducting periodic checks and laboratory testing of seeds
- Maintaining and keeping seed storage program
- Forwarding records keeping to the appropriate person

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Select and maintain storage facilities
- Maintain and store quality seeds
- Conduct periodic checks and laboratory testing of seeds
- Maintain and keep seed storage program
- Forward records keeping to the appropriate person

Learning Instructions:

7. Read the specific objectives of this Learning Guide.
8. Follow the instructions described below.
9. Read the information written in the information Sheets
10. Accomplish the Self-checks

Information Sheet 8

8.1 Select and maintain storage facilities

Key Qualities of a Good Storage Facility

A. Good Security

Providing a good lock is helpful. The storage facility should also be well-lit, have an access gate, and be monitored 24/7. Good lighting will help detract thieves, while an access gate will limit the number of people who are able to get near your belongings.

B. Multiple Size Options

When looking for a storage facility, you want to find one with enough space for everything you have. That's why it's so important that a facility has a range of size options for storage units. With more diverse options, a good storage facility can offer the right amount of space you need, from a storage bin to a large room. Even better, a facility with a wide range of options means you can comfortably change units if the amount of space you need changes.

C. Climate-Controlled Storage

It is becoming increasingly clear that the best storage facilities provide climate-controlled storage units. What this means is that the facility provides units that have their temperature and humidity controlled to be at a consistent level. This is so important because without this, your belongings could be ruined. In regular storage units, your property could be subjected to constantly changing temperatures and humidity. The humidity is especially important because it determines how much moisture your things are experiencing. This moisture can be devastating for any belongings made out of wood or paper. Changing humidity can cause wood furniture to expand, warp, and even crack.

D. Pickup and Delivery Services

Pickup and delivery services may not be common with most storage facilities, but that's why the best facilities are the best. These services are especially great for people who are elderly, disabled or don't have the time or transportation necessary to effectively move all of their belongings to storage.

E. Cleanliness or No Pests

A good storage facility is one that does not have pests. The last thing you want to do when you open your storage unit is to find mouse poop or dead cockroaches. This can leave questions on what might be living in your belongings, and what kind of damage they may be causing. A storage facility that keeps its property clean and free from pests can ensure that you don't have to check constantly to make sure that holes aren't being chewed in your belongings.

F. Insurance for Your Belongings

This is secretly one of the most important qualities of a good storage facility. You want to have your belongings stored at a facility that can insure them. Even with the best security and climate-controlled units, accidents and acts of God are always possible. What separates a regular storage facility from a great storage facility is the ability to protect not just your belongings, but the value of your belongings.

Factors influencing seed storage

A. Factors related to seed

i. Genetic makeup of seed
ii. Initial seed quality
iii. Provenance
iv. Seed Moisture content

B. biotic factor

i. Insects
ii. Fungi
iii. Rodents
iv. Mishandling during sampling, testing

C. Abiotic factors

i. Temperature
ii. Relative humidity
iii. Seed store sanitation
iv. Gaseous atmosphere
v. Packaging material

Genetic factors

The storage is influenced by the genetic make-up of the seed. Some kinds are naturally short lived (e.g) onion, soybeans, ground nut etc., Based on the genetic make-up seeds are classified into: Micro biotic: short lived, Meso biotic: medium lived and Macro biotic: long lived.

Initial seed quality

The seeds of high initial viability are much more resistant to unfavorable storage environmental conditions than low viable seed. Once seed start to deteriorate it proceeds rapidly. The seed which injured mechanically suffered a lot and loses its viability and vigor very quickly. Generally small seeds escape injury whereas large seeds are more likely to be extensively damaged (e.g) bean, lima-bean and soybean. Spherical seeds usually give more protection than flat or irregularly shaped seeds.

Seed moisture content

The amount of moisture in the seeds is the most important factor influencing seed viability during storage. Generally if the seed moisture content increases storage life decreases. If seeds are kept at high moisture content the losses could be very rapid due to mould growth very low moisture content below 4% may also damage seeds due to extreme desiccation or cause hard seededness in some crops.

Since the life of a seed largely revolves around its moisture content it is necessary to dry seeds to safe moisture contents. The sage moisture content however depends upon storage length, type of storage structure, kind / variety of seed type of packing material used. For cereals in ordinary storage conditions for 12-18 months, seed drying up to 10% moisture content appears quite satisfactory. However, for storage in sealed containers, drying upto 5-8 % moisture content depending upon particular kind may be necessary.

Orthodox: the seed able to tolerate moisture loss and less seed moisture favours the storage. i.e. decreased moisture increased storage period. Eg. Rice, sorghum most of the cultivated species

Recalcitrant: just opposite to the orthodox. Seeds not able to tolerate moisture loss. Required high moisture for viability maintenance.

Abiotic factors:

Relative humidity: Relative Humidity and temperature are the most important factors determining the storage life of seeds. Seeds attain specific and characteristic moisture content when subjected to given levels of atmospheric humidifies. This characteristic moisture content called equilibrium moisture content.

Equilibrium moisture content for a particular kind of seed at a given Relative Humidity tends to increase as temperature decreases. Thus the maintenance of seed moisture content during storage is a function of relative humidity and to a lesser extent of temperature. At equilibrium moisture content there is no net gain or loss in seed moisture content.

Temperature: Insects and moulds increase as temperature increases. The higher the moisture content of the seeds the more they are adversely affected by temperature. Decreasing temperature and seed moisture is an effective means of maintaining seed quality in storage. The following thumb rules by Harrington are useful measures for assessing the effect of moisture and temperature on seed storage. These rules are as follows.

- For every decrease of 1% seed moisture content the life of the seed doubles. This rule is applicable between moisture content of 5-14%.
- For every decrease of 5^{o}C in storage temperature the life of the seed doubles. This rule applies between 0^{o}C to 50^{o}C.
- Good seed storage is achieved when the % of relative humidity in storage environment and the storage temperature in degrees Fahrenheit add up to one hundred but the contribution from temperature should not exceed 50 ^{o}F.

8.2 Maintain quality and germination capacity storing seeds

To maintain the quality and germination capacity of stored seeds, several factors should be considered.

Seed storage conditions: Seeds should be stored under optimal conditions to maintain their quality and viability. Proper storage facilities with controlled temperature, humidity, and ventilation are necessary to prevent deterioration.

Seed moisture and temperature: The moisture content and storage temperature are the most important factors in determining how long seeds will remain viable. Good seed storage results when seeds are kept dry (below 8 percent moisture) and the temperature is controlled.

Seed packaging: Adequate packaging should be used to protect the seeds from moisture, insects, and rodents. Oxygen absorbers and freezing can help control insects during storage.

Seed selection: Selecting high-quality seeds for storage is crucial. The better the storage conditions, the longer the seeds will maintain their original quality.
By paying attention to these factors and implementing proper storage techniques, seed viability and germination capacity can be preserved over an extended period, ensuring the quality of the stored seeds for future use.

Most kinds of seed will maintain quality for 2-3 years when stored at 600F and 50-55% relative humidity or better. For storage longer than 3 years, conditions should be 500 F and 50% relative humidity or better. The seeds harvested in different climates (or) at different times show differences in viability.

8.3 Conducting periodic checks and laboratory testing of seeds

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

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

Objective & Importance of Seed Testing

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

- To identify the quality problem and their probable cause
- To determine their quality, that is, their suitability for planting

- To determine the need for drying and processing and specific procedures that should be used
- To determine if seed meets established quality standards or labelling specifications.
- To establish quality and provide a basis for price and consumer discrimination among lots in the market.

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

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

Seed sampling

Seed sampling is aimed at obtaining a sample of the required size and consisting of the same components as the whole lot of seeds.

Seed lot: It is specified quantity of seed, physically identifiable, in respect of which a seed test certificate can be issued.

Types of Seed Samples There are three types of seed samples received by a seed-testing laboratory.

A. Service Samples

It means a sample submitted to the central seed testing laboratory or to a state laboratory for testing the results to be used as information for seeding, selling or labeling purposes. Any private individual i.e Farmer, seed dealer or any individual /agency can send sample to know the quality status of seed lot. The main purpose of analyzing service sample is to provide results for sowing or labeling purpose.

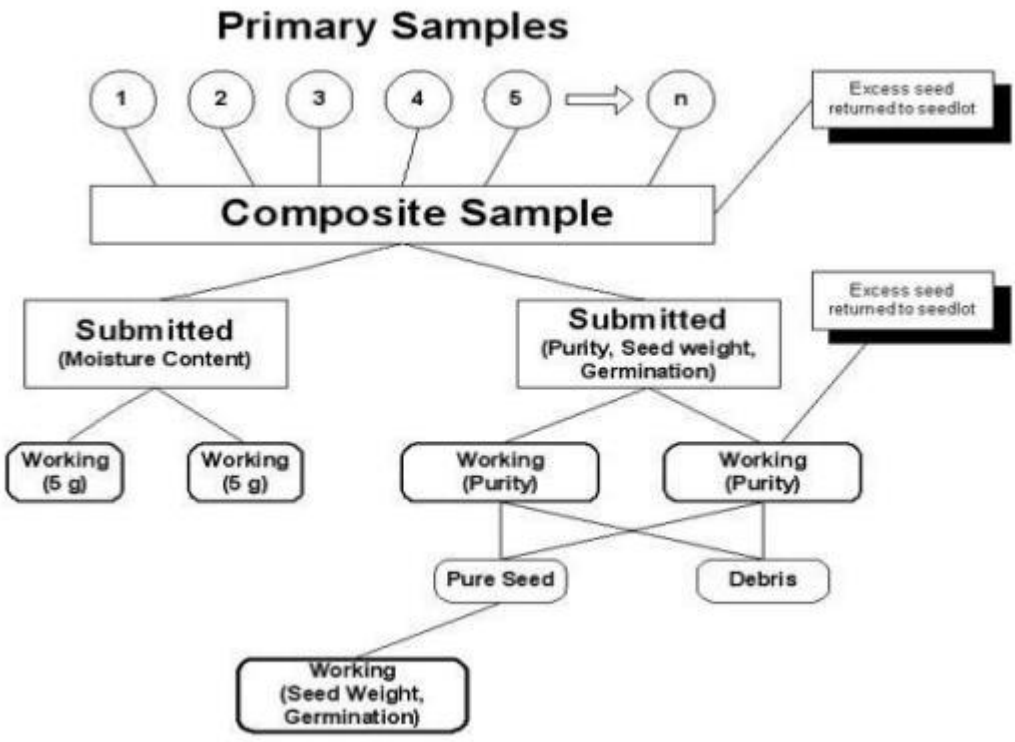
B. Certification Sample

It means a sample of seed drawn by a certification agency or by a duly authorized representative of a certification agency established under section 8 or recognized under section 18 of the Seed Act 1966. The main purpose of such sample is to determine that sample in question confirms the prescribed quality standards for the purpose of seed certification or not.

C. Official Samples Or Seed Law enforcement sample

Official sample means a sample of seed drawn by recognized official of seed law enforcement agency (Seed inspector) to ascertain that the seeds meet minimum limit of specified quality. All possible efforts are made to start testing a sample on the day of receipt. However under unavoidable circumstances the sample shall be stored in dry cool, ventilated room so that changes in the quality of seed are minimized the purpose of such sample is to know the quality status of a lot for the purpose of seed legislation.

Figure 8.1: Types of sample drawn at various stages



Primary sample: is the small portion taken from a lot at particular stage.

Composite Sample: Formed by combining & proper mixing of all primary sample Or pooled sample of all primary samples.

Submitted Sample: A sample which is submitted to seed testing laboratory and obtained from composite sample

Working Sample: Working Sample is a sub sample taken from Submitted Sample in the laboratory on which one of the quality tests is made.

Physical purity Analysis

A purity test is conducted on approximately on 2,500 seeds which are broken down into four components: Pure seed, other crop seed, Weed seed, and Inert matter. The components are then weighed from which percentages are calculated. The percentage is based on the weight of each component, not the number of seeds.

Need for physical purity analysis

- Seed Certification or Seed Law Enforcement Agencies to judge that the seed lot conforms to the prescribed standards.
- Seed processing plants for using right kind of processing equipment.
- Physical purity analysis is a pre-requisite for germination test because 'pure seed' component is used for germination testing.

Objective: The primary objective of physical purity analysis is to determine

- The percentage composition by weight of the sample being tested and by inference the composition of seed lot
- The identity of various species of seeds and inert particles constituting the sample.

Components of Seed physical purity Analysis

A. Pure seed: Seeds of kind/species stated by sander or found to predominant in the test.
B. Other crop seeds: seeds of plants which are as crops, other than main crop.
C. Inert matter: includes seed units and all other matter and structures not defined as pure seed, other crop seed or weed seed.

D. Weed seeds: Seeds of a weed species which are recognized as weeds by law/general usage.

Purity (%) = Weight of pure seeds (g) x 100
Total weight of working sample (g)

Germination

Seed Germination is the process by which a seed can reproduce an organism / healthy Seedling that lead to healthy plant. Seed germination is also a process by which the embryo in the seed becomes activated and begins to grow into a new seedling.

Types of germination:

A. Hypogeal germination:

Hypogeal germination implies that the cotyledons stay below the ground. The epicotyle (part of the stem above the cotyledon) grows, while the hypocotyle (part of the stem below the cotyledon) remains the same in length.

The cotyledons or storage organs do not emerges above the soil surface; only plumule emerges above the ground. Ex: Most of the monocots and pea, Green peas, Horse Gram, Green gram, Maize, Coconut, Mango.

B. Epigeal Germination:

Germination of a plant takes place above the ground. Epigeal germination implies that the cotyledons are pushed above ground. The hypocotyl elongates while the epicotyl remains the same in length.

The cotyledon or storage organs emerge above the soil surface. Ex: Most of the dicots i.e Common Beans, Castor, Sunflower, Pumpkin, Watermelon, Cucumber, Gourds, Lilies.

C. Viviparous germination:

It is a special type of germination found in plant which are salt-loving and are thus halophytes. In viviparous germination the seeds get germinated being attached to the parent plant. The embryo

grows out of the seed and then out of the fruit and projects out as a seedling with roots and hypocotyl.

Viviparous plants produce seeds that germinate before they get detach from the parent plant. This phenomenon is commonly observed in mangroves (for example - Rhizophora species).

Steps occurring during seed germination

1. Imbibition: The first step in the seed germination is imbibition i.e. absorption of water by the dry seed. Imbibition results in swelling of the seed as the cellular constituents get rehydrated. The swelling takes place with a great force. It ruptures the seed coats and enables the radicle to come out in the form of primary root.
2. Active Metabolism/ Enzymatic activity: Major metabolic events begin Imbibition of water causes the resumption of metabolic activity in the rehydrated seed. Initially their respiration may be anaerobic (due to the energy provided by glycolysis) but it soon becomes aerobic as during germination the cells of the embryo resume metabolic activity and undergo division and expansion.

   Stored starch, protein or fats need to be digested. These cellular conversions take place by making use of energy provided by aerobic respiration. Oxygen begins entering the seed. The insoluble food is rendered soluble and complex food is made simple. These simpler food solutions, comprising of sugars and amino acids thus formed, are diluted by water and passed towards the growing epicotyl, hypocotyl, radicle and plumule through the cotyledon.
3. Initiation of embryo growth: During germination the cells of the embryo resume metabolic activity and undergo division and expansion. Stored starch, protein or fats need to be digested. These cellular conversions take place by making use of energy provided by aerobic respiration. This Synthesis of material is reflected in increase in size of root and shoot axis (Epicotyle, mesocotyle and hypocotyle and radical)
4. Rupture of seed coat and emergence of seedling: After the emerging of the radicle and the plumule, the seed activates its internal physiology and starts to respire and produce proteins and metabolize the stored of food. This is a lag phase of the seed germination. Due to

increase volume of seed, seed coat get ruptured and plumule and radical are ready to come out.

5. Seedling establishment: This is a final stage of seed germination. In this stage, the cell of the seeds are elongated and divided, which brings out the root and radicle out of the seed and cotyledons are expanded which, are the true leaves of the new plant.

Factors affecting seed germination:

- Water: It is essential for enzyme activation, breakdown, translocation and use of reserve storage materials.
- Oxygen: It is required for germination of most of species. If CO_2 concentration is higher than 0.03 % it retards germination. Respiration increases sharply during seed germination. Since respiration is essentially an oxidative process, an adequate supply of oxygen is a must.
- Temperature: Seed germination is a complex process involving many individual reactions and phases, each of which is affected by temperature. The effect on germination can be expressed in terms of cordial temperature i.e., minimum, optimum and maximum temperature. The optimum temperature for most of the seeds is 15 to 30 ^{0}C. Maximum temperature is 30 to 40 ^{0}C. Some species will germinate even at freezing point also ex. Alpine
- Light: Some species required light for seed germination. Both light intensity (lux) and light quality (colour and wavelength) influence seed germination
- Soil factor: Soil structure, soil texture and soil temperature influences on seed germination.

$$\text{Germination \%} = \frac{\text{Number of germinated seed}}{\text{Number of seed placed for test}} \times 100$$

Seed Moisture Estimation

The main purpose of moisture determination of seeds is to prevent loss of seed viability till it is planted for commercial purposes. The moisture content of a seed sample is the loss in weight

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

Method of moisture determination

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

- Electronic moisture meter
- Universal moisture meter
- Infrared moisture balance

Hot Air Oven Method:

- Low constant temperature method (103 degree C for 17 hours)
- High constant temperature method (130 degree C for 2-3 hours)

Determination of moisture content by hot air oven method

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

- Weight of the submitted sample 100 g for species that have to be ground. 50 g for all other species. The sample should be submitted in polythene bag of 700 gauge (moisture proof container)
- Materials required

Grinding mill

This is used for seed requiring grinding. It should not cause heating of the ground material. Air currents that might cause loss of moisture must be reduced to a minimum. The fineness of grinding should be adjustable.

Container

Container of glass or non-corrosive metal (e.g.) stainless steel should be used.

Hot Air Oven

A good quality electric air oven with a thermostatic electronic temperature control for maintaining temperature with Desiccator Analytical balance, Sieves. A set of wire mesh sieves with meshes of 0.5 mm, 1.0 mm and 4.0 mm. within ±1°C is required.

Grinding For some seeds (e.g. Cereals and Cotton) fine grinding is essential before the moisture content is determined. In such cases, at least 50% of the ground material should pass through a wire sieve with meshes of 0.5 mm and not more than 10% remain on a wire sieve with a mesh of 1.0 mm. For leguminous seeds, coarse grinding is recommended; at least 50% of the ground material shall pass through a wire sieve with meshes of 4.0 mm.

Pre drying if the species is one for which grinding is necessary and the moisture content is more than 17%. (or 10% in the case of soybean and 13% in rice) pre drying before grinding is necessary. For this purpose, two 50 g portions are weighed and placed on open trays at 130 °C for 5-10 min. If seed moisture content is about 25% or more it should be pre-dried at 70 ° C for 2-5 hours, depending on the initial water content. The pre dried seeds should be kept in a closed desiccator for cooling. Then each of the duplicate quantities is weighed separately and about 20 g is ground. The ground material is then subjected to moisture testing using a hot air-oven as described below.

Moisture estimation Moisture testing is always conducted in duplicate on two independently drawn 5-10 g working samples, weighed with an accuracy of 1 mg. Most species are dried for 1 hr at 130 °C, cereals for 2 hours (130°C) and maize for 4 hours (130°C). Seeds containing high percentage of oil should be dried at 103°C for 17 hours.

Procedure/steps for conducting moisture test

1. Weighed the empty container along with its cover/lid
2. The submitted sample should be mixed thoroughly and two small portions or seed sample are to be drawn and it should be ground as per the requirements.
3. Then fill the container with4- 5 grams of ground sample and weigh it.
4. After weighing, remove the cover or lid of the container and the open container should be kept in the oven which has already been heated to the prescribed drying temperature.
5. At the end of the drying period, container should be closed with its cover or lid. The container should be transferred into a Desiccator. The Desiccator should be closed and the sample should be allowed to cool for 30 minutes.

6. The sample should be weighed again and the moisture content may be calculated to one decimal place by the following formula-

$$m = \frac{m2 - m3}{m2 - m1} \times 100$$

Where, m = Seed moisture content (in %age) m1 = Weight of the empty container with its cover m2= Weight of the container with its cover and seeds before drying m3 = Weight of the container with its cover and seeds after drying The duplicate result of the determination may not differ by more than 0.2% otherwise the analysis should be repeated.

If sample is pre dried, the moisture content is calculated from the results obtained in the first (pre-drying) and second stages of the procedure. If S1 is the moisture lost in the first stage and S2 is the moisture lost in the second stage, each calculated as above and expressed as a percentage, the original moisture content of the sample is calculated as below.

$$m = S_1 + S_2 \ (-) \ \frac{S_1 \times S_2}{100}$$

m= moisture content (in %age) S1 =Moisture percentage lost in pre-drying stage (First satge) S2= Moisture percentage lost in drying stage (second stage)

Seed Dormancy

It is common observations that seeds of many plants species do not germinate when freshly harvested even under favourable conditions. They need a period of rest/ storage before they become capable of germination.

Inability of viable and mature seeds to resume growth immediately after harvest under favourable for the germination of the concerned plant species is known as seed dormancy. The period of dormancy varies from a few days to several years depending on the plant species.

Advantages:

- Storage of seeds is prolonged, it is a survival mechanism

- Seed can pass through adverse situation /conditions
- Prevents the in-situe germination i.e., vivipary

Disadvantages:

- No uniform germination
- Difficult to maintain plant population
- Interferes in seed testing procedure

Types of dormancy

Seed dormancy is classified into three broad classes are as below:

A. Exogenous Dormancy: Dormancy is due to some external features of the seed located outside the embryo
   i. Impermeability of seed coat to water: due to seed coat structure, which is hard enough to restrict the entry of moisture into the seeds, thereby preventing seed germination. Ex: Malvaceae, Leguminoseae, Lilaceae
   ii. Impermeability of seed coat to gases; is related to the insufficient intake of oxygen by seeds due to impermeability of seed structure enclosing embryo. Ex: Graminaceae, fruit crops & forest trees
   iii. Mechanical resistances of seed coat: growth of embryo is checked due to extremely hard seed/fruit structure such as seed coat, endosperm per carp etc., Ex: Acacia species.
   iv. Inhibitors present in seed coat/endosperm: biochemical substances present in seed coat or endosperm block the germination of embryo. Ex: Iris appinhibitors present in the endosperm,Barley- Aflotoxin, Squash-Dichlobenil Tomato-Feruline and Caffeie acid, All spp.- Coumarin

B. Endogenous dormancy: This type of dormancy occurs due to internal factors that is present within the embryo
   i. Incomplete embryo development: due to an incomplete development of the embryo. In such cases, germination does not occur until the embryos develop to their normal size. Ex: Palmaceae, Amgnoliaceae

ii. Inhibitors present within the embryo: Dormancy arises from metabolic blocks produced by biochemical substances called inhibitors present within the embryo. In such cases germination can commence only when these inhibitors are leached out of the embryo Ex: Xanthium, Fraximus

C. Combined Dormancy: dormancy is produced by a combination of two or more factors which act in complementary fashion. Ex: Fraximus

Methods of breaking Dormancy

A. Natural breaking of dormancy: in nature dormancy terminates when embryo gets suitable environment such as adequate moisture, aeration and temperature. The impermeable seed coat present in many species became permeable due to the rupturing of softening action of natural agents like micro organism, high or low temperature, humidity fiber and abrasion due to wind or digestive tracts of birds and animals which feed on these seeds. Ex: Rhizoctonia damages seed coat

B. Treatments to break Dormancy: the various treatments for overcoming dormancy may be divided into the following three groups

C. Seed coat treatments: These treatments aim at making hard seed coat permeable to water or gases either cracking or softening them. The process is usually referred as scarification. These treatments are either physical or chemical in nature.

i. Scarification: Acid scarification: treating seeds with concentrated acids like H2SO4 HCL etc.,

ii. Thermal scarification: the seeds are treated with different temperatures and gases.

iii. Mechanical scarification: The seed coat is damaged using mechanical means. Viz., *Rubbing seeds on sand paper or by using mechanical scarifier.

*Making small incision by piercing. Ex. Bitter gourd

*Removing of entire seed coat. Ex. rubber

D. Embryo treatments:

i. Stratification: the incubation of seeds at a suitable low temperature (Usually 0-5 0C) over a moist substratum before transferring them to a temperature optimum for germination. Ex. Cherry (Prunus cerasus), Mustard and rape seeds

ii. High temperature treatment: in some species, incubation at 40-50 0C for few hours to 1-5 days may be effective in overcoming dormancy. Ex. Rice seeds more than 15% seed moisture treated in hot water of 40 0C for 4-5 hours.

c. Chemical treatments: alternatively growth regulators or other chemicals may be applied to induced germination growth regulators commonly used GA3 (100ppm), kinetin (10-15ppm) and thio-urea (0.5-3%).

8.4 Maintain and keep seed storage program

How to Maintain and Store Seeds

Seed storage and maintenance should be an integral part of your crop management strategy. The vitality and success of your crops depend on the quality of the seeds you plant, and that quality is maintained through proper storage and maintenance practices.

By choosing the right storage containers, maintaining optimal temperature and humidity, regularly monitoring your seeds, practicing labeling and organization, and conducting seed viability testing, you can safeguard your investment and maximize your crop yields.

- Choose the Right Storage Containers

The first step in seed storage is selecting the appropriate containers. Ensure they are clean, dry, and airtight. Sealable plastic bags, glass jars, or metal containers are commonly used and provide an effective barrier against moisture, pests, and air.

- Maintain Optimal Temperature and Humidity

The environment in which seeds are stored greatly affects their longevity. Most vegetable seeds prefer cool, dry conditions. Aim for temperatures between 32°F and 50°F (0°C to 10°C) with relative humidity levels below 50%. Avoid temperature fluctuations and moisture, as they can trigger premature germination or seed rot.

- Regular Monitoring

Periodic checks of your stored seeds are essential. Inspect the containers for signs of moisture or pests. Mold, discoloration, and unusual odors are indicators that something may be wrong. If you find any issues, take immediate action to rectify them.

- Labeling and Organisation

Accurate record-keeping and labeling are crucial for seed storage. Clearly mark each container with the seed variety, date of collection or purchase, and any other relevant information. Organise your seeds systematically to minimize the risk of misplacement.

- Seed Viability Testing

Over time, the viability of stored seeds can decrease. To ensure that your seeds are still good for planting, perform a germination test. Moisten a paper towel, place a few seeds on it, and keep it in a warm, well-lit area. After a few days, count how many seeds have sprouted. If the germination rate is still high, the seeds are likely viable and can be used for planting.

8.5 Forwarding records keeping to the appropriate person

The most important information to record is:

- The name and variety of the plant from which the seed was taken. Write down all local names of the plant, and also the scientific names. If you don't know the scientific names, ask an extension worker.
- The name and address of the person who collected the seed and the date the seed was collected.
- The place where the seed was collected. Add any helpful information such as the distance from a well-known landmark. Note special details of the location. For instance, is this a sloped area, is the soil well drained, are there trees?
- Special characteristics of the plant from which all, or some, of the seed was taken. For example, if some of the seed came from a crop which tolerated drought, direct sunlight, wind or shade, then list these characteristics.
- The date the seed was stored, and the general weather conditions during the season that the seeds were produced. For example, you may write that the seed was collected in July 1994 when the weather was dry, skies were clear, and there were lots of insects.

Write all this information on a piece of paper and put it in the bag or container with the seed. Also write the information on the outside of the container. It should also be copied onto a separate piece of paper so that the seed bank workers can refer easily to the seed supply. This gives the community extra historical information about local plants and weather conditions. Keep the list up to date. You may want to make extra copies in case the main list is lost.

Self-Check – 8	Written test

Directions: Answer all the questions listed below.

Part I. write true if the statement is correct false if not

1. Storing seeds in a cool and dry environment helps maintain seed viability and quality.
2. Seed moisture content should be kept high during storage to prevent seed deterioration.
3. Seed evaluation involves assessing seed germination, purity, and vigor.
4. Seeds can be stored indefinitely without any loss in viability or quality.

Part III. Choose the correct answer from the given alternatives

1. What is the recommended temperature range for long-term seed storage?
   a) 5-10°C (41-50°F) c) 35-40°C (95-104°F)
   b) 20-25°C (68-77°F) d) 60-70°C (140-158°F)
2. Which of the following is a common method for seed moisture content reduction during storage?
   a) Air-drying c) Freezing the seeds
   b) Adding excessive moisture d) Storing seeds in a humid environment
3. What is the purpose of seed vigor testing?
   a) To assess the physiological quality and potential performance of the seeds
   b) To determine the seed weight and market value
   c) To evaluate the physical appearance and color of the seeds
   d) To measure the moisture content of the seeds

Part III. Short answer questions

1. What are some key factors to consider when selecting a suitable storage facility for seeds?
2. Explain the importance of monitoring temperature and humidity levels in seed storage.
3. What are some indicators of seed deterioration or loss of quality during storage?

References

Books

McDonald, M. F., & Copeland, L. O. (2012). *Seed production: principles and practices*. Springer Science & Business Media.

Thomson, J. R. (1979). *An introduction to seed technology*. Leonard Hill..

Khare, D., & Bhale, M. S. (2016). *Seed technology*. Scientific publishers.

Black, M., & Bewley, J. D. (Eds.). (2000). *Seed technology and its biological basis*. Crc Press.

Khare, D., & Bhale, M. S. (2016). *Seed technology*. Scientific publishers.

Web addresses

1. https://www.youtube.com/watch?v=4aJB_PQSkqg accessed date 20/12/2024
2. https://www.youtube.com/watch?v=Ie3H_icKWb4 accessed date 22/12/2024
3. https://www.youtube.com/watch?v=nax0F7t3VCQ accessed date 23/12/2024
4. https://www.youtube.com/watch?v=If8OspxeqjU accessed date 24/12/2024
5. https://www.youtube.com/watch?v=IYBGrbI7XDQ accessed date 10/01/2024
6. https://www.youtube.com/watch?v=iSpGZLVyMBk accessed date 14/01/2024
7. https://www.youtube.com/watch?v=0ceLmfNde1w accessed date 14/01/2024
8. https://www.youtube.com/watch?v=E0jzPVGiKHs accessed date 14/01/2024
9. https://www.youtube.com/watch?v=3GX1piaXem0 accessed date 16/01/2024
10. https://www.youtube.com/watch?v=s-ygoMFvstM accessed date 20/01/2024
11. https://www.youtube.com/watch?v=JJkP8THKJuY accessed date 20/01/2024

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