TRAINING MODULE

BASIC LEVEL TRAINING PROGRAM ON SEEDS AND SEED CERTIFICATION FOR (PARA-SEED WORKERS)

WASSAN

Revitalising Rainfed Agriculture
The RRA Network

Working Group on Seeds Systems (WGoSS) – RRA Network

Watershed Support Services and Activities Network (WASSAN)

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BASIC LEVEL TRAINING PROGRAM ON SEEDS AND SEED CERTIFICATION FOR PARA-SEED WORKERS

1/ INTRODUCTION

Agriculture, being a major income source in India , needs timely support of inputs and investment. Seed is a critical input for agriculture particularly in rainfed farming systems. Supply of good quality seed within sowing window certainly increase the yields. However there is no strong system to supply quality, desired seed with subsidized rates in India. Public sector is not able to reach all acres due to constrains in terms of human resources and financial resources. Private seed sector is restricted to low volume and high value seed.

Seed quality depends on many factors such as genetic, environmental and agronomical conditions and also influenced by farmers skill and interest . Knowing the basics about pollination, fertilization, seed setting and seed quality is essential for any volunteer/worker/employee who works for seed industry or organization.

2/ IMPORTANCE OF TRAINING

Since all para seed workers are coming from low education back ground , without much knowledge on seeds , seed quality and legally ensured certification, there is a need of training in theoretical and practical aspects of seeds and certification. This is basic level course which covers all basic aspects of seeds and seed quality. It starts with basic biology of flowers and pollination , fertilization and seed setting. So that they can familiarize with their roles and responsibilities. After qualifying this, para seed workers will undergo secondary level training which will cover advanced aspects of seed production and seed processing and certification pertaining to Groundnut crop and other major crops of pulses and millets.

3/ TRAINING NEEDS OF PARA SEED WORKERS

- Knowledge on seeds and seed quality.
- Capacity building in seed certification.
- Acquaintance with govt. departments and their protocols.
- Respect for rules and regulations.
- Institutional development and organization building.
- Data generation and management.

4/ DURATION OF THE TRAINING

- 5 days (33.30 Hours)

5/ METHOD OF TEACHING / TRAINING

The class room cum practical teaching classes will be conducted. Field visits will be organized within selected village of their respective locations. During the class room teaching technical handout /inputs will be supplied.

At the end of training, based on instructor assignment, candidates submit posters /records according their leanings and understandings.

6/ WHAT WE CAN EXPECT FROM THIS TRAINING(OUTCOME)?

These 5 days basic level training program aims at building capacities (knowledge, skills and attitudes) of the participants so that they can perform the role of "seed Certifier".

By the end of this training program, the participants would able to

- Learn basics of pollination, fertilization and seed formation.
- Know qualities of seed.
- Submit application form and ensure farmers registration process.
- Ensure isolation distance and Roughing of off types.
- Ensure separate harvesting and threshing of the seed produced.
- Complete all certification compliances.
- Collect samples and submit to State Seed Certification Agency.

7/ ABOUT TRAINING MODULE

The training course is designed to prepare technically sound para-seed workers who can able distinguish seed and grain, check all quality parameters in the fields and fulfill desired formalities in certification. The module is designed in such a way that the participant can implement his knowledge and skill immediately after the course. Theoretical classes are followed immediately with practical sessions/field visits. Participants get technical content / training material at the time of training. At the end of basic level training, participants submit records, posters. All participants receive certificates.

8/ TRAINING OBJECTIVES

- To assess the knowledge, Skill and attitude of provisionally selected para seed workers pertaining to seed production and certification.
- To create awareness about floral biology, pollination fertilization and seed formation.
- To empower knowledge on Seeds and seed quality.
- To build capacities of the Para seed workers.
- To make para seed certifier as qualified seed workers who can assist State Seed Certification Agency during seed certification.

9/ COURSE SCHEDULE

S.No.	Topic	Day	Duration (Hours)	Method of instruction
	Registration, Inauguration and introduction and objectives	I	I	Class room
Module - I	**Pollination and Fertilization**			
I	Inflorescences	I	0.30	Class room
2	Floral Biology	I	0.30	Class room
3	Pollination	I	0.30	Class room
4	Fertilization	I	0.30	Class room
5	Seed Setting (Seed Formation)	I	0.30	Class room
6	Seed development and seed maturation	I	0.30	Class room
7	Practical: Observing different inflorescences , flowers, pollination methods	I	I	Practical
Module - 2	**Seeds**			
I	What is Seed? Difference between seed and grain	I	0.30	Class room
2	Seed structure and function	I	0.30	Class room
3	Varieties and cultivars	I	0.30	Class room
4	Hybrids and hybridization	I	0.30	Class room
5	Land races	2	0.30	Class room
6	Practical- Differentiation of seeds and grains. Listing of known varieties, land races and hybrids of selected crops.	2	1.30	Practical
Module-3	**Participatory Varietal Selection**			
I	Participatory varietal Selection (PVS)	2	0.30	Class room
2	Steps involved in PVS	2	0.30	Class room
3	PVS trails in different crops	2	I	Class room
4	PPV& FRA	2	0.30	Class room
Module – 4	**Seed classification**			
I	Nucleus seed.	2	0.30	Class room
2	Breeder seed.	2	0.30	Class room
3	Foundation seed.	2	0.30	Class room
4	Certified seed.	2	0.30	Class room
5	Truthful Labeled seed (TFL).	2	0.30	Class room

S.No.	Topic	Day	Duration (Hours)	Method of instruction
6	Practical: Understanding flow of seed and purity throughout the chain. identification of colors and content of labels	3	I	Practical
Module – 5	**Seed quality**			
I	Physical purity and seed moisture	3	0.30	Class room
2	Genetic purity.	3	0.30	Class room
3	Factors affecting the quality (deterioration of varieties).	3	I	Class room
4	seed standards.	3	I	Class room
5	Seed multiplication ratio and seed replacement ratios.	3	0.30	Class room
6	Farmers check list for seed quality.	3	0.30	Class room
7	Interactive practical class: Differentiation of seed and grain. Practical learning on Physical and Genetic purity	3	I	Practical session
Module – 6	**Maintaining the Purity**			
I	Isolation distances	3	0.30	Class room
2	Rouging	3	0.30	Class room
3	Quality harvest	4	0.30	Class room
4	Field visit: hands on experience of rouging , finding the isolation distances	4	2.00	Field visit
Module – 7	**Seed Physiology**			
I	Seed Dormancy	4	0.30	Class room
2	Breaking of Seed Dormancy	4	0.30	Class room
3	seed germination	4	0.30	Class room
4	Practical: Dormancy breaking methods, Seed germination	4	I	Practical
Module – 8	**Seed Certification**			
I	Certification Procedure	4	I	Class room
2	Field Inspection (In detail)	4	I	Class room
3	Sample collection and sending to State Seed Certification Agency (in details)	5	0.30	Class room
4	Tagging and Sealing (In detail)	5	0.30	Class room
5	Filling up forms	5	0.30	Class room
6	Practical – Certification Procedure, sampling, tagging and filling up forms.	5	2	Practical

10/ MODULES

Module - 1: Pollination and Fertilisation

Learning objectives: By end of this session , participants would able to

1) Learn basic knowledge of inflorescence and floral biology of crops and plants.
2) Know the mechanism of pollination and fertilization.
3) Understand seed setting and seed maturation after fertilization.
4) Apply basic science of flowers and seeds for agriculture and seed production.

Methodology: Class room teaching with interactive sessions and practical class.

Materials required: Flip charts, marker board , marker pens, LCD projector, flowers, seeds.

Resource person: Subject Matter Specialist/ Scientist/ Officer from Govt. dept./Best Farmers/NGO

Time frame: 4 hours (Topic-1: 0.30 hr, Topic-2: 0.30 hr, Topic-3: 0.30 hr, Topic-4: 0.30 hr, Topic-5: 0.30 hr, Topic-6: 0.30 hr, Topic-7: 1 hr)

Instructions to resource person:

- Content is with scientific terminology and complex phrase , resource persons need to simplify and explain in local language.
- Use pictures/photographs and live materials to explain morphological and anatomical features of flower and seeds.
- Play videos showing animated versions of pollination, fertilization and seed setting(you tube link or down loaded videos provided separately) .

Content:

Topic - 1: Inflorescences

- An inflorescence is a group or cluster of flowers arranged on a stem that is composed of a main branch or a complicated arrangement of branches.

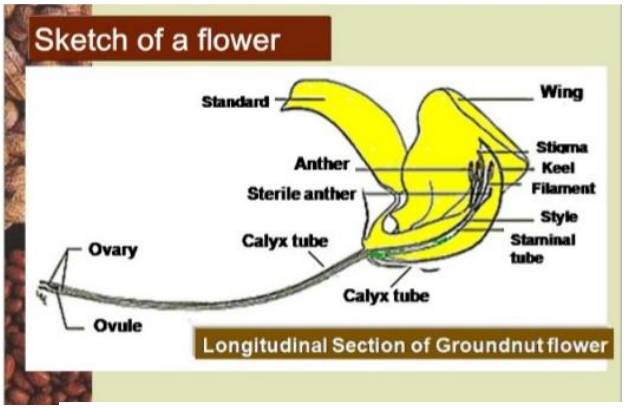
- The stem holding the whole inflorescence is called a peduncle and the major axis (incorrectly referred to as the main stem) holding the flowers or more branches within the inflorescence is called the rachis.
- The stalk of each single flower is called a pedicel.
- A flower that is not part of an inflorescence is called a solitary flower and its stalk is also referred to as a peduncle.
- Any flower in an inflorescence may be referred to as a floret, especially when the individual flowers are particularly small and borne in a tight cluster, such as in a pseudanthium.
- The fruiting stage of an inflorescence is known as an infructescence.
- Inflorescences may be simple (single) or complex (panicle). The rachis may be one of several types, including Single, Composite, Umbel, Spike or Raceme.

General Characteristics:

1) Bracts
2) Terminal Flowers
3) Phyllotaxis
4) Metatopy

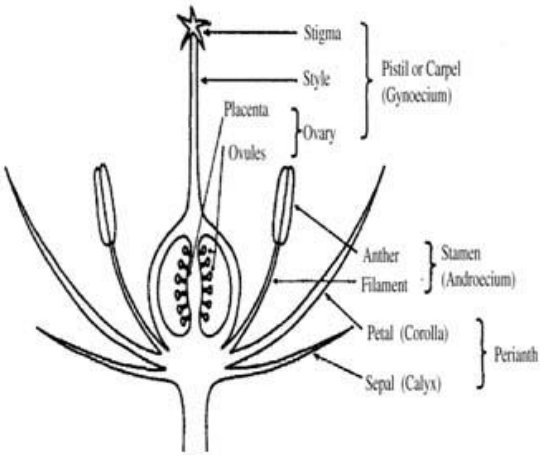
Organization:

1) Simple inflorescence
2) Compound inflorescence
3) Others



Topic - 2: Floral Biology

Flower is a reproductive organ bearing pistil, stamen and usually sepals and petals. Male part of a flower is androecium consisting of anther sac, anthers and pollen grains. Female part is gynoecium consisting of ovary, style and stigma.



Perfect flower: A flower that contains both male and female parts is called perfect flower.

A flower with both functional male and female is called as bisexual or hermaphrodite.

Sometimes male or female mature slightly at different times. This nature is called dichogamy which favours cross pollination. If male matures first it is called as protandry, if female – protogyny.

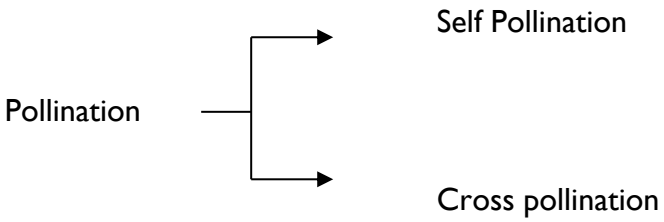
Imperfect flowers: A flower that have either male (staminate flower) or female (pistillate flower) part is called imperfect flower.

Such flowers are called as unisexual flowers.

When both type of flowers occur in same plant – monoecious, if they occur in different plants – dioceious.

Topic - 3: Pollination

What is pollination? A pollination is the process of transfer of pollen grain from anthers to stigma. For successful fertilization viable pollen and receptive stigma are essential. The mature anthers dehisce and release pollen grains. Seeds usually developed from the fertilized flower for which pollination is pre requisite.



Self-Pollination: When pollen grains are transferred from an anther to the stigma of the same flower the process is called self-pollination or autogamy.

Self-pollination occurs in those plants where bisexual flowers achieve anther dehiscence and stigma receptivity simultaneously.

In some plants, flowers do not open at all such flowers is called cleistogamous, and this is the most efficient floral adaptation for promoting self-pollination.

Examples of self-pollinated crops: wheat, rice, barely, mungbean and cowpea.

Cross Pollination: If pollen grains are transferred to the stigma from anthers of another flower it called cross-pollination or allogamy.

Cross-pollination is occurred in plants which bear unisexual flowers.

In bisexual flowers also self-pollination may be prevented by self-sterility.

In following cases cross pollination is possible:

- ***Dichogamy*** - maturation of male and female organs at different time

- ***Herkogamy***-where the structure of male and female sex organs proves a barrier to self pollination.
- ***Heterostyly*** -where flowers are of different types depending on the length of the style and stigma and pollination occurs only between 2 dissimilar types.

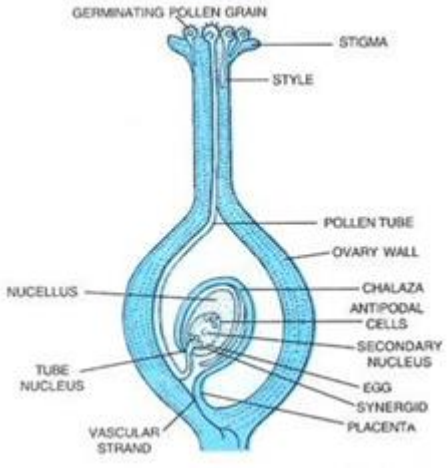
Examples of cross pollinated crops are; maize, rye, forage legumes and vegetables like carrot, cauliflower and onion.

Often cross-pollinated crops: crops such as cotton and pigeon pea where there may be only 10-40% cross pollination occurs.

Pollen must transfer from male to female by pollen vector. The flowing methods are in nature.
- Anemophily - By wind.
- Hydrophily - By water.
- Entomophily - By insects
- Cheiropterophily - By bats.

Topic - 4: Fertilisation

Fertilization is the union of sperm and egg which occurs deep within the flower after pollination.



- **Process:** When a pollen grain lands on the stigma, it generates a tiny tube tipped with sperm. The tube fits into a conduit called a style in the female pistil. The pollen tube expands down the style to the opening of the ovary and deposits the sperm at the egg. The sperm and egg each contain half of the genetic material needed to form a new plant. When they combine, the sexual union is complete and the egg is fertilized. The fertilized egg will develop into a plant seed.

- **Apomixis:** Development of seed without fertilization is called apomixes. All apomitic seeds have genetic material only from the female plant. Apomixis may or may not require pollination and pollen tube germination to initiate seed formation, however sexual union never occurs.

- **Parthenocarpy:** Development of fruit without fertilization

Topic - 6: Seed Development and Seed Maturation

Seed Development: After fertilization process, the development of fertilized ovule into a mature seed is called seed development. It involves different stages.

Seed formation takes place within the embryo sac. The seed develops according to the genetic information of concerned species.

- The integument of the ovule becomes the seed coat of the mature seed.
- Normally the nucellus is absorbed and is absent.
- The Endosperm serves as a principal nutritive support for the embryo of many species during both seed development and germination. The endosperm normally grows more rapidly than embryo.

Embryo: The first few cells division from the zygote forms the Pro-embryo. Although the mature embryo of monocotyledons and dicotyledons appears considerably different, their pattern of embryogeny is similar. The Pro-embryo is divided into Suspensor and Embryo proper. The suspensor forms into a chain of cells, pushing the embryo proper into the center of the ovule thus making it in contact with the available food supply. The pro-embryo may vary greatly in size and shape.

Embryo Development

- The first division of the zygote is transverse in dicots and it results in a small apical cell and a large basal cell.
- Cell ci divides transversely giving rise to n and n'. These 2 cells divide further resulting in a row of 3 or 4 cells, forming suspensor.

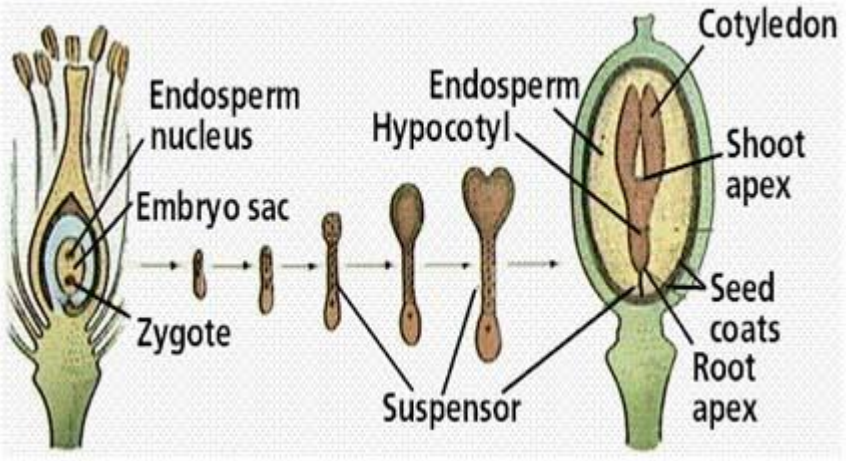
Endosperm Development: There are 3 types of endosperm development;

(a) **Nuclear** Where the endosperm nucleus undergoes several divisions prior to cell wall formation, e.g., wheat apple, squash,

(b) **Cellular** In which there is no free nuclear phase and

(c) **Helobial** Where the free nuclear division is preceded, and is followed by cellularization as in some monocots. During the course of seed development, reserve food materials are accumulated in the endosperm from the adjacent tissues.

Seed - Coat Development: Integuments of the ovule undergo marked reorganization and histological changes during maturation to form seed coats.



Seed Growth and Maturation: Wheat and soybean representing monocots and dicots may

illustrate the changes in the pattern of accumulation of reserve materials at different stages of seed maturation.

Topic - 6: Practical - Observing and Recording different inflorescences, flower, pollination methods

Instructor gives examples of crops or plants with inflorescence, floral biology and pollination methods, with suitable diagrams. If possible supply live floral parts, embryos etc. Participants observe and record types, methods with diagrams.

Key messages:

- Arrangement of flowers on plant stem or on the apical part is called inflorescence. Each crop and each plant having its own inflorescence.
- Flower is a reproductive organ bearing pistil, stamen and usually sepals and petals. Male part of a flower is androecium consisting of anther sac, anthers and pollen grains. Female part is gynoecium consisting of ovary, style and stigma.
- Pollination is passing of pollen grains from anthers to stigma which enable the fertilization process. Pollination two types self-pollination and cross pollination.
- Fertilization always takes place in female gametophyte, therefore pollen must transferred from male to female by pollen vector which may be abiotic including wind (anemophily) and water (hydrophily) or biotic including insects (entomophily) and bats (cheiropterophily).
- Seed setting occurs in various forms in different plant s./crops. Acumulation of reserve materials done in the seed maturation phase.

Learning outcome: Participants would learn basic biology concepts like inflorescence, anatomy of flowers, mechanism of pollination, fertilization and seed formation in different crops and plants.

Assignment for the participants:

- List out pollination methods, crop wise.
- Draw a diagram of flower showing both male and female parts.

Module - 2: Seeds

Learning objectives: By end of this session, participants would able to

1) Understand differences between seed and grain.
2) Learn about stricture and functions of seed.
3) Know about varieties, landraces, hybrids.

4) Realize the importance of land races as reservoir of genetic diversity.

Methodology: Class room teaching with interactive sessions and practical class.

Materials required: Flip charts, marker board, marker pens, LCD projector, seeds, grains, seed packets.

Resource person: Subject Matter Specialist/ Scientist/ Officer from Govt. dept./Best Farmers/NGO

Time frame: 4 hours (Topic-1: 0.30 hr, Topic-2: 0.30 hr, Topic-3: 0.30 hr, Topic-4: 0.30 hr, Topic-5: 0,30 hr, Topic-6: 1.30 hr)

Instructions to resource person:

- Supply seeds and grain, ask them to differentiate physically. Explain genetic characters of seed.
- Open seed, explain internal parts and external coat of different seeds. Show monocotyledons and di-cotyledons seeds.
- Effective use of illustrations, through PPT, useful in this session.
- Play videos on seed structure and related topic (you tube link or downloaded videos provided separately).

Content:

Topic - 1: What is Seed? Difference between Seed and Grain

What is Seed? Seed is a basic agricultural input and it is an embryo, embedded in the food storage tissue. Seed is also defined as a matured ovule which consists of an embryonic plant with storage of food and surrounded by a protective seed coat.

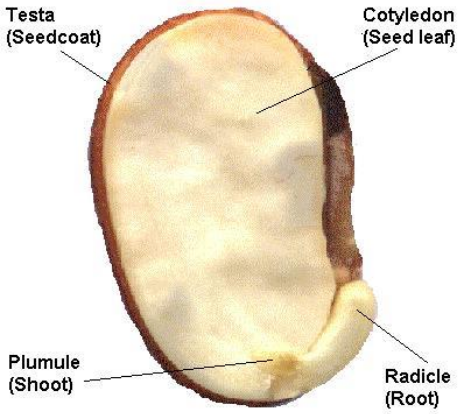
Difference between seed and grain:

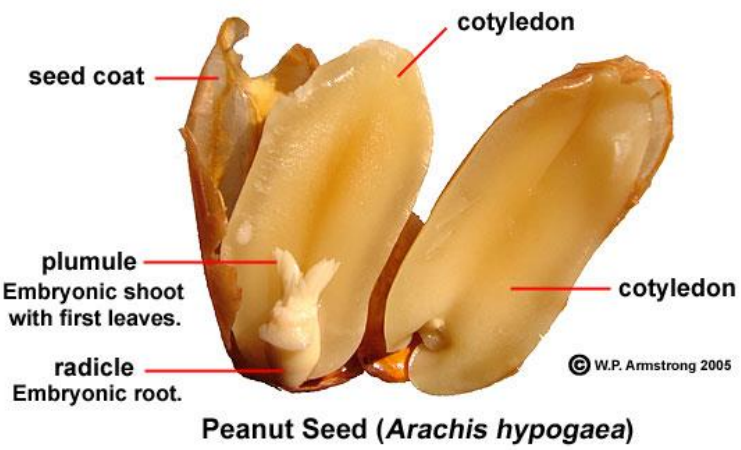
Scientifically produced seeds	Grains used as seeds
Production of these seeds follow a well-designed seed programme.	No designed seed programme for production is done
Varietal purity of the seed is clearly identified from its breeder seed and is genetically pure.	Variety purity of the grain as seed is not known.
During seed production process, quality standards like removal of off-types, diseased plants, weed plants and other crop plants are carried out.	Quality standards are not followed.

Scientifically produced seeds	Grains used as seeds
Seeds have physical purity and good germination.	Physical purity and germination is not ensured.
Scientific seed production follows the processing, treatment, packaging and labelling procedures.	Processing, labelling and tagging are not followed in grain production.
Drying of seeds is done in a controlled condition.	Grains are dried in higher temperature and thus the quality of the seeds are affected.
During seeds storage, viability and vigour of seeds are maintained.	During storage grains are protected against pests and diseases and not for vigour and viability.
Seeds produced are certified and labelled properly.	Grains which are used as seeds will not have any certification labels and tags.
Seeds can never be converted into grains unless it is directed by the seed inspector.	Can be utilized for commercial grain purpose and sometimes can be utilised for seed purpose.

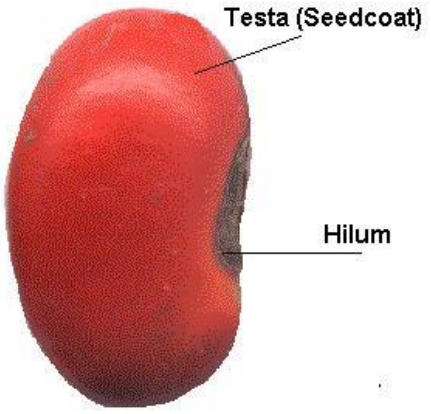
Topic - 2: Seed Structure and Function

- **Seed structure:** A seed (in some plants, referred to as a kernel) is a small embryonic plant enclosed in a covering called the seed coat, usually with some stored food. It is the product of the ripened ovule of gymnosperm and angiosperm plants which occurs after fertilization and some growth within the mother plant. The formation of the seed completes the process of reproduction in seed plants (started with the development of flowers and pollination), with the embryo developed from the zygote and the seed coat from the integuments of the ovule.





Peanut Seed (*Arachis hypogaea*)



Source: TNAU

- **Testa:** A tough, hard, outer coat, the testa protects the seed from fungi, bacteria and insects. It must be split open by the radicle before germination can proceed.
- **Hilum:** The hilum is a scar left by the stalk which attached the ovule to the ovary wall.
- **Micropyle:** The micropyle is a tiny pore in the testa opposite the tip of the radicle. It admits water to the embryo before active germination.
- **Radicle:** The radicle is the embryonic root which grows and develops into the root system of the plant.
- **Plumule:** The plumule is the embryonic shoot. In it two or more leaves are usually visible, with a growing point enclosed between them.
- **Cotyledons:** The grasses and narrow-leaved plants like the iris and bluebell have seeds with only one cotyledon. The other flowering plants all have two cotyledons. They are leaves attached to the plumule and radicle by short stalks, and they often contain food reserves which are used during the early stages of germination. In most plants the cotyledons are brought out of the testa and above the ground where they become green and make food by photosynthesis. The cotyledons eventually fall off, usually after the first foliage leaves have been formed. The cotyledon leaves bear no resemblance to the foliage leaf, the shape of which is first apparent when the plumule leaves open and grow.

- **Seed Functions:** Seeds serve several functions for the plants that produce them. Key among these functions are nourishment of the embryo, dispersal to a new location, and dormancy during unfavorable conditions. Seeds fundamentally are a means of reproduction and most seeds are the product of sexual reproduction which produces a remixing of genetic material and phenotype variability that natural selection acts on.

- **Good qualities of seed:**

    - It should have good shape, size, colour, etc., according to specifications of variety
    - Should have high physical soundness & weight
    - It should posses high physiological vigour and stamina
    - It should posses high longevity and shelf life
    - It should have optimum moisture content for storage
        - Long term storage - 8 % & below
        - Short term storage -10-13%
    - It should have high market value

Topic - 3: Varieties and Cultivars

Variety is a naturally occurring variation of individual plants within a species. The distinguishing characteristics are reproducible in offspring. . That means the seedlings grown from a variety will also have the same unique characteristic s of the parent plant.

Plant variety is a term applied to plants for which patent protection has been applied. Plant breeders' rights (PBR), also known as plant variety rights (PVR), are rights granted to the breeder of a new variety of plant that give exclusive control over the propagating material (including seed, cuttings, divisions, tissue culture) and harvested material (cut flowers, fruit, foliage) of a new variety for a number of years.

Cultivar comes from the term 'cultivated variety.' These plants are selected through specific hybridization, plant selection, or mutation, to achieve specific characteristics or traits.

Topic - 4: Hybrids and Hybridisation

Hybrids are crosses between two species or distinct parent lines and can be developed from a series of crosses between parents. Seeds saved from hybrids usually don't 'come true from seed' meaning seeds saved and planted from hybrids won't yield the exact same fruit as the year before.

Hybrids cost more compared to varieties. The higher price is related to the amount of time that it takes to produce new hybrids. The carefully selected parent plants must be cross-pollinated by hand to produce offspring with the desirable characteristics. Then the seeds from those crosses have to be grown out and the plants have to then be evaluated to ensure that the resulting plants have the right combination of characteristics.

- **Disadvantage:** Farmers have to buy hybrids seeds every year, they cannot re use the harvest as seed for next season.
- **Advantage:** Hybrids offer improved disease resistance and are more adapted to environmental stresses.

Hybridization:

What is hybridization? <u>The mating or crossing of two plants or lines of dissimilar genotype is known as hybridization.</u>

- The chief objective of hybridization is to create genetic variation, when two genotypically different plants are brought together in F_1.
- Segregation and recombination produce many new gene combinations in F_2 and the later generations, i.e., the segregating generations.
- The aim of hybridization may be the transfer of one or few qualitative characters, the improvement in one or more quantitative characters, or use the F_1 as a hybrid variety.

Types of Hybridization: <u>Based on the taxonomic relationships of the two parents, hybridization may be classified into two broad groups:</u>

1. **Intervarietal Hybridization:** The parents involved in hybridization belong to the same species; they may be two strains, varieties or races of the same species. It is also known as

intraspecific hybridization. In crop improvement programmes, intervarietal hybridization is the most commonly used. An example would be crossing of two varieties of wheat (T. aestivum), rice (O. Sativa) or some other crop. The intervarietal crosses may be simple or complex depending upon the number of parents involved.

- **Simple Cross:** In a simple cross, two parents are crossed to produce the F_1. The F_1 is selfed to produce F_2 or is used in a backcross programme , e.g., A x B → F_1 (A x B)

- **Complex Cross:** More than two parents are crossed to produce the hybrid, which is then used to produce F_2 or is used in a backcross. Such a cross is also known as convergent cross because this crossing programme aims at converging genes from several parents into a single hybrid.

Three Parents (A, B, C)

A x B

F1(A XB) X C

Complex Hybrid (A XB) X C

2. **Distant Hybridization:** This includes crosses between different species of the same genus or of different genera. When two species of the same genus are crossed, it is known as inter-specific hybridization; but when they belong to two different genera it is termed as intergeneric hybridization. Generally, the objective of such crosses is to transfer one or few simply inherited characters like disease resistance to a crop species.

- **Procedure of Hybridization:** The breeder should have clear cut objectives in making a cross, and the parents should be selected to fulfil these objectives. The parents are evaluated for various characteristics before being crossed. Flowers of the parent to be used as female are emasculated by hand, suction, hot, cold or alcohol treatment, male sterility or self-incompatibility.

  The emasculated flowers are immediately bagged and tagged. Emasculation is done one day before the stigma becomes receptive, usually in the evening between 4-6 P.M. The emasculated flowers are pollinated by hand the next morning. It is desirable to use as large an F_1 population as the resources permit to provide the maximum chance for recombination.

Topic - 5: Land Races

A landrace is a local variety of a domesticated plant species which has developed largely adaptation to the natural and cultural environment in which it lives. It differs from a cultivar which has been selectively bred to conform to a particular standard of characteristics. Landrace

populations are often variable in appearance, but they can be identified by their appearance and have a certain genetic similarity. Landraces have a continuity with improved varieties. The relatively high level of genetic variation of landraces is one of the advantages that these can have over improved varieties. Although yields may not be as high, the stability of landraces in face of adverse conditions is typically high. As a result new pests or diseases may affect some, but not all, the individuals in the population.

- **On-farm conservation:** Landrace on-farm conservation is the active management of LR diversity within the traditional agricultural systems where they have developed their unique characteristics. It implies that conservationists work closely together with farmers in order to manage and monitor their LR populations aiming at the long-term preservation of the dynamic of the agricultural systems while maintaining genetic richness and evenness of the included diversity.

- **Consequences of land races genetic erosion:** A decrease in genetic diversity availability means genes and alleles will not be available for breeders to develop improved varieties and meet:
  - Changing consumer demands;
  - Changing environmental conditions;
  - Exploit new markets or environments;
  - Provide food security

- **Cultivars grown by farmers become increasingly genetically homogenous:** Agro-ecosystem functioning and its provision of services (e.g., pest and disease control, pollination, soil processes, biomass cover, carbon sequestration, prevention of soil erosion, etc.), as well as potential innovation in sustainable agriculture are each likely to be seriously impacted.

Topic-6: Practical- Differentiation of seeds and grains. Listing of known varieties, land races and hybrids of selected crops.

Participants observe and differentiate seeds and grains, from samples. In a group exercise participants list out names of land races, varieties and hybrids of major crops cultivated in their local area.

Key messages:

- Seed is basic agriculture input. It is fertilized ovum embedded in stored food material, covered by external coat.
- A variety is a type of plant that arose in nature while a cultivar is the result human intervention.
- Crossing of two plants or parental lines of dissimilar genotype is known as hybridization, the resultant off spring is called hybrid. Seeds harvested from hybrid crop cannot be used for further cultivation.

- A landrace is a local variety of a domesticated plant species which has developed largely adaptation to the natural and cultural environment in which it lives.

Learning outcome: Participants would learn basics about seeds and seed forms.

Assignment for the participants:

- Write differences between seeds and grains.
- What is hybridization , explain advantages and disadvantages of hybrid seeds.
- What is difference between variety and cultivar?

Module - 3: Participatory Varietal Selection

Learning objectives: By end of this session, participants would able to

1) Understand basic concepts about participatory varietal selection.
2) Learn steps to be followed in varietal selection.
3) Know case studies of PVS in different crops.
4) Familiarize with legal support for farmer rights.

Methodology: Class room teaching with interactive sessions.

Materials required: Flip charts, marker board, marker pens, LCD projector.

Resource person: Subject Matter Specialist/ Scientist/ Officer from Govt. dept./Best Farmers/NGO

Time frame: 2.30 hours (Topic-1: 0.30 hr, Topic-2: 0.30 hr, Topic-3: 1 hr, Topic-4: 0.30 hr)

Instructions to resource person:

Resource person recap topics of varieties and land races.

Present case studies of farmers and organization with different crops. May use internet for instant access of cases and crops.

Content:

Topic - 1: Participatory Varietal Selection (PVS)

What is Participatory variety selection? This is an approach to provide an option to farmers to select varieties from available range of genetic diversity for increasing yields within existing agro-ecological condition. This is also used to select, test and release of promising genotypes in farmers field. PVS includes research and extension activities to deploy genetic materials at on farm experiment. Therefore, the variety has developed through PVS can meet demand of farmers and researcher.

Participatory varietal selection to identify preferred cultivars has three phases:

- identifying farmers' needs;
- searching for suitable material to test with farmers; and
- experimentation on farmers' fields.

Once identified, the seed of farmer-preferred cultivars needs to be rapidly and cost-effectively supplied to farmers.

Importance of Participatory Variety selection.

- Provide an opportunity to the farmers to select large number of varietal choices on their own resources.
- Enhance farmers access to crop varieties and increase in diversity.
- Increase production and ensure food security.
- Help to disseminate the adoption of pre and released varieties in larger areas.
- Allow to varietal selection in targeted areas at cost-effectiveness and also in less time.
- Help seed production at community based seed.

Difference between Conventional Varietal Trials and PVS Trials

Conventional Varietal Trials	Participatory Varietal Selection (PVS) Trials
In conventional breeding and testing programs, on-farm trials are conducted as the final step in a long selection process that may involve many replicated trials conducted on research stations. Researchers usually manage conventional on-farm trials. These trials are good for measuring agronomic traits, but they often do not include a step where farmers are asked their opinion about the varieties in the test.	PVS trials are managed by farmers or use the same management techniques used by farmers, and they always include a step in which farmers opinions are collected in a way that allows the information to be summarized as numbers or ratings, as well as in lists of farmers comments about the varieties. In this step, the opinions of women farmers, poor farmers, and farmers from minority ethnic and social groups are specifically sought.

Topic - 2: Steps Involved in PVS

Design

- Replication
- Randomization
- Plot size
- Layout

Management

- Plot Selection
- Cultural Practices

Evaluation

- Farm Walks
- Data Collection
- Yield data

Mother Trial: The mother trial is an on-farm trial in which a set of new lines or introduced varieties is compared with local checks using farmers crop management practices.

In this step, agronomists measure yield and other important traits.

Groups of farmers are invited to visit the trial and rate the varieties using a simple technique called preference analysis (PS).

The mother trial does not have to be a separate trial given that name.

If the breeding program already conducts researcher-managed on-farm trials, demonstration trials in which data are collected, or even advanced on-station multi-location trials at several research centers, farmers can be invited to visit the trial site and perform PA.

Baby Trial: Varieties that perform well and are preferred by farmers in the mother trial are evaluated by farmers on their own farms in baby trials.

Baby trials are small trials of 2 to 5 varieties that are given directly to farmers.

Researcher do not lay out these trials. They are planted and harvested by farmers.

Researchers may take crop cuts to measure yield if resources permit, but farmer ratings, comments, and yield reports have been shown to be highly reliable and are the main output of the baby trial. Farmers rate the varieties in comparison to their own.

Topic - 3: PPV& FRA

In compliance to the TRIPS Agreement of WTO, India established Protection of Plant Varieties and Farmers Rights (PPV&FR) Authority, under the Protection of Plant Varieties and Farmers Rights Act, 2001. PPV & FR Authority has become operational since 11th November, 2005.

The objectives of the Authority are:

- Establishment of an effective system for protection of plant varieties, the rights of farmers and plant breeders and to encourage development of new varieties of plants.
- Recognition and protection of the rights of farmers in respect to their contribution in conserving, improving and making the available plant genetic resources for the development of new plant varieties.
- Accelerated agricultural development in the country by stimulation of investment for research and development both in public and private sector.
- Facilitate growth of seed industry to ensure the availability of quality seeds and planting material to the farmers.

Any of the following persons can make an application to the PPV & FRA for registration of a variety:-

- Any person claimed to be a breeder of a variety.
- Any person being the assignee of the breeder of a variety.
- Any farmer or group of farmers or community of farmers claiming to be the breeder of a variety.
- Any University or publicly funded agricultural institution claiming to be breeder of a variety.

PPV & FR Authority shall maintain a National Register of Plant Varieties.

The certificate of Registration shall be valid for a 9 years in the case of trees and vines and six years in case of other crops.

The total period of variety shall not exceed 18 years for trees and vines and 15 years for extant varieties notified under Seeds Act and for other crops.

PPV & FR Authority shall invite claims for beneficiary in respect of any variety for which registration has been granted.

The PPV & FR Authority shall determine beneficiary on the basis of following:-

- The extent and nature of the use of genetic material of the claimant.
- Commercial utility and demand in market of the variety relating to which benefit hasbeen claimed.

The benefit determined by the PPV & FR Authority shall be deposited by the breeder with the National Gene Fund. The amount of benefit sharing shall be recoverable as arrear of land revenue. Certificate of Registration shall confer an exclusive right on the breeder, his successor, his agent or licensee the right to produce, sell, market, distribute, import or export the variety.

Farmer who has developed or bred a new variety shall be entitled for registration as a breeder of a variety. Farmer shall be deemed to be entitled to save, use, sow, re-sow, exchange, share or sell his farm produce including seed of a variety protected under this Act in the same manner as he was entitled before coming into force of this Act provided that the farmer shall not be entitled to sell branded seed of a variety protected under this Act. Farmers' variety shall be entitled for registration.

Farmer who is engaged in the conservation of genetic resources of land basis and wild relatives of economic plans and their improvement and preservation shall be entitled to recognition and reward from the Gene Fund provided the material so selected and preserved has been used as a donor of genes in varieties register able under the PPV & FR Act. Any person or group of persons (whether actively engaged in farming or not) or any other Governmental or Non-governmental organization may stake a claim on behalf of the village or local community.

There is a provision for compulsory licensing to meet the reasonable requirement of the public for seed or other propagating material.

Key messages: PVS is an approach to select desired variety from wide range of available genetic diversity of crop within his agro-ecological conditions. It differs in conventional trials in scientific approach and replications. PPV&FRA a legal act which support farmers in conserving and preserving his own variety.

Learning outcome: Participants would understand the process of participatory varietal selection and find difference between conventional trails and PVS. Participant would know steps involved in PVS trials. He also familiarizes with farmers rights.

Assignment for the participants:

- What is participatory varietal selection how it differs with conventional trial.
- What are steps involved in PVS trials?
- What are advantages of PPV&FRA.

Module - 4: Seed Classification

Learning objectives: By end of this session, participants would able to

1) Learn various seeds moving through the seed supply chain
2) Understand the source and suppliers of seed right from breeding to marketing.
3) Identify the purity of seed across classes.
4) Differentiate different seeds by their labels.

Methodology: Class room teaching with interactive sessions and practical class.

Materials required: Flip charts, marker board, marker pens, LCD projector, seed labels.

Resource person: Subject Matter Specialist/ Scientist/ Officer from Govt. dept./Best Farmers/NGO

Time frame: 3.30 hours (Topic-1: 0.30 hr, Topic-2: 0.30 hr, Topic-3: 0.30 hr, Topic - 4: 0.30 hr, Topic-5: 0.30 hr, Topic-6: 1 hr)

Instructions to resource person:

- Ask participants what type of seed they are using their villages (certified or TFL).
- Explain clearly the difference between certified and TFL seed.
- Activity sessions /interactive sessions: Explain the seed chain with its purity and supplier, right from nuclear to certified seed. Let participants Involve in identification of labels by its colors. Supply model label cards ask them to arrange them in designated box on chart. Ask them to paste purity % and class of seed by using colour cards in descending manner.

Content:

Topic - 1: Nucleus Seed

Nucleus seeds are the basic seed class for seed production. These seeds are maintained by the breeder for further multiplication. It is produced under the direct supervision of the concerned plant breeder. It is produced based on the various crop multiplication techniques and methods. Nucleus seeds possess high percentage of genetic purity (100%)

Topic - 2: Breeder Seed

Breeder seeds are produced using nucleus seeds in the Research institutes or Universities under the supervision of a breeder. The entire production process will be monitored by the Scientists and Officers of the Seed Certification Department and by the representatives of the National

Seed Corporation. The genetic purity of the breeder seeds is 100% and the tag provided for the breeder seed is golden yellow in colour.

Topic - 3: Foundation Seed

Foundation seeds are produced from the breeder seeds. It is produced at Government farms or by private seed producers. Its production can also be taken up by the farmers by getting suitable breeder seeds. Genetic purity of the foundation seeds are 99.5% and its certification tag is white in colour.

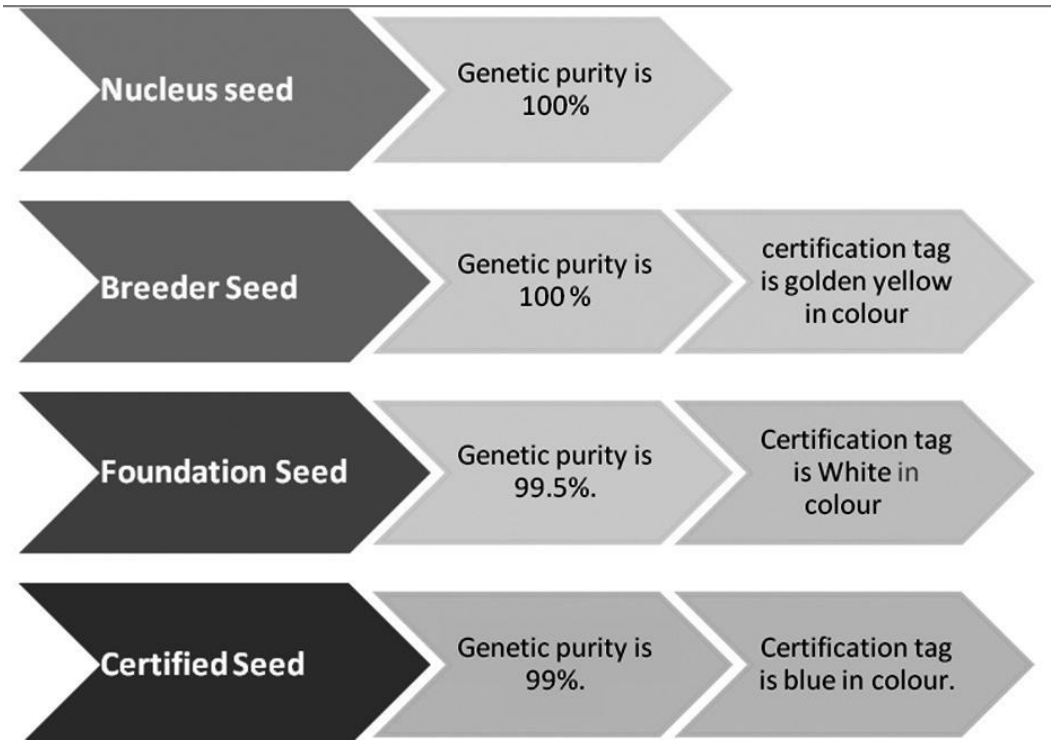
Topic - 4: Certified Seed

Seeds produced from foundation seeds are known as certified seeds. The production of certified seeds is taken up by the National and State Seed Corporation, private seed companies and also by farmers. The certified seeds should possess uniformity and purity as defined by the Department of Seed Certification. The genetic purity of the certified seeds is 99% and the certification tag provided is blue in colour.

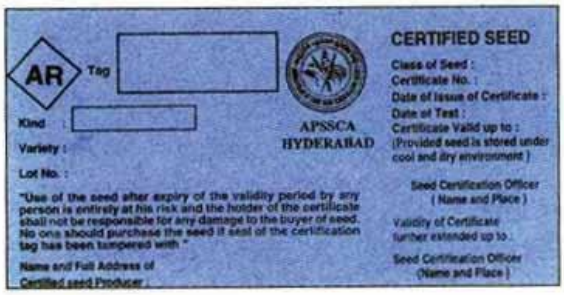
Topic - 5: Truthful Labeled (TFL) Seed

One more class of seeds is truthfully labeled seeds. This type of seeds does not come under the purview of the Department of Seed Certification. This kind of seeds are tested only for its physical purity and germination. By this method, any farmer can produce seeds and market it as truthfully labeled seeds. Labeling is compulsory but certification is voluntary.

Topic - 6: Interactive session- Understanding the flow of seed and purity throughout the supply chain



Topic - 7: Practical Class - Identification of Colours and Content of Labels



Key messages: Nucleus seed is mother for seed production which has 100% purity. It is produced by research institution. Breeder seed is produced from nucleus seed which also has 100 %. It is labeled with golden yellow color . Foundation seed is produced from breeder seed, it has 99.5% purity, labeled with white color. Certified seed is marketable seed produced by licensed seed producers. It is certified by certification agency, has 99% purity, labelled with blue color.

Learning outcome: Participants would understand various classes of seeds, their purity and labeling colors.

Assignment for the participants:

- Write down classes of seeds with purity and supplier description.
- What is TFL seed? write advantages and disadvantages.

Module - 5: Seed Quality

Learning objectives: By end of this session, participants would able to

1) Maintain physical and genetic purity, in practice
2) Learn Groundnut seed standards
3) Understand various factors that affect the seed quality
4) Teach farmers, how to check label for seed quality in the market.

Methodology: Class room teaching with interactive sessions.

Materials required: Flip charts, marker board, marker pens , LCD projector, groundnut seed and pods.

Resource person: Subject Matter Specialist/ Scientist/ Officer from Govt. dept./Best Farmers/NGO

Time frame: 5 hours (Topic-1: 0.30 hr, Topic-2: 0.30 hr, Topic-3: 1hr, Topic-4: 1hr, Topic-5: 0.30 hr, Topic-6: 0.30 hr, Topic-7: 1hr)

Instructions to resource person:

- Bring seed packet from market and ask participants to identify quality parameters and check list to follow while purchasing.
- Explain groundnut seed standards, compare with other cross pollinating crops.

Content:

Topic - 1: Physical Purity and Seed Moisture

- The physical purity of the seeds should be maintained at 96-98% and the seeds should be of uniform size and shape without any damage.
- The seeds should be devoid of inert matter like dust, stones, seeds of other crop varieties, broken seeds, weed seeds, etc.
- After harvest, seeds should be separated from chaffy seeds and insect or disease affected seeds in order to maintain the physical purity of the seeds.
- Seeds with high moisture content will lose its germination vigour and viability soon. Hence, it is necessary to maintain correct moisture content of the seeds in order to ensure the good germination capacity and viability.
- It is also essential to protect the seeds from pest infestation and attack by diseases. Seeds should be stored at a safe moisture level of 9 – 13%.

Topic - 2: Genetic Purity

- Genetic purity of the seed should be maintained in order to ensure the quality of the seeds.
- The traditional and inherent characteristics of the seed should be maintained from generation to generation and is referred as genetic purity.
- The characteristics of the progeny should exactly resemble its mother plant.

Topic - 3: Factors affecting the seed quality (Deterioration of Varieties)

The main objective of seed production is to produce good quality and genetically pure seeds. But during seed production due to certain reasons the genetic purity of the seed may be lost, this is said to be deterioration of a particular crop variety. Some of the reasons for crop deterioration are discussed below:

- Developmental Variation
- Mechanical Mixtures
- Natural Crossing
- Genetic drift
- Influence of Disease
- Mutations

Topic - 4: Seed Standards

Quality standards of seed.

- **It must be genetically pure:**

Breeder/nucleus	:	100 %
Foundation seeds	:	99.5%
Certified seeds varieties	:	98%
Certified hybrid seeds	:	95%
Certified hybrid cotton	:	90%
Certified hybrid castor	:	85%

- **It should have required level of physical purity:**

All crops	:	98%
Carrot	:	95%
Ragi	:	97%

- **Free form other crop seeds (number/kg):** Designated inseparable crop seeds are the plants seeds cultivated crops found in the seed fields and whose seeds are so similar to crop seed that is difficult to separate them economically by mechanical means, cause physical admixtures with the crop seeds only when these crop mature approximately at the same time when seed crop matures. Ex. In barley: oats and wheat seeds

- **Free from objectionable weed seeds:** These are seeds of weed species which are harmful in one or more of the following ways:

  a. The size and shape of weed seeds are similar to the crop seed and difficult to separate them by mechanical means
  b. Weeds growth habit is determinate type and compete with the crop for all resources
  c. Weed plant parts are poisonous or injurious to human and animals
  d. Weed plants also serve as alternative hosts for pests and diseases

    - Paddy : Wild paddy (Oryza sativa var. fatua)
    - Cucurbits : Wild cucurbits spp.
    - Lettuce : Wild lettuce
    - Bhendi : Wild Abelmoscous spp
    - Wheat : Convolvulus arvensis (Hirankuri)

- **Free from designated diseases:** It refers to the diseases specified for the seed certification which may cause contamination of seed lot, Example for:

    - Loose smut of wheat (Ustilago tritici)
    - Kernal smut of sorghum (Sphacelotheca sorghi)

- Grain smut of pearl millet (Tolyposporium penicillariae)
- Ergot of bajra (Claviceps microcephala)
- Early blight of tomato (Alternaria solani)
- Little leaf of brinjal (Datura virus-2) etc.,

- **High germination and vigour**

- **Optimum moisture content**

  - Cereals : 10-12 %
  - Pulses : 7-9%
  - Oilseeds : 6-7%
  - Vegetables : 5-6%

Example: Seed standards of Groundnut

	Foundation	Certified
Pure seed (minimum) (%)	96	96
Inert matter (maximum) (%)	4	4
Off-type plants (maximum) at the final inspection in the field (%)	0.1	0.2
Other crop seed (maximum)	Nil	Nil
Weed seeds (maximum)	Nil	Nil
Germination of the hand-shelled seeds (minimum) (%)	70	70
Moisture content for hand-shelled seeds (maximum) (%)	9	9
Moisture content under vapor proof containers for hand-shelled seeds (maximum) (%)	5	5

Topic - 5: Seed Multiplication Ratio (SMR) and Seed Replacement Ration (SRR)

SMR It is the number of seeds to be produced from a single seed when it is sown and harvested.

$$\text{SMR} \quad \frac{\text{Seed Yield}}{\text{Seed Rate}}$$

SRR Seed replacement rate is the percentage of area sown out of total area of crop planted in the season by using certified / quality seeds other than the farm saved seeds.

SRR X / Y x 100

Where, X = Quantity of farmer saved seed. Y = Quantity of quality seeds of a particular variety reported to cover a given area.

This is essential for maintaining genetic purity and quality seed production. The seed replacement rate gives an idea about the quantity of the quality seeds used by the farmers.

Groundnut SRR is 5, whereas SMR is 1:8

Topic - 6: Farmers Checklist for Seed Quality

Seeds should be procured / purchased only from the authorized outlets.

Check the following details in the producer label on the packet

- Label Number
- Crop
- Variety
- Lot number
- Inspected date, month and year
- Expiry date, month and year
- Germination percentage (minimum)
- Physical purity (minimum)
- Genetic purity (minimum)
- Net weight
- Certification logo
- Seed producer label.
- Name and address of the producer who offers for sale, sells or suppliers.

Collect the receipt from the dealer with the details of the seeds purchased and retain the same along with the seed packet till the crops are harvested / sold

Topic - 7: Interactive Session (Practical): Practical Learning on Physical and Genetic Purity

- Participants isolate pure seed from admixtures, unequal size, stones, plant parts and other foreign material.
- Candidates measure seed moisture with digital moisture meter.
- Candidates use colour cards, posters for documenting observations.

Key messages:

- Seed quality is based on physical properties and genetic vigour.
- Seed is produced scientifically by maintaining proper standards and procedures.
- Seed quality is greatly influenced by field factors and neighbor crops.
- Groundnut seed standards are to be ensured while certification.
- Farmers should check quality parameters and standards before purchase from market.

Learning outcome: Participants would learn about physical and genetic purity by theory and practice. Participants would learn about factors that affect the quality of seed during seed production process. Participants train in measuring seed moisture with digital moisture meter.

Assignment for the participants:

- How you can maintain physical and Genetic purity?, describe briefly.
- What are seed standards? write its importance in seed certification.
- Write with values of Foundation and certified seed of groundnut.

Module - 6: Maintaining the Seed Purity

Learning objectives:

By end of this session, participants would able to

1) Know the importance of isolation distance in the seed production
2) Learn the practice of rouging in removing off types
3) Realize the importance of quality harvest for quality seeds.

Methodology: Class room teaching with interactive sessions.

Materials required: Flip charts, marker board , marker pens and LCD projector.

Resource person: Subject Matter Specialist/ Scientist/ Officer from Govt. dept./Best Farmers/NGO

Time frame: 3.30 hours (Topic-1: 0.30 hr, Topic -2: 0.30 hr, Topic-3: 0.30 hr, Topic-4: 2 hr)

Instructions to resource person:

- Show isolation distances in seed fields.
- Learning of rouging process and quality harvest both theoretically and practically are equally important. Engage participants in the field activities.
- Emphasis given on indicators of crop maturity.

Content:

Topic - 1: Isolation Distances

It is the distance maintained between the seed crops and the different varieties of the same crop located in the adjacent area in order to maintain the genetic purity of the seeds.

Isolation distance is based on the pollination behaviour, pollinating agent, flying capacity of the pollen, stages of seed crop and nature of variety or hybrid.

Maintaining appropriate isolation distance avoids cross pollination and crossing of genes. Two types of isolation are followed – space isolation (planting distance) and time isolation (difference in the time of sowing).

An isolation distance of 3 m between varieties is required for all classes of certified seeds.

Topic - 2: Rouging

In the seed production technology rouging is an important technique to be followed from field to storage. It is the process of removing the plant varieties of other than the variety grown for seed production like other crops, weeds etc. Rouging should not be done in intense sun light. Off-types should be removed before their flowering stage. Off-types should also be removed after harvest, during drying, processing and storage. Timely rouging is critical for the conservation of the genetic purity of the seeds.

Normally four roguings should be carried out at different stages of crop growth, viz, seedling stage, flowering stage, podding stage and at harvest, to remove off-type groundnut plants in the seed production field.

The weak, distorted, variegated, diseased and out of the row alignment seedlings should be removed and destroyed at seedling stage.

The late flowering plants and other off-types based on peg morphology and other vegetative characters should be removed at podding stage.

The last roguing should be done on harvested plants to remove plants with diseased pods and off-types based on pod and seed characteristics.

Topic - 3: Quality Harvest

Pod maturity in a groundnut plant is not uniform because of its indeterminate growth habit.

The timing of harvesting is very critical as it can significantly affect the economic yield and the quality of seeds.

The easiest and most practical method of assessing the optimum time of harvesting is by evaluating the internal pericarp color of pods removed from a few representative plants in the field around the expected time of maturity.

The darkening of internal pericarp is a sign of pod maturity.

Yellowing of top leaves and withering of old and lower leaves are also indications of maturity.

The crop should be harvested when 70–75% of the pods are mature.

Topic - 4: Field Visit - Hands on Experience of Rouging, Finding the Isolation Distances

- Visit nearest seed production field. Observe rouging and record the steps.
- Learning by doing: participants involve in the field activities , practice rouging .
- Observe crop maturity, involve in quality harvest. Note down crop maturity indicators.

Key messages:

- Isolation distances and rouging of off types is crucial steps in seed production.
- Identifying the crop maturity , harvesting at right time also contribute for seed quality.

Learning outcome:

- Participants would learn importance of isolation distances and rouging , both theoretically and practically.

Assignment for the participants:

- What is isolation distance for groundnut ?
- Explain the process of rouging

Module - 7: Seed Physiology

Learning objectives: By end of this session, participants would able to

1) Understand seed physiological processes like dormancy and germination.
2) Learn various methods available for breaking seed dormancy.
3) Know the method of seed germination and calculate germination %.

Methodology: Class room teaching with interactive sessions and practical class.

Materials required: Flip charts, marker board , marker pens, LCD projector, seed labels.

Resource person: Subject Matter Specialist/ Scientist/ Officer from Govt. dept./Best Farmers/NGO

Time frame: 2.30 hours (Topic-1: 0.30 hr, Topic-2: 0.30 hr, Topic-3: 0.30 hr, Topic-4: 1 hr)

Instructions to resource person:

- Ask participants why some seeds do not germinate even after sowing or soaking. Any time noticed such instance?
- Any traditional method they noticed in their village to break dormancy?
- In an activity work , involve participants to learn what factors influencing germination of seed.
- Play videos of seed dormancy and seed germination (You tube Link or downloaded videos provides separately)

Content:

Topic - 1: Seed Dormancy

Seed dormancy: is the temporary suspension of growth of viable seeds accompanied by reduced internal metabolic activity. It is the resting stage of the seed and it delays germination of the seed.

Unfavorable climatic conditions like temperature, variation and lack of water leads to seed dormancy. Dormancy may occur due to the presence of a hard seed coat, immature embryo and also due to the presence of germination inhibitors in the seeds.

It may also be due to the exposure of seeds to excess heat, light or darkness and also due to the presence of chemical toxins in the seeds.

The seed dormancy is two types:

1) Innate Dormancy or Primary Dormancy
2) Secondary dormancy

1) **Innate dormancy / primary dormancy:** It is the state of the seed itself or dormancy induced in the seeds at the time of dispersal from the mother plant i.e. the dormancy may be induced before maturity, during maturity and after maturity but before seed is dispersed from mother plant. Primary dormancy is further classified into endogenous and exogenous.
   - **Exogenous dormancy -** is due to the seed coat factor either due to presence of inhibitors or hard seed nature. It is further classified into,

- **Physical -** Dormancy is due to the hard seed coat which prevents the entry of water and sometimes gaseous exchange is also prevented. e.g., Hard seeds of pulses, acacias. Prosopis, sapota etc.,
- **Chemical -** Presence of some inhibitors in the seeds coat which prevents the germination
- **Mechanical -** restriction of the growth of protruding radicle due to structure. (e.g.) inadequate space in the seeds of *Terminalia* sp.
- **Endogenous dormancy** - Dormancy due to embryo. May be the presence of inhibitors, immature embryo or combination of both. It is further classified into
- **Morphological** - Due to immature embryo, which is not able to putforth germination even under favourable conditions. (e.g.) Apple
- **Physiological** - Due to arrest of the metabolic activity in the seeds due to presence of some inhibitors like ABA, coumarines, phenols etc.,
- **Morphophysiological** - Combination of immature embryo with inhibitors.

2) **Secondary dormancy:** Secondary dormancy can take place only in a matured and imbibed seed by certain environmental conditions, which are unfavourable to germination. (e.g.) Spring wheat and winter barley, the secondary dormancy could be imposed by

1. Exposure of dry barely seed to temperature between 50 and 90 0 C
2. Storage of winter barely for seven days in high moisture containers at 20 0 C.
3. Storage of spring wheat for one day at high moisture content in airtight containers at 50^0 C.
4. Placement of seed under water and in darkness for 1 to 3 days at 2 0 C.

Induction of secondary dormancy was possible one and half months after physiological maturity. Secondary dormancy in Spring wheat could not be broken by two weeks of storage. However, it was completely broken by treatment with 0.1% GA3, 0.5 to 1.0 % Ethanol, low temperature stratifications, removal of pericarp and storage at 20 0 C. Secondary Dormancy Mechanism:

- Imposition of blocks of crucial points in the metabolic sequence that leads to germination.
- An unfavourable balance of growth promoting versus growth inhibiting primary dormancy (coat imposed dormancy)

In many species seed dormancy is imposed by the structures surrounding the embryo (seed coat), which may include glumes, palea and lemma (grasses, the pericarp, perisperm and endosperm). The embryo in these cases are non-dormant one.

- **Types of secondary dormancy:** Thermo – Dormancy due to temperature Skoto – Light; Photo – Quality of light and Osmotic – stress or high osmotic stress prevents germination
- **Advantages of dormancy:**
  1. Storage life of seed is prolonged
  2. Seed can pass through adverse situation
  3. Prevents the *in situ* germination.

- **Disadvantages:**
  1. Long periods of time needed to overcome dormancy (for uniform germination)
  2. Contributes to longevity of weed seed.
  3. While raising a crop it is very difficult to maintain the population in the field with dormant seed lot

Topic - 2: Breaking of Seed Dormancy

Dormancy of the seeds can be broken by any of the following methods,

1. Scarification treatments
   - Acid Scarification (100 ml conc. H_2SO_4/Kg seed for 2-3 minutes)
   - Mechanical Scarification (sand and seed ratio 2:1 rub against 5-10 minutes)
   - Steam Scarification (steam for about 5-10 minutes)
2. Stratification
   - Cold Stratification (0 to 5oC for 2-3 days)
   - Warm Stratification (40-50oC for few days)
3. Hot water treatments (60-80oC for 5-10 minutes)
4. Leaching of metabolites
5. Temperature treatments
6. Light and photo chrome treatments
7. Pressure treatments
8. Infrared radiation treatments
9. Magnetic treatments
10. Promoter vs. inhibitors treatments

Topic - 3: Seed Germination

Germination capacity of a seed lot refers to the capacity of the seeds in that lot to germinate normally and produce all parts of a healthy seedling and grow. The necessary parts of the seedling include well developed primary roots, young pair of leaves and one or two cotyledons.

Conditions for Germination:

- **Water:** Before they can begin germination, seeds need a supply of water. This softens the testa or fruit wall and allows the radical to grow and push its way out. Water activates the enzymes which convert the starch stored in the cotyledons or endosperm into soluble sugars which are then transported in solution to the growing regions.
- **Oxygen:** At this stage seeds also need a supply of oxygen. This gas is necessary for aerobic respiration, from which the seed derives its energy for all the chemical processes which contribute to growth.
- **Warmth:** Seeds will not start to germinate if the temperature is too low. The minimum temperature needed varies with the species of seed.

- **Light:** Only a small number of species of plants have seeds which need light to begin germination. Once the cotyledons or plumule are above ground light is needed for photosynthesis.

Following formula is used for calculation of germination:

$$\% \text{ of germination} = \frac{\text{Number of normal seedlings}}{\text{Total number of seeds germinated}} \times 100$$

A germination rate of 70-80% is an indication of high seed viability.

Germination can also be affected by seed dormancy.

Topic - 4: Practical - Dormancy Breaking Methods and Germination

- Instructor play videos on dormancy and germination
- Participants break seed dormancy with any available method in the laboratory.
- Participants also observe the method of germination. Calculate the germination per cent.

Key messages:

- Seed dormancy is defined as failure of viable seed to germinate at specified length of time in a set of environmental conditions. There are methods to break dormancy artificially.
- Seed germination is capacity of seed to grow seedling under favorable environmental conditions.

Learning outcome: Participants would learn mechanisms of dormancy and germinations and breaking of dormancy through artificial methods.

Assignment for the participants:

- What is seed dormancy, what are available methods to break dormancy?
- What are conditions that favors seed germination?
- How do you calculate seed germination %

Module - 8: Seed Certification

Learning objectives: By end of this session, participants would able to

1. Learn certification procedure with all legal compliances.
2. Know the field inspection importance and quality management

3. Know the process of sample collection and sending it to State Seed Certification Agency (SSCA).
4. Learn filling up of formats specified for seed certification.

Methodology: Classroom teaching with interactive sessions and practical class.

Materials required: Flip charts, marker board, marker pens, LCD projector, seed labels, seed samples, formats, tags.

Resource person: Subject Matter Specialist/ Scientist/ Officer from Govt. dept./Best Farmers/NGO

Time frame: 5.30 hours (Topic-1: 1 hr, Topic-2: 1 hr, Topic-3: 0.30 hr, Topic-4: 0.30 hr, Topic-5: 0.30 hr, Topic-6: 2 hr)

Instructions to resource person:

- Supply seed certification standards booklet and formats published by SSCA. Ask participants to follow while exercising and filling forms.
- Take them to field for inspection and complete practical part.
- Since this topic deals with legal compliances, procedures as per seed law and APSSCSA norms, care must be taken.

Content:

Topic - 1: Certification Procedure

The purpose of seed certification is to maintain and make available to the public, through certification, high quality seeds and propagating materials of notified kind and varieties so grown and distributed as to ensure genetic identity and genetic purity. Seed certification is also designed to achieve prescribed standards.

- **Certification Agency:** Certification shall be conducted by the Certification Agency notified under section 8 of the Seeds Act, 1966.
- **Certified Seed Producer:** Certified seed producer means a person/organization who grows or distributes certified seed in accordance with the procedures and standards of the certification.
- **Eligibility Requirements for Certification of Crop Varieties:** Seed of only those varieties which are notified under section 5 of the Seeds Act, 1966 shall be eligible for certification.
- **Phases of Seed Certification:**

  Certification shall be completed in six broad phases listed as under:

(a) Receipt and scrutiny of application;
(b) Verification of seed source, class and other requirements of the seed used for raising the seed crop.
(c) Field inspections to verify conformity to the prescribed field standards.
d) Supervision at post-harvest stages including processing and packing.
e) Seed sampling and analysis, including genetic purity test and/or seed health test, if any, in order to verity conformity to the prescribed standards; and
(f) Grant of certificate and certification tags, tagging and sealing.

Establishing Source of Seed: The individual intending to produce seed under certification shall submit to the Certification Agency, one or more relevant evidence such as certification tags, seals, labels, seed containers, purchase records, sale records etc., as may be demanded by the Certification Agency during submission of the application.

Field Area for Certification: There is' no minimum or maximum limit for the area offered by a person for certification, provided the certified seed production meets all the prescribed requirements.

Unit of Certification: For the purpose of field inspections, the entire area planted under seed production by an individual shall constitute one unit provided,

Use of Chemical Hybridising Agents (CHAs'): In case of hybrid seed production, the seed producer can use proper Chemical Hybridising Agents on seed parent (female line) in order to induce male sterility.

Field Inspection:
(a) The field inspection work which requires technically trained personnel, shall be performed by the persons who have been so authorized by the Certification Agency.
(b) Field inspection meant to verify those factors which can cause irreversible damage to the genetic purity or seed health shall be conducted without prior notice to the seed producer.
(c) Soon after the completion of the field inspection, a copy of the report shall be handed over to .the seed producer or his representative.

Re-inspection: Seed fields not conforming to prescribed standards for certification at any inspection, the -Certification Agency shall, upon the request of seed producer and after he removes the sources of contamination in the seed field and within the prescribed isolation distance and/or the contaminated plants in the seed field (if so directed by the Certification Agency) perform one -or more re-inspections provided such removal can ensure conformity of the seed crop to the prescribed standards and provided further the no irreversible damage has been caused to the quality of seed by the contaminant(s).

Harvesting, Threshing and Transportation: Seed crop meeting field standards for certification shall be harvested, threshed and transported to the seed processing plant in accordance with the guidelines issued by the Certification Agency. During these operations, seed producer will take all precautions to safeguard the seed from admixture and other causes of seed deterioration.

Bulking: Bulking of unprocessed seed stocks to obtain larger homogeneous seed stocks may be permitted by the Certification Agency provided the stocks to be bulked meet the requirements.

Seed Processing and Packing Schedule: The Certification Agency shall prepare and communicate seed processing and packing schedule to all certified seed producers soon after the certification of seed crops at field stage. The seed producers shall adhere to the schedule specified by the Certification Agency. However, re-scheduling may be accepted by the Certification Agency on the request of seed producer on genuine grounds.

Seed Lot:A seed lot is a physically identifiable quantity of seed which is homogeneous.

Lot Size: A seed lot would represent any quantity of agricultural seeds upto a maximum of 20,000 kg for seeds of the size of rice or larger and 10,000 kg for seeds smaller than rice subject to a tolerance limit of 5.0 %.

Construction of Seed Lot Number: Each seed lot shall be assigned a specific number in order to facilitate maintaining its identity, tracing back to its origin, handling in stores, transit etc., accounting and inventory maintenance and referring/communicating about a certain quantity of seed.

Seed Processing: Seed processing means cleaning, drying, treating, grading and other operations which will improve the quality of seeds. Seed from fields which conformed to the standards of certification at field stage shall, as soon as possible after the harvest will be brought at processing plant for processing

Seed Treatment: When a variety, seed of which is under certification is susceptible to a seed borne disease organism or when seed under certification is carrying a seed borne pathogen and a seed treatment is available which may control the disease or pathogen when properly applied, the Certification Agency may require such seed to undergo such treatment before Certification.

Samples and Sampling of Seeds: Soon after completion of the seed processing or after seed treatment as the case may be, the Certification Agency shall draw. a representative composite sample as per procedure specified in Seed Testing Manual. The quantity of seed samples so drawn shall be sufficient to provide three samples of the size of submitted sample. The composite sample will be divided into three equal parts, and one shall be sent" for analysis

to a notified Seed Testing Laboratory, the second part to the seed. producer and retain the third part as a guard sample.

Seed Analysis Report: The Seed Testing Laboratory shall analyse the seed samples in accordance with the prescribed procedure and deliver the Seed Analysis Report to the Certification Agency as soon as may be, but not later than 30 days from the date of receipt of the samples unless the seed is subjected to such tests which require. more than 30 days for completion of the test.

Seed Standards of Genetic Purity: All certified seed lots shall conform to the minimum Standards for genetic purity unless otherwise prescribed (mentioned in separate topic).

Grow-out Test: The Certification Agency shall conduct grow-out test to determine -genetic purity of a seed lot wherever-it is a pre-requisite for grant-of the certificate and also on the seed lots where a doubt has arisen about the genetic purity. The grow-out test can be complemented by certain related laboratory tests.

Re-cleaning, Re-sampling and Retesting: When a seed lot does not meet the prescribed (seed [standards, the Certification Agency on the request of seed producer may permit re-cleaning, re-sampling and retesting. The re-cleaning, re-sampling and retesting shall be permitted only once.

Seed Standards for Insect Damage: A seed lot under certification shall not have apparent or. visible evidence of damage by insects for both Foundation and Certified seed classes in excess of 1.0%for the seeds of maize and legumes and 0.50%for the seeps other than maize and legumes unless otherwise prescribed.

Seed Moisture Content: Seed standards in respect of seed moisture shall be met at the time of packing of seed.

Downgrading of Seed Class: If a seed field or a seed lot is not found meeting prescribed standards for the class for which it has been registered but conforms to the prescribed standards to the immediate lower class, the Certification Agency may accept such seed fields/seed lots for certification to the immediate lower class provided request has been made to this effect by seed producer. However, downgrading of the seed class shall not be applicable in case of hybrids and their parents.

Specification of the Certification Tag: Size, quality, colour, layout and contents of the certification, tag shall be as per specification.

Packing, Tagging, Sealing-and Issuance of the Certificate:

(a) On receipt of Seed Analysis Report and the results of the grow out test wherever prescribed, and if seed lot has met prescribed standards, the Certification Agency shall ensure packing, tagging and sealing and issuance of certificate expeditiously. An authorized official of the Certification Agency shall endorse the signature on the reverse of each certification tag and shall affix rubber stamp indicating the official's name and designation. Containers to be used for packing of the certified seeds shall be durable and free from defects.
(b) Advance tagging may be permitted at the discretion of the Certification Agency with proper safeguards.

Refusal for Certification: The Certification Agency shall have the authority to refuse certification of any seed production field or any seed lot that does not conform to the Minimum Standards prescribed for that particular crop, either for field or for seed or for both. Such refusal will be subject to any appeal made to the Appellate Authority constituted under section 11(1) of the Seeds Act, 1966.

Validity Period of the Certificate: The validity period shall be nine months from the date of test at the time of initial certification. The validity period could be further extended for six months provided on retesting seed conforms to the prescribed standards in respect of physical purity, germination and insect damage for all seeds except vegetatively propagating material for which lot shall be re-examined for seed standards specified for respective crop. A seed lot will be eligible for extension of the validity period as long as it conforms to the prescribed standards.

Revocation of Certificate: If the Certification Agency is satisfied, either on reference made to it in this behalf or otherwise that:

(a) The certificate granted by it under section 9(3) of the Act has been obtained by misrepresentation as to an essential fact; or
(b) The holder of the certificate has, without reasonable cause, failed to comply with the conditions subject to which the certificate has been granted or has contravened any of the provisions of the Act or the Rules made there under, then, without prejudice to any other penalty to which the holder of the certificate may be liable under the Act, the Certification agency may, after giving the holder of certificate an opportunity of showing cause revoke the certificate , under the provisions of section 10 of the act.

Retention of Certification Records: The Certification Agency shall preserve in order all the documents including the guard samples pertaining to certification of each seed lot for two years from the date of grant/extension of the certificate and four years in respect of rejected seed crops or lots from the date of communication of rejection unless and otherwise required for longer period.

Topic - 2: Field Inspection (in details)

Field Inspection at Pre-flowering, Flowering and post-flowering stages: For each crop at least two field inspections should be conducted. Apart from the assigned field inspections, the Seed Certification Officer can visit the seed farm at any time during the crop growth stage.

Two field inspections in a same seed farm are not allowed in a same day.

Re-inspection should be done to confirm that the shortcomings found during the first inspection have been solved.

Inspection during pre- flowering stage:

- Verification of the location and area of the seed farm in the farm map as shown in the sowing report
- Verification of seed source
- Verification of the acreage of the seed farm
- Verification of the uniform planting ration and boarder rows
- Verification of the isolation distance as specified
- Also guide the growers in identifying and removal of off types
- Check for proper rouging

Inspection during flowering stage:

- Ensuring maintenance of isolation distance
- Confirming the removal of off-types and proper rouging

Inspection during post flowering stage:

- Conforming that the finding made in the previous inspection are taken care of
- Explaining to the grower about when and how to harvest the seed crop

Field inspection at Pre-harvest and harvest stages:

- Inspection during pre-harvest stage:
  - Conforming that the finding made in the previous inspection are taken care of
  - Explaining to the grower about when and how to harvest the seed crop

- Inspection during harvest stage:
  - Verification of the maturity of the crop
  - Guiding the grower in processing and handling techniques

- Other steps in field inspection:
  - Uninformed field inspection should be conducted during the flowering stage for all

the crops other than the self-pollinated crops.

- The complete details of the seed certification programme should be explained to the farmer if he / she is new to the seed certification programme.
- The grower/producer should accompany the Seed Certification Officer during the field inspection.
- The details of the field inspection report should be explained to the producer of the seeds.
- The inspector should inspect the entire stretch of the field without any bias.
- The details of remedial actions that have to be implemented and the time limit for the same should also be mentioned in the inspection report.
- In the inspection report, the seed certification officer will record the rough sketch of the seed farm with boundaries and directions

Rejection of Seed field: The fields which do not conform to the required standards for any of the following factors will be rejected.

- When the size of the seed farm exceeds the registered size
- When there is no cultivation of the crop in the registered seed farm
- Drying of the seed farm due to water scarcity
- Inability to carry out the minimum number of field inspections
- Lodging of the crop in one third of the seed farm seed crop affected by flood or very poor crop management
- Difference found in the seed farm when compared with the sowing report
- Not allowing the seed certification officer to take the count

Topic - 3: Sample Collection and Sending to State Seed Certification Agency

Seed sample should be sent to the seed testing laboratory for analysis through the Assistant Director of Seed Certification.

The fee of Rs…… (Rupees …….. only) for seed analysis should be paid during the registration of the seed farm.

To analyse the genetic purity of the seed sample, the producer should pay a fee of Rs. ……..(Rupees …….. only) to the Assistant Director of Agriculture.

Topic - 4: Tagging and Sealing (in detail)

Approved seed lots should be tagged with certification tag within two months from the date of the receipt of seed analysis report or within 30 days from the date of genetic purity test performed.

On receipt of the seed tags, it is verified by the Seed Certification Officer.

All the prescribed details are entered in the tag without any omission.

The green colour (10 – 15 cm size) producer tag should also be attached to the seed lot along with the certification tag.

Avoid stitching more than once on the tags. All the tagging operations should be done in the presence of the Seed Certification Officer.

If tagging has not been done within the specific time limit, confirmation samples can be taken with prior permission from the Assistant Director of Seed Certification.

In such cases the validity of the seed lot will be fixed from the initial date of seed analysis and tagged. The fee for the delayed tagging is *Rs. ……./- (Rupees ……only and seed analysis fee of Rs. ……../- (Rupees ……only) has to be paid in such cases*

Topic - 5: Filling up Forms

The following forms to be filled:

- F1: Growers agreement
- F2: Cash memo
- F3: Seed Directory
- F4: Calendar of operations
- F5: Advance payment
- F6: Seed Receipt
- F7: Daily seed report
- F8: Seed Sample coupon
- F9: Format of sending seed samples for analysis.

Application for seed production: Any person who wants to take up certified seed production should submit a sowing report in triplicate to the Assistant Director of Seed Certification to register the crop and season with a registration fee of Rs. ……..(Rupees……. only) and prescribed certification charges.

Along with this fee for seed certification the label of the seed source should be submitted

Separate sowing reports are required for different crop varieties, different classes, and different stages.

Separate sowing reports are required to be registered for the same crop variety if the seed production fields are separated by more than 50meters, sowing or planting dates differ by more

than 7 days and if the seed farm area exceeds 25 acres.

The sowing report should reach the concerned Assistant Director of Seed Certification within 35 days from the date of sowing or 15 days before flowering whichever is earlier.

In the case of transplanted crop the sowing report should be sent 15 days before flowering.

Registration of sowing report: The farmers, who are interested in producing Foundation/Certified seed, have to register with the State Seed Certification Agency. They have to fill in the 'Seed farm sowing report' in triplicate for which the proforma can be obtained from the office of Assistant Director of Agriculture (ADA).

After paying the appropriate fees fixed by the state government, the seed production field is registered by the Deputy Director of Agriculture (DDA) (Seed Certification) with the State Seed Certification Agency. After registration, a copy of the seed farm sowing report is given to the ADA (Seed Certification), another copy to the Seed Certification Officer (SCO) of the concerned block and the third copy to the seed producer/farmer.

Once a seed production field is registered, the SCO inspects it to verify if the prescribed standards of land requirement, field and seed for a particular crop are met.

The State Seed Certification Agency has the authority to refuse certification of any seed production field or any seed lot that does not conform to the minimum standards prescribed for that particular crop, either for field or for seed or for both.

However, a seed producer aggrieved by a decision of the State Seed Certification Agency can make an appeal on payment of fees to such authority as specified by the state government under section 11(1) of the Seed Act, 1966.

Normally, the special permission for re-inspection of the field can be sought from the ADA (Seed Certification) by paying the required fees (75% of the field inspection fees).

Topic - 6: Practical - Certification Procedure, Sampling, Tagging and Filling up Forms

- Taking help of Agriculture officers (certification), participants involve in field inspection process.
- Field inspection under guidance of senior inspector.
- Fill all the formats, under supervision of senior officer/instructor.
- Maintain records, formats.

Key messages:

- The purpose of seed certification is to maintain and make available to the public, through certification, high quality seeds and propagating materials of notified kind and varieties so grown and distributed as to ensure genetic identity and genetic purity.
- Field inspection meant to verify those factors which can cause irreversible damage to the genetic purity or seed health shall be conducted without prior notice to the seed producer.
- On receipt of Seed Analysis Report and the results of the grow out test wherever prescribed, and if seed lot has met prescribed standards, the Certification Agency shall ensure packing, tagging and sealing and issuance of certificate expeditiously.

Learning outcome:

- Participants would learn complete procedure of seed certification. Also learn method of sample collection, packing and tagging of seed bags.
- Participants would know the writing of forms that are mandatory for seed certification.

Assignment for the participants:

- Write steps that are involved in the seed certification.
- At what stage of crop you would inspect the fields to ensure standards.
- What is GoT, why it is done?

11/ PARTICIPANTS EVALUATION / TEST, AFTER BASIC LEVEL TRAINING

Participant's evaluation done in two parts; Part- A and Part- B.

Total marks: 100 (Part –A: 50 , Part-B: 50)

To qualify, participant has to secure 20 marks from each part, i.e. total 40 marks out of 100.

Part-A: Written Test

Participants attend written examination.

Facilitator provide question paper (descriptive type). 10 questions from 8 modules. Each question carries 5 marks. Total marks 50.

Time allocated for written test is 1.30 hour.

Part-B: Assignment work/Record Books

- Participants submit record books consisting content of all topics, practical, field visits which are maintained for all modules.
- Participants submit Assignment books, which are given at the end of the each module.
- Participants submit posters, flow charts which are generated in group discussions, interactive session.

While participators write examination, facilitator scrutiny record books, assignment books and poster/flow charts.

Marks allocated for record book, assignment book and posters/flow charts;
Record book: 20 marks

Assignment book: 20 marks

Posters/flowcharts :10 marks

Total: 50 marks.

12/ REFERENCES

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7) Landraces; FAO publication.
8) Principles and practices of Groundnut seed production in India. Information Bulletin No. 94, ICRISAT.
9) Seed Production and Training Manual. Published by FAO.
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11) Technical brochure on Groundnut crop, ANGRAU.
12) TNAU Agritech portal.

12/ NOTES

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