ANGRAU

Course No: DA-211

Seed Production, Testing & Certification

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Course Content

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Course Title: Seed Production, Testing & Certification

Course Credits: 2 (1+1)

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Introduction to seed – Importance – Differences between seed and grain used as seed - Characters of good quality seed - Different classes of seed

Seed: Seed may be defined as "Structurally a true seed is a fertilized matured ovule, consisting of an embryonic plant, a store of food and a protective seed coat, a store of food consists of cotyledons and endosperm".

It also refers to propagating materials of healthy seedlings, tuber, bulbs, rhizome, roots, cuttings, setts, slips, all types of grafts and vegetatively propagating materials used for production purpose.

As per Seed Act (1966) seed includes

1. Seed of food crops including edible oil seeds and seeds of fruits & vegetables.
2. Cotton seeds
3. Seeds of cattle fodder
4. Jute seeds
5. Seedlings, tubers, bulbs, rhizomes, roots, cuttings, all types of grafts and other vegetatively propagated material for food crops (or) cattle fodder.

Importance of seed

Seed is a vital input in crop production

1. It is the cheapest input in crop production and key to agriculture progress
2. Crop status largely depends on the seed quality
3, Response of other inputs in crop production depend on quality of the seeds
4. The farm income is increased due to quality seeds
5. It is estimated that good quality seeds of improved varieties can contribute about 20-25 % increase in yield

Grain vs Seed: Generally, after harvest of the rice crop, the farmers preserve a part of the harvested grain and use that as seed for the next season. For them, there is no difference between grain and seed. But in reality, we use grain as our food for which we never care for the quality or germination percentage of it. But seed is a living grain which can produce a living plant and is used for crop production. Therefore, lot of importance is given on its physical purity, germination capacity, seed moisture and genetic purity of seed; and it is emphasized that, "every seed is a grain, but every grain is not a seed".

Differences between scientifically produced seed and the grain used as seed

S. No	Scientifically produced seed	Grain used as seed
1.	It is the result of well planned seed	It is the part of commercial produce

	programme	saved for sowing or planting purposes
2.	It is the result of sound scientific knowledge, organized effort, investment on processing, storage and marketing facilities.	No such knowledge or effort is required
3.	The pedigree of the seed is ensured. It can be related to the initial breeders seed	Its varietal purity is unknown
4.	During production, effort is made to rogue out off-types, diseased plants, objectionable weeds and other crop plants at appropriate stages of crop growth which ensures satisfactory seed purity and health.	No such effort is made. Hence, the purity and health status may be inferior
5.	The seed is scientifically processed, treated and packed and labeled with proper lot identity.	The grain used as seed may be manually cleaned. In some cases, prior to sowing it may also be treated. This is not labeled
6.	The seed is tested for planting quality namely, germination, purity, admixture of weed seeds and other crop seeds, seed health and seed moisture content.	Routine seed testing is not done.
7.	The seed quality is usually supervised by an agency not related with production (seed certification agency)	There is no quality control.
8.	The seed has to essentially meet the "quality standards". The quality is therefore well known. The labels, certification tags on the seed containers serves as quality marks.	No such standards apply here. The quality is non-descript and not known.

Quality Seed: Quality seed is pure, clean and viable. Pure seed is without any mixture of other types or varieties whereas clean seed is free from weed seeds, litter, stones and diseased, damaged or deformed grains. Viable seed is a healthy seed with appropriate moisture content and high germination potential.

Characteristics of quality seed:

- Should have genetic purity

- Should have physical purity
- Should be free from other crop seeds
- Should be free from weed seeds
- Should be free from diseases
- Should have high germination and vigour
- Should have optimum moisture content
- Should have sound health
- Should have high size, weight & specific gravity
- High yield

Use of quality seed is the foundation of success in farming. By using quality seed, yield can be increased by 15-20%. In order to achieve higher seed yields, seed production should be undertaken in the most favourable areas where irrigation is guaranteed, and with adequate and balanced use of fertilizers together with integrated nutrient and pest management.

Different classes of seed and stages of seed multiplication:

Seed class	**Development process**
Nucleus seed	Nucleus seed is produced by a breeder or institution which possesses 100% genetic and physical purity. Generally, it is produced by a breeder / institution using the basic nucleus seed stock. Nucleus seed is used for production of breeder seed. No tag is issued.
Breeder seed (Tag colour: Golden Yellow)	Breeder seed is directly controlled by the originating plant breeder, sponsoring institution or firm which supplies the initial source. Breeder seed production means the increase of seed stock obtained from nucleus seed in an isolated field. Breeder seed is used for the production of foundation seed.
Foundation seed (Tag colour: White)	Foundation seed is obtained from breeder seed. It is genetically pure and is the source of certified seed. Foundation seed is produced under the control of the originator or sponsoring institution or licensee.
Certified seed (Tag colour: Azure Blue)	Certified seed is produced from foundation, certified, or other approved seed stocks. To be certified, seed must meet certain rigid requirements regarding purity and quality. Certified seed is available for general distribution to the farmers for commercial crop production. Certified seed cannot be used to produce certified seed again without the approval of the state certification agency.
Truthfully labelled seed	Truthfully labelled seed is produced by cultivators and private seed growers. Though this type of seed does not need certification, seed standards should

(TLS) (Tag colour: Opal green or Greenish buff)	be maintained. In the case of notified varieties, germination and purity is tested for truthful labelling.

GENERATION SYSTEM OF SEED MULTIPLICATION AND QUALITY CONTROL (NOTIFIED VARIETIES AND HYBRIDS)

Agency	Class of seed	Quality control system
Concerned breeder or Sponsoring institution or Breeder himself	**NUCLEUS SEED (no specified tag)**	Maintenance breeding
Concerned breeder or Sponsoring institution or Seed Technologist	**BREEDER SEED (Golden yellow tag)**	Breeder seed monitoring team- field inspection tocheck genetic purity -(Grow out test)
State Department of Agrl., National seeds Corporation Cooperative agencies, Central and State Seed Corporations, Private sectors	**FOUNDATION (White tag) SEED Stage I & II**	State Seed Certification Agency- Field inspection and testing to check minimum required physical purity and other quality stds
	CERTIFIED SEED (Azure blue tag)	
Truthful labeled seed (Opel green) FARMER		

Principles of seed production – Genetic and agronomic principles - Deterioration of crop varieties – Factors responsible for loss of genetic purity- Safeguards for maintenance of genetic purity – Types of Isolation distance – Roguing- Synchronization of flowering – Supplementary pollination

General Principles of Seed Production:

Production of genetically pure good quality seed is exact task of seed producer which require high technical skill and high financial investment. During seed production strict attention must be given to maintenance of genetic purity and other qualities of seed. Therefore seed production must be carried out under Standardized and well organized condition. It is achieved by using genetic and agronomic principles during seed production programme.

Genetic principles:

The main aim of seed production is to produce genetically pure and good quality seed. But why/how the genetic purity of a variety is lost or deteriorated during seed multiplication. The several factors that are responsible for loss of genetic purity during seed production as listed by kadam (1942) are:

1. Developmental Variation
2. Mechanical Mixtures
3. Mutations
4. Natural Crossing
5. Genetic drift
6. Minor Genetic Variation
7. Selective influence of Diseases
8. Techniques of the Breeder
9. Breakdown of male sterility
10. Improper / defective seed certification System

Agronomic Principles:

1. Selection of suitable agro-climatic condition
2. Selection of field and its preparation
3. Selection of variety
4. Isolation of seed crops
5. Seed treatment
6. Time and method of planting
7. Nutrition of the seed crop
8. Seed rate (lower seed rates for easy rouging)

9. Depth of sowing (small seeds sown upper , larger seeds at more depth)
10. Weed control (clean seedbed, clean weed, use herbicide if required)
11. Irrigation of seed crop (moderate irrigation, stop 2 weeks before)
12. Pollination control (rearing honey bees aid)
13. Field inspection (one at flowering and another on grower request)
14. Rouging (rogue at vegetative, flowering and maturity stage)
15. Plant protection (disease and insect control)
16. Harvesting of seed crop (fully matured seed)
17. Drying of seeds (dry seeds upto 9-12 %)
18. Storage of seed (less than 21^{o}C)
19. Seed packaging (seed packed in cotton, jute bag or plastic bag)

Factors responsible for loss of genetic purity:

1. **Developmental Variation:** When a seed crop is grown in difficult environmental conditions such as different soil and fertility conditions, under saline or alkaline conditions or under different photo-periods or different elevations or different stress conditions for several consecutive generations the developmental variations may arise as differential growth response.

To avoid or minimize such developmental variations the variety should always be grown in adaptable area or in the area for which it has been released. If due to some reasons (for lack of isolation or to avoid soil born diseases) it is grown in non-adaptable areas it should be restricted to one or two seasons and the basic seed i.e. nucleus and breeder seed should be multiplied in adaptable areas.

2. **Mechanical Mixtures:** This is the major source of contamination of the variety during seed production. Mechanical mixtures may take place right from sowing to harvesting and processing in different ways such as;

a. Contamination through field – self sown seed or volunteer plants
b. Seed drill – if same seed drill is used for sowing 2 or 3 varieties
c. Carrying 2 different varieties adjacent to each other.
d. Growing 2 different varieties adjacent to each other.
e. Threshing floor
f. Combine or threshers
g. Bags or seed bins
h. During seed processing

To avoid this sort of mechanical contamination it would be necessary to rogue the seed fields at different stages of crop growth and to take utmost during seed production, harvesting, threshing, processing etc.

3. **Mutations:** It is not of much importance as the occurrence of spontaneous mutations is very low i.e. 10-7. If any visible mutations are observed they should be removed by rouging. In case of vegetatively propagated crops periodic increase of true to type stock would eliminate the mutants.

4. **Natural Crossing**: It is an important source of contamination in sexually propagated crops due to introgression of genes from unrelated stocks/genotypes. The extent of contamination depends upon the amount of natural cross-fertilization, which is due to natural crossing with undesirable types, offtypes, and diseased plants.

On the other hand natural crossing is main source of contamination in cross-fertilized or often cross-fertilized crops. The extent of genetic contamination in seed fields is due to natural crossing depends on breeding system of the species, isolation distance, varietal mass and pollinating agent.

To overcome the problem of natural crossing isolation distance has to be maintained. Increase in isolation distance decreases the extent of contamination. The extent of contamination depends on the direction of the wind flow, number of insects presents and their activity.

5. **Genetic drift:** When seed is multiplied in large areas only small quantities of seed is taken and preserved for the next years sowing. Because of such sub-sampling all the genotypes will not be represented in the next generation and leads to change in genetic composition. This is called as genetic drift.

6. **Minor Genetic variation:** It is not of much importance, however some minor genetic changes may occur during production cycles due to difference in environment. Due to these changes the yields may be affected.

To avoid such minor genetic variations periodic testing of the varieties must be done from breeder's seed and nucleus seed in self-pollinated crops Minor genetic variation is a common feature in often cross-pollinated species; therefore care should be taken during maintenance of nucleus and breeder seed.

7. **Selective influence of Diseases:** Proper plant protection measures much be taken against major pests and diseases otherwise the plant as well as the seeds get infected.

a. In case of foliar diseases the size of the seed gets affected due to poor supply of carbohydrates from infected photosynthetic tissue.
b. In case of seed and soil borne diseases like downy mildew and ergot of Jowar, smut of bajra and bunt of wheat, it is dangerous to use seeds for commercial purpose once the crop gets infected.
c. New crop varieties may often become susceptible to new races of diseases are out of seed production programms. Eg. Surekha and Phalguna became susceptible to gall midge biotype 3.

8. **Techniques of the Breeder :** Instability may occur in a variety due to genetic irregulaeities if it is not properly assessed at the time of release. Premature release of a variety, which has been breed for particular disease, leads to the production of resistant and susceptible plants which may be an important cause of deterioration.

When sonalika and kalyansona wheat varieties were released in India for commercial cultivation the genetic variability in both the varieties was still in flowing stage and several secondary selections were made by the breeders.

9. **Breakdown of male sterility:** Generally in hybrid seed production if there is any breakdown of male sterility in may lead to a mixture of F1 hybrids and selfers.

10. **Improper Seed Certification :** It is not a factor that deteriorates the crops varieties, but is there is any lacuna in any of the above factors and if it has not been checked it may lead to deterioration of crop varieties.

Maintenance of Genetic Purity during seed Production

Horne (1953) had suggested the following methods for maintenance of genetic purity:

1. Use of approved seed in seed multiplication
2. Inspection of seed fields prior to planting
3. Field inspection and approval of the Crop at critical stages for verification of genetic purity, detection of mixtures, weeds and seed borne diseases.
4. Sampling and sealing of cleaned lots
5. Growing of samples with authentic stocks or Grow-out test

Isolation : Isolation is required to avoid natural crossing with other undesirable types, off types in the fields and mechanical mixtures at the time of sowing, threshing, processing and contamination due to seed borne diseases from nearby fields. Protection from these sources of contamination is necessary for maintaining genetic purity and good quality of seed.

There are several techniques for isolating varieties.

1. Spatial isolation : The simplest technique is to cultivate only one variety of each species in one plot. ...

2, Time isolation : The periods of culture of two varieties of the same vegetable can be staggered over time. ...

3. Barrier isolation: A barrier crop which is of 6-8 feet height should be grown around the seed plot for to 10 meters. The commonly used barrier crops are daincha, sugarcane, sorghum etc,

Rouging of Seed Fields: The existence of off type plants is another source of genetic contamination. Off type plants differing in their characteristics from that of the seed crop are called as off types. Removal of off types is referred to as roughing. The main sources of off types are

a. Segregation of plants for certain characters or mutations

b. Volunteer plants from previous crops or

c. Accidentally planted seeds of other variety

d. Diseased plants

Off type plants should be rouged out from the seed plots before they shed pollen and pollination occurs. To accomplish this regular supervision of trained personnel is required.

Synchronization of flowering:

The success in hybrid seed production depends on synchronization of flowering between male and female parent. For maintenance of A-line synchronization of flowering will not be a problem as both A and B-lines are iso-genic and come to flowering at the same time, while in hybrid seed production synchronization will be a problem as A-line and R-line have different genetic constitution. Generally the A-line is sown once while the B-line or R-line is sown three times at an interval of five days. It can be achieved by:

1. Staggered sowing

2. Nutrient management

3. Irrigation **management**

Supplementary pollination :

Rubbing the heads of two neighbouring plants with each other for increasing seed set. It is done by hand pollination and keeping of bee hives in sunflower , rope pulling, flag leaf clipping and GA application in rice.

Paddy Varietal and hybrid Seed Production

Varities: Bharani, Somasila , Swetha , Cottondora sannalu (MTU 1010), Nellore Mahsuri (NLR 34449),Vijetha (MTU 1001), Nandyal sannalu (NDLR 8) Nellore Sona (NLR 3041), NDLR 7,JGL 384,1798,3844,3855

Hybrids: APHR – 1, APHR – 2 , KRH1

Seed Production of Varieties:

Land requirement: The same crop should not be grown on the same piece of land for the last one season, unless it is the same variety and certified by seed certification agency for its purity. The land requirement should be followed for nursery and the main field.

Isolation Requirement: Paddy is highly self-pollinated crop, however, some cross-pollination does occur. The extent of natural cross-pollination varies from 0-6.8%. For pure seed production the seed fields must be isolated by at least 3m for both foundation and certified seed production from other varieties and same varieties not confirming to varietal purity.

Source of seed: Obtain appropriate class of the seed from the source approved by seed certification agency.

Brief cultural practices: Paddy can be cultivated as direct sown, puddle seeding or by transplanting. For seed production it is desirable to grow paddy under transplanting system so as to avoid the weed problem. The seed rate required is 30-40 kg/ha. The spacing adopted is 10x15 cm for early duration varieties and 15x15 and 20x15 for medium and late duration varieties. Transplanting should be done when the seedlings are 3-4 weeks old. Follow all the recommended package of practices and take necessary prophylactic measures so as to raise a good crop.

Rouging: Rouging of off types should be done once prior to flowering then at flowering and maturity. Major rouging should be done before flowering. The off types should be identified based on morphological characters such as plant type, plant height, days to flowering, leaf color, flag leaf shape, flag leaf angle, shape of the panicle, color of glumes, color of apiculus etc. Rogue out the wild rice plants, plants infested by stem borer and diseased plants such as false smut, paddy bunt etc.

Number of field inspection: the numbers of field inspections required are two and they should be done between flowering and harvesting. During field inspection verification should be done for isolation requirement, volunteer plants, off types and diseased plants. The field standards required are as follows;

	Foundation class	certified class

Offtypes	0.05 %	0.20 %
Objectionable weed plants	0.01 %	0.02 %
Diseases plants (Paddy bunt – *Neovossia horrida*)	0.10 %	0.50 %

Harvesting : The crop should be harvested when the grains are hard and yellow with a moisture percentage of 23-24 %. For combine harvesting the moisture percentage should be in the range of 16-18%. The crop is cut at the base with the sickle and the plants are left in the field for 2-3 days. Then they are threshed on clean threshing floor or tarpaulin. After winnowing and cleaning the seed should be dried to safe moisture limits of 13% before storage.

Seed Yield: The seed yields are in the range of 5.0 to 6.0 t/ha depending up on the variety and the management practices adopted.

Hybrid Seed Production

Prof. Yuan Long Ping is the father of hybrid rice. The successful development and use of hybrid rice technology in China during 1970's led the way for development and release of rice hybrids in India. At present more than 10 rice hybrids have been developed in the country from different states. However the first rice hybrids APHR-1 & 2 have been developed in the country by ANGRAU.

Hybrid rice can be produced by three different methods :

1. **Three line system**: In this method hybrid rice is produced by utilizing cytoplasmic genetic male sterile system. In this method there are three different lines i.e. A-line or male sterile lines, B-line or maintainer line and restorer line or R-line. For maintaining A-line it has to be crossed with B-line and for producing hybrid seed A-line has to be crossed with R-line.
2. **Two line system**: This method of hybrid rice seed production involves the use of photoperiod sensitive genetic male sterile system or temperature sensitive genetic male sterile system. In this method any normal line can be used as restorer line.
3. **By Using chemical emasculants**: The chemicals which kills or sterilise the male gamete with little no effect on the normal functioning of the female gamete can be used to emasculate female parental line in hybrid seed production. In China chemical emasculants are commonly used in hybrid seed of rice. In India they are not used commercially for hybrid seed production, but they are used in academic studies. The chemicals which can be used as potent gametocides are etheral, maleic hydrazide, etc.

Hybrid seed production (using three line system)

The hybrid rice seed is produced by utilizing Cytoplasmic Genetic Male Sterility system. The source of cytoplasm used is **wild abortive.** One of the drawbacks of wild abortive cytoplasm is incomplete panicle exertion from the flag leaves.

Hybrid seed production involves two steps:

1. Maintenance of parental lines (A-line, B-line and R-line)
2. Commercial hybrid seed production (AxR).

Maintenance of parental lines is generally referred as foundation seed production and hybrid seed production as certified seed class. The A-line can be maintained by crossing with B-line in an isolated plot, while in hybrid seed production A-line is crosses with R-line or fertility restorer line. The B-line and the R-line can be maintained just like normal varieties by following the required isolation and field standards. As the maintenance of B-line and R-line is just like normal varieties, it is not discussed in detail.

Maintenance of A-line or Hybrid seed Production:

Land requirement: The same crop should not be grown in the same piece of land in the previous one season. The land requirement should be followed for nursery as well for the main field.

Isolation requirement: The hybrid paddy fields should be isolated from the other paddy fields, including commercial hybrids and same hybrid not confirming to varietal purity requirements for certification by atleast 200 meters for seed classes A, B & R-line production and by 100 meters for hybrid seed production (AxR). For hybrid seed production (A x R), if space isolation is a problem we can go for time isolation or barrier isolation. For time isolation the difference between the flowering of seed plot and the contaminating plot should be atleast 4 weeks. When both space and time isolation is not possible we can go for barrier isolation. In barrier isolation a barrier crop which is of 6-8 feet height should be grown around the seed plot for 10 meters. The commonly used barrier crops are daincha, sugarcane, sorghum etc.

Brief cultural practices: The success in hybrid seed production depends on synchronization of flowering between male and female parent. For maintenance of A-line synchronization of flowering will not be a problem as both A and B-lines are iso-genic and come to flowering at the same time, while in hybrid seed production synchronization will be a problem as A-line and R-line have different genetic constitution. Generally the A-line is sown once while the B-line or R-line is sown three times at an interval of five days.

When both A and R-line are of same duration sowing of A-line should be adjusted with second sowing of R-line. If A and R lines are of different growth duration, the difference in duration should be adjusted with second sowing of R-line.

(For example if A-line comes to flowering in 65 days and R-line in 72 days then the difference is 7 days. After second sowing of R-line adjust the sowing of A-line with a gap of 7 days i.e. if first sowing of R-line is done on 1st June, Second sowing on 5th June and third sowing on 10th June, then sowing of A-line should be done on 12th June)

Planting ratio: The row ratio of female and male parental varies from region to region depending on weather conditions and potentiality of parental lines. The commonly adopted planting ratios of male and female are 2:8, 2:6 or 3: 8. Factors influencing the row ratio are;

There can be more than 8 A lines in relation to 2 R-lines,

1. If R-lines are taller than seed parent
2. Have good growth and vigour
3. Have large panicles and
4. Shed a large amount of residual pollen.

The Character of A-line should be

1. It should be shorter than pollen parent
2. Has long duration of floret opening and stigma receptivity
3. Should have wide angle of floret opening and
4. Should have a higher percentage of stigma exertion

Transplanting should be done when the seedlings are 25-28 days old. Before transplanting mix all the B or R-lines sown on three different dates. All the missing hills should be replaced within seven days. The spacing adopted for A-line is 15x15 cm and for B or R-line is 20x15 or 30x15 cm. All the recommended package of practices should be followed to raise a good crop.

Number of Field Inspections: A minimum of four field inspections should be conducted. The first field inspection should be conducted before flowering stage, second and third during flowering stag and fourth before harvesting. During the first field inspection verification should be done for volunteer plants, isolation requirement, errors in planting and the actual acreage sown. During the second and third field inspection verification should be done for isolation requirement, off types, diseased plants, pollen shedders and objectionable weed plants. Actual counts should be taken during second or third field inspection. Fourth or final field inspection should be done to verify for all the above factors and the off types can be identified based on panicle or seed characters.

	Foundation class	certified class
Offtypes	0.05 %	0.20 %
Pollen shedders	0.05 %	0.10 %
Objectionable weed plants	0.01 %	0.02 %
Diseases plants (Paddy bunt – *Neovossia horrida*)	0.10 %	0.50 %

Rouging: Roughing should be done in both male and female parental lines. Remove all the off type and volunteer plants from both male and female parental line. During flowering period rouging should be done daily to remove the pollen shedders from female parental line. The male sterile plants have shrivelled anthers and they do not shed pollen while the pollen shedders have yellow colored plumpy anthers, which shed large amount of residual pollen. The off type plants should be identified based on morphological characters like plant height, plant type, flag leaf shape, flag leaf angle and other characters. Remove all the plants, which are infected with stem borer, and diseased plants like paddy bunt.

Methods of increasing out-crossing rate: Paddy is highly self-pollinated crop and the extent of natural cross—pollination is very less. Hence to increase the out-crossing rate certain methods should be followed like Flag leaf clipping, spraying of GA_3 and rope pulling.

a. **Flag leaf clipping**: Flag leaves are taller than panicles and are the main obstacles for pollen dispersal and cross-pollination. Hence the flag leaves should be removed so as to improve cross-pollination and seed set. The flag leaves should be clipped one or two days before heading so that it enhances uniform pollen movement and wide dispersal of pollen grains to give higher seed set. First cut the flag leaf of the main tiller at the flag leaf joint and use it as a guide in clipping the rest of the plants. The flag leaves should be cut to half or 2/3 of the blade from the tip. Do not clip the flag leaves in plants, which are infected with bacterial leaf blight or sheath blight. The cut leaves can infect other plants or contaminating tools used for flag leaf clipping can spread infection. The infected plants may be clipped after completing the clipping of healthy plants.
b. **GA_3 application**: Application of GA3 increases the internode length and the panicles will be fully exerted from the flag leaves. It increases the duration of floret opening and stigma receptivity. Helps in adjusting the plant height of both the parents. It also

increases the growth rate of secondary and tertiary tillers so that they bear productive panicles.

Spraying of GA3 should be done twice first when 15-20% of the plants started heading with 40% of the chemical and second at 50% flowering with 60% of the chemical. The dosage required is 50 grams with knapsack sprayer and 25 grams with ultra low volume sprayer. For first spray use 20 g GA3 in 500 litres of water and for second spray use 30 g in 500 litres of water.

c. **Rope Pulling**: Rope pulling should be done during the peak flowering time, which helps in shaking of the male plants and dispersal of pollen grains. Rope pulling should be done daily during peak flowering stage at 8.30 AM and it should be repeated 3-4 times a day at an interval of half an hour.

Harvesting and threshing: Harvest the male row first and remove them from the field so a to avoid mechanical mixtures. Then harvest the female rows. Precautions should be taken while harvesting not mix male and female plants. Threshing should be done on a clean threshing floor and the seed should be winnowed and dried to safe moisture limits before storage.

Seed Yield: Depending on the management practices adopted and the potentiality of the parental line the seed yield may be in the range of 0.5 to 1.5 t/ha.

Maize Varietal and hybrid seed production

Varieties: Madhuri, Priya, Win Orange(sweet corn), Amber popcorn, Pearl popcorn, VL popcorn, VL 42, Him 123, Him 128, Him 129, Madhuri, Prakash, VL78

Hybrids: DHM 111,113,117 Kohinoor, Prabhal, Bisco 855, Trishulata **,** DHM 115

Seed production of Open Pollinated varieties (Synthetic's and Composites):

Land requirement: No specific land requirements are there for maize seed production, however the field should be free from volunteer plants and have good drainage facility.

Isolation distance: Maize is a highly cross pollinated crop, therefore for pure seed production the fields of maize should be isolated from other varieties of maize and same varieties not confirming to varietal purity by 400 m and 200 m foundation and certified seed production respectively.

Brief Cultural Practices: obtain appropriate class of the seed from the source approved by seed certification agency. Seed rate required is 15 kg/ha and the spacing adopted is 60-70 cm between the rows and 20 cm between the plants in a row. The recommended package of practices should be adopted for raising a good crop.

No of Field inspections: A minimum of two field inspections shall be made in such a way that one is conducted before flowering and the other during flowering stage so as to check for isolation distance, off types, designated diseases and other relevant factors.

	Foundation class	Certified class
Offtype plants that have shed or are Shedding pollen at any one inspection during Flowering when 5% or more plants in the seed Field are with receptive silks	1.0	1.0

Rouging: Not much rouging is required in open pollinated varieties as they have broad genetic base and are phenotypically uniform for most of the characters. However rouging for offtypes such as very tall or dwarf should be completed before pollen shedding. Remove malformed and diseased plants affected by stalk rot from time to time. At harvest sorting should be done to

remove off-colored and off-textured ears.

Harvesting of maize ears: Maize ears can be harvested at high moisture content (30-35 %) when artificial heated air drying facilities are available, otherwise harvest the crop when the seed moisture content is 15-16 %. After harvest, sort out all off-type maize ears, particularly those showing different colour and texture and the diseased ears before placing them in bins for drying.

Shelling: After drying, the ears are once again examined and any offtypes or diseased ears are removed before shelling. The certification standards require bin inspection of maize ears before shelling. Therefore shelling should be undertaken after taking the approval from seed certification agency.

Seed Yield: Depending upon the management practices adopted and the potentiality of the variety the yield may be in the range of 25-30 q/ha.

1. Hybrid seed production

In maize we have single cross, double cross and three-way cross hybrids. Maintenance of parental lines/inbred lines and single cross seed production is considered as foundation seed class and commercial hybrid seed production or double cross seed production or three-way cross seed production as certified seed production.

Maintenance of Parental lines/ Inbred lines:

Land requirement: No specific land requirements are there for maize seed production, however the field should be free from volunteer plants and have good drainage facility

Isolation requirement:

400 m	From any maize varieties and hybrids with same kernel color and texture of seed parent
600 m	From maize varieties and hybrids with different kernel color or texture of that of seed parent

In case where space isolation is a problem we can go for time isolation. Time isolation is provided 5% or more plants in the seed field should not be with receptive silks when more than 0.1% of plants in the contaminating field are shedding pollen.

Brief Cultural practices: Obtain appropriate class of the seed from the source approved by seed certification agency. The seed rate required is 15 kgs /ha and the recommended cultural practices should be followed as that for raising a commercial crop.

Number of field inspections: A minimum of four field inspections shall be made in such a way that first field inspection is done before flowering stage an the remaining three during flowering stage to verify isolation distance, offtypes and other relevant factors.

Offtypes plants that have shed or are shedding pollen when 5.0 % or more of the plants in the seed field have receptive silks.	0.20 %

Rouging: Inbred lines are true breeding strains and rigorous rouging should be done to remove off types before they shed pollen. Remove tall and vigorous growing plants from the knee-high stage onwards. At preflowering stage, rogue out offtypes based on morphological characters such as leaf shape, tassel color and silk color. Final rouging should be done to remove disease-affected plants.

Harvesting & Shelling: Similar to open pollinated varieties.

Seed Yield: depending upon the yield potentiality and the management practices adopted the yield may be around 5-6 Q/ha.

Single cross seed production:

The single cross seed is produced by crossing two specific inbred lines by following a planting ratio of 2 lines of male parent and 4 lines of female parent in alternate rows with 4-6 male parents around the seed production plot. The female parent has to be detasselled before shedding pollen to ensure cross-pollination with male line. The seed harvested from female rows is the single cross hybrid seed.

Land requirement and isolation requirement: same as maintenance of inbred lines. Depending on the differences in duration adjust the sowing dates of male and female inbred lines. Necessary precaution may be taken to avoid mixing of male and female lines. The male lines have to marked on both the ends by a label or tag or by sowing the seed of other crops like sunhemp or daincha.

Cultural Practices: The seed rate required is 10 kg /ha for female parent and 5 kg/ha for male parent. After adjusting the sowing dates the recommended package of practices should be followed.

Number of field inspections: A minimum of four field inspections shall be made in such a way that first field inspection is done before flowering stage and the remaining three during flowering stage to verify isolation distance, offtypes and other relevant factors.

	Foundation class
Offtypes plants that have shed or are shedding pollen when 5.0 % or more of the plants in the seed field have receptive silks.	0.20 %
Shedding tassels in female parent any inspection During flowering when 5.0% or more of the plants In the seed parent have receptive silks.	0.50 %
Total pollen shedding tassels including tassels that Have shed pollen from all three inspections conduced during flowering on different dates.	1.00 %

Detasselling: When Cms line is not used the seed parent has to be detasselled so that it will be fertilized by the pollen from the male parent. Removal of the tassel from the female parent before shedding pollen is called as detasselling. For detasselling hold the stalk by left hand and take a firm grip of the entire tassel in the right hand and pull it gently to detassel.

Roguing: Rouging should be done both in male and female parental lines. Remove the offtypes from both male and female parental lines before they start shedding pollen.

Shedding tassels should not be there in female rows. Offtypes can be identified based on morphological characters like plant height, leaf shape, tassel and silk color etc. remove all the plants affected with stalk rot and other diseases.

Harvesting and shelling: Harvest the male rows first and remove them from the field to avoid mechanical mixtures. Then harvest the female rows. After harvesting, sorting should be done to remove off-colored, off textured and diseased ear heads. Before shelling, approval should be taken from the seed certification agency.

Seed Yield: average seed yield of a single cross varies from 4-6 Q/ha.

2. Double cross hybrid seed production / Commercial hybrid seed production

The double cross hybrid seed is produced by using high yielding single cross as the female parent. The planting ratio adopted is 2 lines of male parent and 6 lines of female parent. The female single cross has to be detasselled before pollen shedding to ensure cross-pollination with male parent (single cross).

Land requirement: Same as open pollinated variety

Isolation requirement:

200 m	From any maize with same kernel color and texture of seed parent
300 m	From maize with different kernel color or texture of that of seed parent
5 m	From other hybrid seed production plot having same male parent.

Differential blooming dates are permitted for modifying isolation distance provided 5% or more plants of the seed parent should not have receptive silks when more than 0.5% pf plants in the contaminating field shed pollen. Or

Distance less than 200 m may be modified by planting additional border rows of male parent if the kernel color and texture of the contaminating maize are same as that of seed parent.

For area upto 4 hectares and with decrease in isolation distance by 12.5 m an additional border row of male parent should be planted.

Isolation distance	No of male rows
200.0 m	1
187.5	2
175.0	3
167.5	4
150.0	5
..	..
50.0	13

1. Border rows must be planted in continuation to the seed field at the same time and with same seed rate and spacing.
2. Seed fields having diagonal exposure to the contaminating field should be planted with border rows in both the directions of exposure.
3. Natural barriers like thick trees and buildings cannot be substituted with the border rows.
4. When two seed fields with different pollinators are within the isolation distance both are to be provided with border rows.
5. Modification of isolation distance with boarder rows is not permitted if the contaminating field parent is of different kernel color or texture if it is popcorn or sweet corn

Sorghum Varietal and hybrid Seed Production and Bajra Varietal and hybrid Seed Production

Varieties: PSV-1, Palem-2, CSV-10, CSV-11, CSV-13, CSV-15 and Srisaila
Hybrids: CSH-10, CSH-11, CSH-14, CSH-16, CSH- 18, CSH-21

Seed Production of open pollinated varieties

Land requirement: Land should be free from volunteer plants, Johnson grass, Sudan grass and other forage types. The same crop should not be grown on the same piece of land in the previous one season unless it is the same variety and certified by certification agency for its purity.

Isolation requirement: sorghum is an often cross pollinated crop. In some of the varieties with loose or lax panicle types the extent of natural cross-pollination may go up to 50 %. Hence the seed fields must be isolated from other varieties of grain and dual-purpose sorghum and same variety not confirming to varietal purity by 200m for foundation seed class and 100 m for certified seed class. An isolation of 400 m is required from Johnson grass (*Sorghum halepense*) and other forage sorghums with high tillering and grassy panicles. Differential blooming for modifying isolation distance are not permitted (i.e. time isolation is not permitted)

Brief Cultural Practices: Obtain appropriate class of the seed from the source approved by seed certification agency. The seed rate required is 12-15 kg/ha and the spacing adopted is 45cm between the rows and 15cm between the plants. Other cultural practices are similar to raising a commercial crop. Necessary prophylactic measures should be taken so as to raise a good crop.

Rouging: remove all the offtypes and volunteer plants before they start shedding pollen. The rouged plants must be cut from the bottom or uprooted to prevent regrowth. Offtypes can be identified based on morphological characters like plant height, leaf shape, leaf colour, stem pigmentation, days to flowering etc. Rogue out other related plants like Johnson grass, Sudan grass, forage plants and plants affected by kernel smut and head smut from time to time.

Number of field Inspections: A minimum of three field inspection should be done. First inspection should be done during vegetative stage to determine isolation, volunteer plants and designated diseases etc. Second inspection shall be made during flowering to check isolation, offtypes and other relevant factors. Third inspection shall be made at maturity prior to harvest to verify designated diseases true nature of plants, head and seed.

	Foundation class	certified class
Offtypes	0.05 %	0.10 %
Diseases plants	0.05 %	0.10 %

(Kernel smut or grain smut and head smut)

Harvesting and threshing: The seed crop must be harvested when it is fully ripe. The harvested heads should be sorted out to remove the diseased or otherwise undesirable. The heads should be dried on the threshing floor or tarpaulin for a couple of days before threshing. Threshing can be done by threshers or manually. The seed should be thoroughly cleaned and dried to 10 % moisture before storage.

Seed Yield: Depending up on the potentiality of the variety and the management practices adopted, seed yield may be in the range of 35-40 q/ha.

Hybrid Seed Production

In sorghum hybrid seed is produced by utilizing Cytoplasmic Genetic Male Sterility System. The source of male sterile cytoplasm used is **Combined kafir**.

Hybrid seed production involves two steps;

1. Maintenance of parental Lines (A-line, B-line and R-line)
2. Commercial hybrid seed production (AxR)

Maintenance of parental lines is generally referred as foundation seed production and hybrid seed production as certified seed class. The A-line can be maintained by crossing with B-line in an isolated plot, while in hybrid seed production A-line is crosses with R-line or fertility restorer line. The B-line and the R-line can be maintained just like normal varieties by following the required isolation and field standards.

Seed Production of B-line and R-line: The seed is produced in an isolated plot and it is similar to seed production of open pollinated varieties. However the isolation distance required and the fields standards are similar to that of maintenance of A-line.

Maintenance of A-line or Hybrid seed Production (AxR):

Land requirement: Land should be free from volunteer plants, Johnson grass, Sudan grass and other forage types. The same crop should not be grown on the same piece of land in the previous one season unless it is the same variety and certified by certification agency for its purity.

Isolation requirement: The isolation distance for maintenance of A-line (AxB) is 300 m from fields of other varieties of grain and dual purpose sorghum and same variety not confirming to varietal purity and 400 m from Johnson grass, Sudan grass and other forage types. For commercial hybrid seed production (AxR) the isolation distance required is 200 m from fields of other varieties of grain and dual purpose sorghum, and same hybrid not confirming to varietal purity requirements of certification, 5 m from other hybrid seed production plot having the same male parent and 400 m from Johnson grass, Sudan grass and other forage types. Differential blooming dates for modification of isolation distance are not permitted.

Brief cultural practices:

The seed rate required is 8.0 kgs/ha of A-line and 4.0 kg/ha of B or R-line. Other cultural practices similar to commercial crop production should be adopted for raising a good crop.

Planting ratio: The planting ratio of female to male plants is 4:2 with two rows of male parent all around the field.

Synchronization of flowering: The success in hybrid seed production depends on synchronization of flowering between male and female parent. For maintenance of A-line synchronization of flowering will not be a problem as both A and B-lines are isogenic lines and come to flowering at the same time, while in hybrid seed production synchronization will be a problem as A-line and R-line have different genetic constitution. If there is any difference between the male and female parent for days to flowering the sowing dates should be adjusted for proper synchronization of flowering

Cultural manipulation for nicking: Proper synchronization of flowering between A-line and R-line is a common problem. In-spite of taking the precautions like adjusting the sowing dates some times synchronization may be a problem. If the difference between the male and female parent is less than a week it can be manipulated by cultural practices. The parent which is lagging should be sprayed with 1 per cent urea solution 2-3 times at an interval of 2-3 days or additional irrigation should be given to the Lagging parent. Blowing air by operating empty duster with the mouth directed horizontally to the male ears, will help to disseminate pollen.

Rouging: Before flowering remove all off types from both seed parent and pollen rows based on morphological characters.

Some of the precautions to be taken while rouging are:

1. Start rouging before off types, volunteers and pollen shedders in female rows start shedding Pollen.
2. Out crosses can be easily identified because of their greater height and more vigorous growth
   and should be removed
3. At flowering rouging should be done every day to remove pollen shedders from female parent rows. The sterile types have only stigma or a pale aborted anthers without pollen, while the fertile ones have yellow colored plumpy anthers which shed large amount of residual pollen.
4. Remove all plants out of their place (i.e. plants in between the lines), and male plants in female rows and vice versa. Special attention should be given at the ends where there is a chance of male seed falling in female rows.
5. Remove other sorghum related plants like Johnson grass, Sudan grass and other forage types from the seed plot and from within the isolation distance.

6. Remove the plants affected by kernel bunt and head smut.
7. Pre-harvest rouging may be done based on grain and ear characters.

Number of Field Inspections: A minimum of four field inspections should be conducted. The first field inspection should be conducted before flowering stage, second and third during flowering stag and fourth before harvesting. During the first field inspection verification should be done for volunteer plants, isolation requirement, errors in planting and the actual acreage sown. During the second and third field inspection verification should be done for isolation requirement, offtypes, diseased plants, pollen shedders and objectionable weed plants. Actual counts should be taken during second or third field inspection. Fourth or final field inspection should be done to verify for all the above factors and the off types can be identified based on panicle or seed characters.

	Foundation class	certified class
Offtypes	0.05 %	0.10 %
Pollen shedders	0.05 %	0.10 %
Diseases plants	0.05 %	0.10 %
(kernel smut or grain smut and head smut)		

Harvesting and threshing: Harvest the male rows first and keep their heads separate to avoid mixture male and female seed. Then harvest the female parental line and thresh it separately. Precautions may to taken while harvesting and threshing to avoid mechanical mixtures.

Seed Yield: the seed yield may be in the range of 4-6 q/ha depending on the parent line and the cultural practices adopted.

Seed Production of Bajra

Varieties: ICMV 221, ICTP 8203, Raj 171

Hybrids: HHB 67, ICMH 356, RHB 121 and PHB - 3

Seed Production of Varieties, Synthetics & Composites

Land requirement: Land to be used for seed production of bajra open pollinated varieties should be free from volunteer plants

Isolation requirement: Bajra is predominantly a cross pollinated crop with 80% cross pollination due to protogynous condition. Therefore for pure seed production the seed field should be isolated by 400 and 200 m for foundation and certified seed respectively from other varieties of bajra and from same variety not confirming to varietal purity requirements.

Brief Cultural Practices: Obtain appropriate class of seed from the source approved by seed certification agency. Bajra can be directly sown in the field or a nursery can be raised and transplanted after 20-25 days. The seed rate required is 3-4 kg /ha. Transplanting is generally useful under following conditions.

1. If there is shortage of seed and when assured yield is required.
2. When the main field is occupied by previous crop, we can save up to 1 month time.

Number of field Inspections: A minimum of three inspections shall be made as follows;

1. The first inspection shall be made before flowering preferably within 30 days after planting to determine isolation, volunteer plants, offtypes, downy mildew incidence and other relevant factors
2. The second inspection shall be made during 50 % flowering to check isolation, offtypes, downy mildew/green ear (*Sclerospora graminicola*) and other relevant factors.
3. The third inspection shall be made at maturity and prior to harvesting and in order to determine the incidence of downy mildew/green ear disease, ergot, grain smut and to verify the true nature of plant and other relevant factors.

Factor	Foundation class	Certified class
Offtypes at any one inspection at & after flowering	0.05 %	0.10%
Plants affected by downy mildew/green ear disease at any one inspection	0.05 %	0.10 %
**Ergotted earheads at final inspection.	0.02 %	0.04 %
***Earheads infected by grain smut at final inspection stage	0.05 %	0.10 %

** Seed from such fields that have been reported to contain the ergot infection even within the prescribed limits at final stage shall be subjected to floatation treatment with brine to become eligible for certification

*** Seed fields with incidence of grain smut more than the maximum permissible level can however be certified if such seed is treated with appropriate organo-mercurial fungicide not earlier than a month prior to sowing.

Roughing: Rogue out offtypes and volunteer plants before they begin to shed pollen. The rogues must be cut from the base or uprooted. The offtypes can be identified based on morphological characters like leaf shape and color, hairiness, anthocyanin pigmentation on the stem and leaves, plant height etc. at harvest offtypes can be identified by panicle characters. Remove the plants affected by green ear, ergot and grain smut disease from time to time.

Harvesting: Bajra should be harvested when the grains are fully mature. After harvesting remove the ear heads infected with ergot and green ear disease before drying and threshing. Care should be taken during harvesting, threshing and drying to avoid mechanical mixtures.

Seed yield: Depending upon the variety and the management practices adopted the seed yield may vary from 20–25 Q/ha.

Hybrid seed Production

The hybrid seed in bajra is produced by utilizing Cytoplasmic Genetic Male Sterile system. The cytoplasmic male sterile source used in bajra is **Tift 23A/Tifton** identified by **G.W.Burton**. The hybrid seed production in bajra can be discussed under to heads

1. Maintenance of parental lines (A-line, B-Line and R-line)
2. Commercial hybrid seed Production (Crossing A X R)

Maintenance of B-line and R-line: The seed is produced in an isolated plot and it is similar to seed production of open pollinated varieties. However the isolation distance required and the field standards are similar to that of maintenance of A-line.

Maintenance of A-line and Commercial Hybrid seed Production: For maintenance of A-line it has to be crossed with male fertile, non-pollen fertility restoring strain i.e. B-line in an isolated plot, while in hybrid seed production A-line is crosses with R-line or fertility restorer line.

Isolation Requirement: Bajra is a highly cross-pollinated crop. The extent of cross-pollination is above 80 per cent. It is protogyny in nature and also a wind-pollinated crop. Isolation required is 1000 m from other bajra fields for foundation seed production, 200 m from fields of other varieties of bajra and 5 m from fields of other hybrid seed production plots having the same male parent for certified seed prodcution. Time isolation is not permitted in bajra.

Cultural practices:

Seed source: Obtain appropriate class of the seed from the source approved by seed certification agency.

Seed rate: The seed rate required for drilling is 1.5 Kg/ha of A-line and 0.75 kg /ha of B-line or R line, for transplanting the seed rate required is 600-650 g of A-line and 200-300 g of B-line or R line. The spacing adopted is 70-90 cm between the row and 20-25 cm within the row. Follow the recommended package of practices as that of normal cultivation.

Planting ratio: The planting ratio adopted is 4 lines of A-line and 2 line of B-line with 4-6 borders of B-line around the field

Synchronisation of flowering: For maintenance of A-line synchronization of flowering will not be a problem as both A and B-lines are iso-genic and come to flowering at the same time, while in hybrid seed production synchronization will be a problem as A-line and R-line have different genetic constitution. If the difference in flowering is 3-4 days it can be adjusted by cultural practices. The parent, which is late, should be sprayed with urea solution or DAP solution or withholding of irrigation to late parent can be practiced, which enhances flowering.

Jerking: Removal of early formed ear heads at 25^{th} – 35^{th} day after transplanting to have uniform synchronization and harvest is called as jerking.

Roughing: Roughing should be done frequently to produce high quality seed. Following precautions should be taken while rouging.

1. Roughing should be started before flowering to avoid contamination with foreign pollen.
2. Remove offtypes and volunteer from seed parent and pollen parent by uprooting to prevent re-growth.
3. Female parent rows should be roughed daily during flowering to remove pollen shedders
4. Remove plants in between the lines or male plants in female rows and vice-versa. Remove the plants affected with green ear, ergot and grain smut.
5. Remove offtypes and volunteers from within the isolation distance.
6. Before harvest rouging should be done based on seed characters.

Number of field Inspections: A minimum of four field inspection shall be made as follows;

1. The first inspection shall be made before flowering preferably within 30 days after planting to determine isolation, volunteer plants, off types, planting ratio, planting errors, incidence of downy mildew and other relevant factors
2. The second and third inspection shall be made during flowering to check isolation, pollen shedders, off types, downy mildew/green ear (*Sclerospora graminicola*) and other relevant factors.
3. The fourth inspection shall be made at maturity and prior to harvesting and in order to determine the incidence of downy mildew/green ear disease, ergot, grain smut and to verify the true nature of plant and other relevant factors.

Factor	Foundation seed	Certified seed
Offtypes in seed parent at and after	0.05 %	0.10 %

flowering		
Offtypes in pollen parent at and after flowering	0.50 %	0.10 %
Pollen shedding heads in seed parent at any one inspection at flowering	0.50 %	0.10 %
Plants infected by downy mildew /green ear at any one inspection	0.50 %	0.10 %
** Ergotted earheads in seed parent at final inspection	0.02 %	0.04 %
*** Ear heads infected by grain smut in seed parent at final inspection	0.05 %	0.10 %

** Seed from such fields that have been reported to contain the ergot infection even within the prescribed limits at final stage shall be subjected to floatation treatment with brine to become eligible for certification

*** Seed fields with incidence of grain smut more than the maximum permissible level can however be certified if such seed is treated with appropriate organo-mercurial fungicide not earlier than a month prior to sowing.

Harvesting: Harvest the male rows first and keep them separate to avoid mechanical mixture. Then harvest the female rows and sort out the undesirable heads and reject them before drying and threshing.

Seed Yield: Depending on the potentiality of the inbred line and the management practices adopted the seed yield may be 3-4 Q/ha.

Sunflower Varietal and hybrid Seed Production and Castor Varietal and hybrid Seed Production

Sunflower:

Varieties: EC 68414, Surya, Siddeswar

Hybrids: Morden, DRSF-108, KBSH-1, NDSH-1, DRSH-1, APSH-66,

Seed Production of Open Pollinated varieties

Land requirement: Select the fields in which sunflower was not grown in the previous year unless it is the same variety and certified by the seed certification agency for its purity. In addition to that the seed field should have good drainage and the soil should be deep fertile and with neutral pH.

Isolation requirement: Sunflower is partially self and cross pollinated crop. The extent of natural cross pollination varies from 17-62% according to insect activity. The fields must be isolated by atleast 400 meters for foundation seed class and 200 meters for certified seed class from fields of other varieties, same varieties not confirming to varietal requirement and wild sunflower.

Brief cultural practices: Obtain appropriate class of the seed from the source approved by seed certification agency. The seed rate required is 8-10 kgs/ha and the spacing adopted is 60x20 cm. Other cultural practices similar to commercial crop production should be adopted for raising a good crop. Follow the recommended package of practices and take necessary prophylactic measures so as to raise a good crop.

Number of Field Inspection: A minimum of three field inspection should be done. First inspection should be made at the stage of 6-7 pairs of leaves are present to determine isolation, volunteer plants and designated diseases etc. Second inspection shall be made during flowering to check isolation, offtypes and other relevant factors. Third inspection shall be made at maturity prior to harvest to verify designated diseases true nature of plant, head and seed.

	Foundation class	certified class
Offtypes	0.10 %	0.20 %
Objectionable weed plants (Wild Helianthus	Nil	Nil
Diseases plants (Downy mildew)	0.05 %	0.50 %
Orabanche	Nil	Nil

Rouging: Generally two to three rougings are necessary. First rouging should be done at pre-flowering stage and other rouging during flowering stage. Before flowering remove tall, very early and very late flowering plants, branched plants with multiple heads and diseased plants. At maturity remove offtypes, diseases plants and wild sunflower plants, plants affected by wilt, charcoal rot, blight etc. Sunflower continues to shed viable pollen even after removal from stalks. Therefore the heads should be thrown on the ground with face downward towards the soil.

Supplementary pollination: supplementary pollination is done by gently rubbing the palm with a muslin cloth on the heads, so that all the flowers will be fertilized and increases seed setting.

Harvesting and threshing: Sunflower should be harvested when the back side of the head turns to lemon yellow in colour. The heads are to be removed form the plants and dried in sun for a couple of days. Then threshing is done by gently beating with sticks.

Seed yield: Depending up on the variety and management practices adopted the seed yield may be around 15 q/ha.

Hybrid Seed Production

In Sunflower hybrid seed is produced by using Cytoplasmic Genetic Male Sterile system. The source of cytoplasm used is *Helianthus peteolaris*.

Hybrid seed production involves two steps

3. Maintenance of parental Lines (A-line, B-line and R-line)
4. Commercial hybrid seed production (AxR)

Maintenance of parental lines is generally referred as foundation seed production and hybrid seed production as certified seed class.

1. Seed production in parental lines:

A Line production: It is maintained by crossing with male fertile, non pollen restoring strain (B-line). They can be planted in the ratio of 3:1 for maximum seed production. The seed harvested from line A is male sterile and is used for hybrid seed production. The Isolation distance is 600 m.

B Line production:It is grown in isolation of more than 600ms using seed rate 7.5-10 Kg/ha. Other cultural practices like OPV.

R Line production:

R line seed production is taken up at minimum isolation distance is 600m. Seed required is 6-7.5 Kg/ha. All R lines are branching nature, rouging should be taken up of mono head plant along with any off types. Foliar spray of Boron 0.2% concentration on capitula, ray floret opening stage has increased seed yield. Nipping of lateral buds as and when noticed and allowing only main head to develop to get bold seeds and higher yield.

Hybrid seed Production (AxR):

Land requirement: Select the fields in which sunflower was not grown in the previous year unless it is the same variety and certified by the seed certification agency for its purity. In addition to that the seed field should have good drainage and the soil should be deep fertile and with neutral pH.

Isolation requirement: The seed fields must be isolated from other sunflower fields, increase of same line seed fields not confirming to varietal purity requirements of certification and from wild sunflower species by 400 meters

Brief Cultural Practices:.

The seed rate required is 7.5 kgs/ha of A-line and 2.5 kgs/ha of B or R-line. Other cultural practices similar to commercial crop production should be adopted for raising a good crop. If there is any difference between the male and female parent for days to flowering the sowing dates should be adjusted for proper synchronization of flowering. The seed can be sown in two different t methods *i.e* by adopting planting ratio or through block system

Planting ratio: The proportion of female (A-line) and male line (B or R-line) should be 3:1 with two border rows of male parents on the sides of seed production plot.

Block system: Female and male parents are planted in a two separate blocks side by side maintaining the population of 75:25 or 80:20.

Roguing: It should be done in both male and female parental lines. Remove the volunteer plants and offtypes from both male and female parental line. During flowering period roughing should be done daily to remove the pollen shedders. Pollen shedders should be removed in the morning hours before the bee activity starts. Precautions to be taken while rouging are

1. Start rouging before offtypes, volunteers and pollen shedders in female rows start shedding pollen
2. Remove plants with pink or purple colored centre in the heads. As the cultivated forms have greenish yellow in the center.
3. Remove plants showing branching and multifloret types
4. Remove diseased plants and plants which are too early or too late in flowering

5. Before threshing remove the heads with white seeds or seeds with prominent white streaks.

Number of Field Inspections: A minimum of four field inspections should be conducted. The first field inspection should be conducted before flowering stage, second and third during flowering stag and fourth before harvesting. During the first field inspection verification should be done for volunteer plants, isolation requirement, errors in planting and the actual acreage sown. During the second and third field inspection verification should be done for isolation requirement, offtypes, diseased plants, pollen shedders and objectionable weed plants. Actual counts should be taken during second or third field inspection. Fourth or final field inspection should be done to verify for all the above factors and the offtypes can be identified based on panicle or seed characters.

	Foundation class	certified class
Offtypes	0.20 %	0.50 %
Pollen shedders	0.50 %	1.00%
Objectionable weed plants (wild sunflower)	Nil	Nil
Diseases plants (Downy mildew)	0.05 %	0.50 %
Orabanche	Nil	Nil

Supplementary Pollination :

a. Hand pollination: Rub the palm with muslin cloth on the male parental line and then on female parent so as to transfer the pollen from male to female parent during peak flowering time. This as to be repeated daily during the flowering period in the morning hours
b. Bee Hives: Bee hives may be kept at 200 feet distance at 3-4 places in the field to increase bee activity.

Harvesting and threshing: Harvest the male parent first and remove them from the field to avoid mechanical mixtures. Then harvest the female rows. Harvesting and threshing will same as that of open pollinated varieties.

Seed Yield: Depending on the inbred line and the management practices adopted seed yield may be in the range of 4-5 q/ha.

Seed Production Castor

Varieties: Aruna,Bhagya ,Sowbhagya, Kranthi, Haritha, Kiran, Jwala

Hybrids: PCH-111, PCH-222, GCH-4

Castor is most difficult crop for seed production as there is lot of variation in a variety when grown in different seasons for plant height, node number upto primary raceme and other characters. Due to this reason, they have given a range for node number in different classes of seed.

Variety	No. of Nodes upto Primary raceme	Range for Foundation seed	Range for Certified seed
Aruna	12	10-14	9-15
Bhagya	11	9-13	8-15
Sowbhagya	15	13-17	13-18

Land requirement: Land for seed production of castor should be free from volunteer plants.

Isolation requirement: Castor is cross-pollinated crop. Cross-pollination by wind varies from 5-36% according to the prevailing climatic conditions. For pure seed production the seed crop must be isolated from other variety fields and same variety not confirming to varietal purity by atleast 300m and 150 m for foundation and certified seed classes respectively.

Cultural practices: Obtain appropriate class of the seed from the source approved by seed certification agency. The seed rate required is 11-18 kgs/ha. The recommended package of practices for commercial cultivation should be followed for raising a good crop.

Number of field inspections: A minimum of two field inspections are to be made from the time the crop approaches flowering until it is ready for harvest. During field inspection verification should be done for isolation requirement, offtypes and other relevant factors.

	Foundation class	Certified class
Offtypes	0.10 %	0.20 %

Roughing: Remove the offtypes based on morphological characters like stem color, internode length, shape of the leaf, bloom type and remove them before flowering. After initiation of primary spike, examine the plants for number of nodes upto primary raceme, type of internode, proportion of male to female in the spike and remove all undesirable plants not confirming to standards. Any delay in roughing adversely effect the seed quality hence during flowering roughing may be done 3-5 times at an interval of 2-3 days. Remove the plants affected by diseases like phytophthora blight and cersospora leaf spot.

Bloom types:

No bloom – bloom absent on all the above ground plant parts

Single bloom – bloom only on the stem

Double bloom – bloom on stem, fruits, petioles and on lower side of leaves

Triple bloom – Bloom on stem, fruits, petioles and both sides of leaves

Harvesting: the crop is generally harvested in 3-4 pickings. The spikes should be harvested when the fruits start turning to light yellow and should be dried in sun until they are blacken and get dried.

Seed Yield: Depending upon the potentiality of the variety and the management practices adopted the seed yield ma be around 8-10 Q/ha.

Hybrid seed production:

In castor different types of sex phenotypes are observed like;

Monoecious plants: Plants bearing female and male flowers on upper and lower parts of the raceme respectively.

Pistillate/Female parent: Plants containing variable proportion of stable pistillate flowers.

Male parent: Monoecious inbred line used as pollen parent in hybrid seed production.

Bisexual flowers: Under certain environmental conditions the female parent (VP-1) produces 2-5 bisexual flowers per spike

Environmentally sensitive staminate flowers: Interspersed staminate flowers which develop all along the length of female raceme usually after the failure of first developed female flowers to set fruits. The intensity of interspersed staminate flowers is more conspicuous in male promoting environment.

In hybrid seed production of castor Environmentally Sensitive Genetic Male Sterility system is used. Castor is monoecious and under certain environment conditions it produces only female flowers. Presence of male and female flowers in the inflorescence is influenced by temperature and nutrient management. In general when the daily mean temperature is above 32ºC favors production of male flowers and temperature below 32ºC favors production of female flowers. Similarly good crop management with adequate fertilizer management produces more number of pistillate flowers.

Hybrid seed production in castor can be discussed under two heads

1. Maintenance of parental lines (Female and male parental line)
2. Hybrid seed production (Crossing of female and male parent)

Maintenance of female parental line:

The female parent should be grown in Kharif or Summer season when the daily mean temperatures are above 32ºC to promote more number of male flowers. Under this male promoting environment selection should be made for pistillate lines and interspersed staminate flowered plants. There are two methods for maintenance of female parental line conventional method and renovated method.

Conventional method: In conventional method we have to maintain 75% of pistillate lines and 25% of monoecious lines. During flowering period observe the plants regularly and remove all the plants with more than three whorls of male flowers in primary raceme and retain only 25% monoecious plants with male flowers in 2-3 whorls. At flower initiation in primary raceme identify the female plants with pistillate inflorescence with well-defined characters and tag them with red tape. Examine all the monoecious plants and remove those with male flowers beyond three whorls from the base. Count the number of female and monoecious plants in each row and remove the monoecious plants over and above 25%. Examine the tagged plants regularly for reversion to monoecious condition in 2^{nd}, 3^{rd} and 4^{th} order racemes. Remove the tag as and when a female plant reverts to monoecious condition upto 4^{th} sequential order branches. On maturity harvest the female plants bearing the tape and keep the picking wise seed in separate lots after proper drying, packing and labeling. To avoid any possibility of mixing, delay the harvest of monoecious plants and early reverts by 3-4 days.

Renovated method: In renovated method 100 % plants should be pistillate lines. When ever a plants turn to monoecious condition in 2^{nd} , 3^{rd} or 4^{th} order racemes it should be removed. As all the plants are pistillate the first flush of female flowers do not get the pollen and they drop off and 50 - 55% of the plants will produce interspersed staminate flowers, these interspersed staminate flowers supply the pollen required for self pollination and help in fertilization. Here in renovated all the plants are 100 % pistillate upto 4th order raceme. Remove all the plants, which are monoecious, and plants deviating from female parental line.

Isolation: The isolation required is 300m from other varieties and hybrids of castor.

Number of field inspection: A minimum of four inspections shall be made as follows;

1. the first inspection shall be made before flowering in order to determine isolation, volunteer plants, outcrosses, planting ratio, errors in planting, stem color, types of leaves and other relevant factors.
2. The second and third inspections shall be made during flowering to check isolation, offytpes, nature of bloom, petiole, leaves, raceme, sex expressivity, number of nodes upto primary raceme and other relevant factors.
3. the fourth inspection shall be made prior to harvesting after the seed has attained maturity so that true nature of the plant can be verified.

Factor	Foundation seed
Offtypes including plants found to flower over the main stem	0.50 %
Male variants (more then 3 whorls of male flowers)	1.00 %
Female variants	1.00 %
Monoecious plants and the racemes reverted to monoecism on female plant before anthesis	Nil

Harvesting: Harvest the crop when the panicles are fully mature. In general harvesting is done in two or three pickings.

Maintenance of Male parent: It is similar to that of maintenance of varieties but the isolation and field standards are to be maintained as that of foundation seed class.

Commercial hybrid seed production / certified seed production:

The planting ratio adopted is 3 lines of female parent and 1 line of male parent. Commercial hybrid seed production should be taken up during rabi season when the daily mean temperatures are less than 32ºC. Adjust the sowing dates of male and female parent for proper synchronization of flowering.

Isolation: isolation required is 150 m from other varieties and hybrids of castor

Number of field inspection: A minimum of four inspections shall be made as follows;

1. The first inspection shall be made before flowering in order to determine isolation, volunteer plants, outcrosses, planting ratio, errors in planting, stem color, types of leaves and other relevant factors.
2. The second and third inspections shall be made during flowering to check isolation, offytpes, nature of bloom, petiole, leaves, raceme, sex expressivity, number of nodes upto primary raceme and other relevant factors.
3. The fourth inspection shall be made prior to harvesting after the seed has attained maturity so that true nature of the plant can be verified.

Factor	Certified seed
Offtypes including plants found to flower over the main stem	1.00 %
Male variants (more then 3 whorls of male flowers)	2.00 %
Female variants	2.00 %
Monoecious plants and the racemes reverted to monoecism on female plant before anthesis	2.00 %

Roughing:

1. Remove all offtypes from male and female parents.
2. Identify the monoecious plants in female rows before flower initiation as well as the deviants for node number upto primary raceme, uproot and destroy them.
3. Continue this process everyday till all plants in female rows commence flowering.
4. Rogue out male parent for variants depending on node number upto primary raceme.
5. Reversion in female rows to monoecism in 3rd or 4th order racemes should not be uprooted but nipped off.

Harvesting: harvest the male rows first and remove them from the field. Then harvest the female rows picking wise. Care should be taken to avoid mechanical mixtures during harvesting, threshing and drying.

Groundnut varietal Seed Production and Sesame varietal Seed Production

Varieties: Greeshma, Abhaya, Narayani, Dharani, K6, K7, K8, TMV-4

Land requirements:

The same crop should not be grown on the same piece of land for the two seasons, unless it is the same variety and certified by seed certification agency.

Isolation:

Groundnut is highly self pollinated crop. For pure seed production the seed fields must be isolated by at least 3m for both foundation and certified seed production from other varieties and same varieties not confirming to varietal purity.

Source of seed: Obtain appropriate class of the seed from the source approved by seed certification agency.

Brief cultural practices:

The seed rate required is 100-125Kg/ha for Bunch type and 80-100 Kg/ha in case of spreading varieties.. The spacing adopted is 30 × 10-15 cm for Bunch type and 45 × 10-15 cm in case of spreading varieties. The crop can be sown during Kharif (end of June), Rabi (October-November) & summer (December-January).

Roguing:

On the basis of plant size, colour of the leaflet flower etc., the offtype plants should be removed to aviod mechanical mixture. The plant affected disease such as rosette, mosaic and root knot should be removed as and when found.

Number of field inspections: A minimum of two inspections will be done, one at flowering and second at pod maturity stage (15 days prior to harvesting) by the Seed Certification Officer.

	Foundation class	certified class
Offtypes	0.10 %	0.20 %

Harvesting and Pod separation:

The maturity of the crop is indicated by the yellowing of the leaves and pod shows reticulations.The harvesting is done by pulling out the plant by hand and allowed to be sun dried.

Stripping:

Removal of pods from the plant is called stripping. After that pods are dried under the sun.

Shelling: Shelling of groundnut pods for seed should preferably be done manually. Manual shelling can avoid damage and splitting of seeds, which can happen in mechanical shelling. At the time of shelling, any seed, which is infected, damaged, or does not conform to shape, size, and colour of the variety under seed production, should be removed. The seeds should be treated with appropriate fungicides and insecticides before sowing. They are dried to safe moisture level 8-10%.

Seed Yield: The average yield varies from 15-20 qs/ha. The summer crop yield ranges from 30-35 qs/ha.

Seed Production of Sesamum

Varieties: Gouri, Madhavi,Sarada,Swetha til,Chandana,Hima,YLM 17

Land requirements: The land selected should not be cultivated with the same crop in the previous season. The land should be fertile with proper drainage facility

Isolation:

Sesamum is self pollinated crop but cross pollination occurs through honeybees. For pure seed production the seed fields must be isolated by at least 100m foundation and 50m for certified seed production from other varieties and same varieties not confirming to varietal purity.

Source of seed: Obtain appropriate class of the seed from the source approved by seed certification agency.

Brief cultural practices:

The seed rate required is 5Kg/ha .The spacing adopted is 30 × 10-15 cm and follow the recommended package and practices for raising the good crop.

Roguing:

Roguing should be done from vegetative phase to harvesting phase. Off-types are removed based on the branching type, capsule size and colour of the seeds.

Number of field inspections:

A minimum of three field inspections should be done from pre flowering stage to harvesting stage by the Seed Certification Officer. First inspection is done before flowering followed by the second inspection during flowering stage. The third inspection is scheduled between fruit maturity and harvest.

	Foundation class	certified class
Offtypes	0.10 %	0.20 %
Seed borne diseases	0.5%	1.0%

Harvesting:

Harvesting should be done when 75 – 80% of the pods become brown in colour and few at the bottom have dehisced (burst open). The harvested plants are stacked upright in the threshing yard for a period of three days. This will help the immature pods in the terminal edge to mature and also help in drying of the pods. The moisture content of the pods will reduce to 9%. Threshing is carried out manually by beating the capsules with pliable bamboo sticks. Seeds are dried under the sun for 3-4 days to reduce the moisture content before storage.

Seed Yield:

The average yield varies from 15-20 qs/ha. The summer crop yield ranges from 30-35 qs/ha.

Cotton Varietal and hybrid Seed production

Varieties: Aravinda, Srinandi, Yaganti, Kanchana , Narasimha, Sivanand

Hybrids: Interspeccifc hybrids:LAHH-1, LAHH-4, LAHH-5, Lam Cotton Hybrid-7, NDLHH-240 and Orugallu Krishna

Bt Hybrids: Bunny, Mallika, Sai Bt, MRC 6304 Bt

Land requirement: The land should be free from volunteer plants, soil should be fertile, moisture retentive with good drainage.

Isolation requirement: Cotton is a often cross-pollinated crop. For pure seed production the isolation distance required is 50 m and 30 m for foundation and certified seed respectively from other varieties and same varieties not confirming to varietal requirements.

Seed source: Obtain appropriate class of the seed from the source approved by seed certification agency

Cultural practices: The seed rate required is 8-10 kg/ha. The package of practices recommended for commercial cultivation should be followed for raising a good crop.

Number of field inspections: A minimum of two-field inspection is required. First field inspection should be done at vegetative stage and the other at flowering stage to verify isolation requirement, offtypes and diseased plants.

	Foundation seed	Certified seed
Offtypes	0.1 %	0.2 %

Rouging: remove the offtypes and diseased plants first at seedling stage and then at vegetative stage. Subsequent rouging for offtypes and diseased plants should be done at square initiation and flowering stage.

Harvesting and Picking: Picking is commenced when cotton is fully mature i.e. when the bolls begin to open. Several pickings are necessary since the bolls ripen over a period of 2-3 months. In general early pickings give better germination and good quality seed, however the planting seed is mostly gathered from the cotton harvested during peak period. The cotton picked from late-formed bolls (last picking) should not be used for seed purpose.

Precautions:

1. Start picking when the bolls are fully mature.
2. Picking should not be done when the bolls are wet due to rain or dew.
3. Bolls damaged by rains or insects or otherwise should not be used for seed.
4. The cotton should be clean with minimum amount of leaves and plant barks, so that the seed is not damaged during ginning.
5. Moist cotton with 12 % or more moisture content should not be stored because heating may occur which damages the seed.

Seed yield: Seed yield may be around 3-6 Q/ha depending upon the variety and management practices adopted.

Delinting is the removal of seed coat hairs and short fibers that remain after ginning. Delinting can be done by machine, acid or flame delinting. For acid delinting the seeds are treated with concentrated sulfuric acid and then washed with water 3 or 4 times.

Hybrid seed Production

Land requirement: Same as varieties.

Isolation requirement: Isolation distance required is 50 m and 30m for foundation and certified seed respectively and 5 m between the parental lines.

Seed source: Obtain appropriate class of the seed from the source approved by seed certification agency

Cultural practices: The seed rate required for female parent is 3.75 kgs/ha and that of male parent is 2.5 kgs/ha. The spacing adopted for female parent is 150 x 100 cm and for that of male parent is 150 x 50 cm.

In cotton hybrid seed is produced by manual hybridization i.e. emasculation and pollination. Individual flower buds are emasculated in the evening and pollinated next day morning. The male and female are planted inblock system by adopting a ratio of 1:4 or 1:5. The first 4/5th of area are sown with female line and the remaining 1/5th by male line. For example if there are 50 lines then 40 lines are sown with female parent and 10 lines with male parent. Male parent is sown 3-4 times at an interval of 6-8 days while the female is sown only once, so that sufficient number of male flowers should be available when the female flowers are receptive.

Number of field inspections: A minimum of four inspections shall be made as follows:

1. the first inspection shall be made before flowering to verify isolation, volunteer plants, outcrosses and other relevant factors.

2. The second and third inspections shall be made during flowering to verify isolation, offtypes and other relevant factors. In case male sterile is used for producing hybrid seed, the number of pollen shedding plants in female parent shall also be verified.
3. The fourth inspection shall be made during picking of cotton in female parent in order to determine that selfed bolls are eliminated and only cotton from crossed bolls is picked.

	Foundation seed	Certified seed
Offtypes	0.10	0.5 %
Pollen shedding plants in female parent	0.05	0.1 %

Organizing an efficient crossing program:

1. Rogue out all offtypes from both male and female parental lines before starting the crossing program.
2. Emasculation should be done between 2.00 to 6.00 PM and pollination next day morning between 8.00 to 12.00 AM.
3. Select the bud that will open next day and emasculate it by removing the calyx, corolla and the monodelphous stamens without causing injury to the style and stigma.
4. Emasculate and pollinate all the flower buds appearing during the first seven weeks of reproductive phase to ensure good seed setting and development of the bolls.
5. Emasculation should be perfect and complete.
6. Cover the emasculated flower bud with butter paper bag and pollinate next day morning. (As per certification standards it is not necessary to cover the flower bud with butter paper bag as we are following the required isolation distance)
7. Remove all the unemasculated flower buds next day morning before fertilization.
8. Tie a thread to the pedicel of the bud after each pollination.
9. Crossing program should be stopped after the 11^{th} week and remove all buds and flowers appearing subsequently to facilitate better development of the crossed buds.
10. Nip the terminal shoots to stop further growth and to support the development of crossed bolls.

Harvesting and Picking: Pick up the ripe and completely opened bolls along with pedicel and thread and collect in the basket. The bolls may be sorted once again to assure that they are crossed. Sun dry them for 1or 2 days and store in gunny bag until supplied to the processing plants. Care should be taken to avoid mechanical admixtures during picking and there after. Grow out test is generally carried for hybrid seed of cotton produced by manual emasculation and pollination.

Greengram, Blackgram, Bengalgram Varietal Seed Production and Redgram Varietal and hybrid seed production

Green gram Varieties: WGG-2, WGG-37, MGG-295, MGG-348, LGG-450, LGG-460, LGG 407, TM 96-2, IPM 2-14

Black gram Varieties for Kharif and Rabi : T-9, LBG-623, LBG-20, WBG-26 ,TBG 104,

For Rabi only: LBG-752, LBG-648, LBG-645, LBG-402, and LBG-17

Land Requirements

Land to be used for seed production shall be free of volunteer plants. In addition the soil should be light, well drained and with a neutral ph.

Isolation requirements:

Greengram and Blackgram are highly self-pollinated. Natural cross pollination to the extent of 0 to 5% has been recorded. Therefore, for maintaining variety purity an isolation of 10 m. for foundation seed class and 5 m. for certified seed class is necessary from fields of other varieties and of the same variety not confirming to varietal purity requirements of certification.

Brief cultural practices:

Obtain appropriate class of seed from the source approved by seed certification agency. The seed rate required is 15-20 kg/ha for kharif and 20-25 kg/ha for summer and the spacing adopted is 30 x 10 cm. Other cultural practices are similar to raising a commercial crop. Necessary prophylactic measures should be taken so as to raise a good crop.

Roguing:

Rogue the off type plants and diseased plants affected by leaf spot and stem canker, yellow mosaic virus and sterility virus from seed field from time to time, as required. Roguing should be done once before flowering and once after flowering based upon varietal morphological characters

Number a field inspections:

A minimum two field inspections are standardized for certification of different seed production programmes. For green gram and black gram, a minimum of two field inspections are required i.e. first one before flowering and second inspection during flowering and fruiting to determine isolation, volunteer plants, off types and diseased plants etc.

		F/s	C/s
Off types	(%)	0.1 %	0.2 %

Harvesting and threshing:

The crop is harvested soon after the seed is mature. Threshing is done by beating the plants with sticks. After threshing and cleaning the seed should be dried to 8 to 10 percent moisture before storage. Necessary precautions should be taken to avoid mechanical mixtures during these operations.

Seed yield

The average seed yield varies from 10 to 15 quintals per hectare.

SEED PRODUCTION OF BENGAL GRAM

Bengal gram Varieties: JG 11,Nandyal Gram 49 (NBeG 49), Dheera (NBeG 47), Nandyala Sanaga1(NBeG 3), KAK 2, Vihar

Land Requirements

Land to be used for seed production shall be free of volunteer plants. In addition the soil should be light, well drained and with a neutral ph.

Isolation requirements:

Bengal gram is a highly self-pollinated crop. Natural cross pollination to the extent of less than 5% has been recorded. Therefore, for maintaining variety purity an isolation of 10 m. for foundation seed class and 5 m. for certified seed class is necessary from fields of other varieties and of the same variety not confirming to varietal purity requirements of certification.

Brief cultural practices:

Obtain appropriate class of seed from the source approved by seed certification agency. The seed rate required is 50 kg/ha (small seed), 75 kg/ha (medium seed), 100 kg/ha (bold seed), 120kg/ha (kabuli) and the spacing adopted is 30 x 10 cm. The planting time is second fortnight of October to first week of November. Other cultural practices are similar to raising a commercial crop. Necessary prophylactic measures should be taken so as to raise a good crop.

Roguing:

Rogue the off type plants and diseased plants affected by wilt, root rot leaf spot and stem canker, yellow mosaic virus and sterility virus from seed field from time to time, as required. Roguing should be done once before flowering and once after flowering based upon varietal morphological characters

Number of field inspections:

A minimum two field inspections are standardized for certification of different seed production programme. For Bengal gram a minimum of two field inspections are required i.e. first one before flowering and second inspection during flowering and fruiting to determine isolation, volunteer plants, off types and diseased plants etc.

		F/s	C/s
Off types	(%)	0.1 %	0.2 %

Harvesting and threshing:

The crop is harvested soon after the seed is mature. Threshing is done by beating the plants with sticks. After threshing and cleaning the seed should be dried to 8 to 10 percent moisture before storage. Necessary precautions should be taken to avoid mechanical mixtures during these operations.

Seed yield

The average seed yield varies from 10 to 15 quintals per hectare.

Seed Production of Red gram

Seed production of OPV:

Varieties: ICPL – 87 (Pragati): ICPL – 151 (Jagriti), Pusa – 33, JA – 4, JKM – 7, Asha (ICPL – 87119); LRG – 30, LRG – 38, LRG – 41

Land Requirements

Land to be used for seed production of pigeon pea shall be free of volunteer plants. In addition the soil should be light, well drained and with a neutral ph.

Isolation requirements:

Red gram is often cross pollinated crop. Although anthers burst before flowers open, there is considerable cross-fertilization by bees and other insects. Natural crossing to the extent of sixty five percent has also been recorded. Therefore, for maintaining variety purity an isolation of 200 mts. for foundation seed class and 100 mts. for certified seed class is necessary from fields of other varieties and of the same variety not confirming to varietal purity requirements of certification.

Brief cultural practices:

Obtain appropriate class of seed from the source approved by seed certification agency. The seed rate required is 12-15 kg/ha and the spacing adopted is 60 x 25 cm to 75 x 30 cm. Other cultural practices are similar to raising a commercial crop. Necessary prophylactic measures should be taken so as to raise a good crop.

Roguing:

Rogue the off type plants and diseased plants affected by wilt, leaf spot and stem canker, yellow mosaic virus and sterility virus from seed field from time to time, as required.

Number a field inspections:

A minimum two and maximum four field inspections are standardized for certification of different seed production programmes. For red gram, a minimum of two field inspections are required i.e. first one before flowering and second inspection during flowering and fruiting to determine isolation, volunteer plants, off types and diseased plants etc.

		F/s	C/s
Off types	(%)	0.1 %	0.2 %

Harvesting and threshing:

The crop is harvested soon after the seed is mature. Harvesting is normally done with sickle and the crop is left in the field to dry for about one week. Threshing is done by beating the plants with sticks. After threshing and cleaning the seed should be dried to 8 to 10 percent moisture before storage. Necessary precautions should be taken to avoid mechanical mixtures during these operations.

Seed yield

The average seed yield varies from 20 to 25 quintals per hectare.

Hybrid Seed Production:

Hybrids: ICPH – 8 : PPH – 4, COH – 1, COH – 2,: AKPH – 2022, AKPH – 4101

ICPH – 8: The world's first pigeonpea hybrid was developed at ICRISAT and released by ICAR (Saxena et al. 1992b).

The hybrid rice seed is produced by utilizing Genetic Male Sterile System (GMS).

Hybrid seed production inredgram can be discussed under two heads

1. Maintenance of parental lines (Female and male parental line)
2. Hybrid seed production (Crossing of female and male parent)

Maintenance of female parental line:

GMS is controlled by a single recessive gene, it has to be maintained in a heterozygote (*Msms*) form only. To achieve this, the male-fertile heterozygote plants are crossed, either by hand pollination or through pollinating insects, with the male-sterile (*msms*) segregants appearing in the same population. In the subsequent generation, this testcross seed lot will segregate in a proportion of 1 male:1 female. This process is repeated generation after generation to maintain the GMS lines. For large-scale seed multiplication of GMS line, the backcross seeds, harvested from the male-sterile plants, are grown in isolation. At flowering, a young floral bud from each plant is manually opened and its anthers checked for their morphology and the presence (male-fertile) or absence.(male-sterile) of pollen grains. These two types of plants are identified with different colored tags. At maturity, the seeds obtained through cross pollination of male-sterile plants are harvested. The seed harvested from the fertile segregants is rejected.

Maintenance of male parental line:

The male parent is multiplied in a separate isolation. The population should be intensively rogued for the off-types. Growing single plant progenies and selecting uniform progenies will enhance its genetic purity.

Commercial hybrid seed production / certified seed production:

To produce hybrid seed in bulk, male sterile lines are planted in the ratio of **six** male sterile rows (Female): **one** pollinator row (Male). The hybrid seed plot is surrounded by four pollinator rows to provide sufficient pollen load. In genetic male sterility (GMS) system 50% plants appears male fertile in the female (MS) rows. Therefore, these fertile sibs need to be uprooted immediately as the first bud appears on the plant. The male sterile sibs those remain are to be tagged in the female rows. Periodic picking of immature pods from the pollinator rows may prolong their flowering time. It is possible to produce several hybrids in one isolation block using a common male parent and several male sterile, if their flowering can be synchronized. Appropriate isolation distance of 200 m between two seed blocks should be maintained to avoid contamination.

Seed Certification – Role of Seed Certification Officer- Certification standards

Seed certification is a legally sanctioned system for the quality control of seed during seed multiplication and production. As per Indian Seed Act seed certification is voluntary and it is not compulsory. The certification agency is a separate organization meant for certifying the quality of the seed and it has nothing to do with seed production.

The seed that is sold in the market is of two types certified seed or truthfully labeled seed. The seed, which is being certified by seed certification agency, is called as certified seed. The seed certification agency maintains certain strict standards before issuing the certification tag or label.

Role of Seed Certification Officer:

i. Certify seeds of any notified kind and variety.

ii. Outline the procedure for submission of application for growing, harvesting, processing, storage and labelling of seeds intended for certification till the end to ensure that seed lots finally approved for certification are true to variety and meet prescribed standards for certification

iii. Maintain the genetic chain of Certified Seed from Breeder Seed.

iv. Verify, upon receipt of an application for certification that the variety is eligible for certification, that the seed source used for planting was authenticated and the record of purchase is in accordance with the rules and the fees have been paid.

v. Take sample and inspect seed lots produced under the procedure laid down by the Certification Authority and have such sample tested to ensure that the seed conforms to the prescribed standards of certification.

vi. Inspect seed processing plants to see that there are no admixtures of other kinds and varieties.

vii. Ensure that action at all stages, e.g. field inspection, seed processing plant inspection, analysis of samples taken and issue of certificates (including tags, labels, seals etc.) is taken expeditiously.

viii. Carry out educational programmes designed to promote the use of certified seed including a publication, listing certified seed growers and source of certified seed.

ix. Grant of certificates (including tags, labels, seals etc.) in accordance with the provisions of the Seed Act.

x. Maintain such records as may be necessary to verify that seed plots for production of certified seed were eligible for such planting under the Seed rules.

xi. Inspect fields to ensure that the minimum field standards i.e. isolation, permissible off-types, weeds and other seed born diseases to maintain certification standards

Procedure for seed certification: Seed certification is voluntary and that too for the kind and variety notified by the government of India. It can be completed in six broad phases.

1. Receipt and scrutiny of the application.
2. Verification of seed source, class and other requirements.
3. Filed inspection should be conducted to see that fields are up to the prescribed field standard.
4. Post harvest inspection, including processing and packing.
5. Seed sampling and testing to confirm that the seeds are up to the prescribed seed standards.
6. Grant of certificate, tagging and sealing.

1. **Receipt and scrutiny of the application**: All those persons who are interested in seed certification should submit an application in Form No 1 to the concerned seed certification officer with the prescribed fees of Rs 25/-. The fee is for one season for a single variety and for an area up to 25 acres (10 ha.) If the area is more than 25 acres or if more than one variety is planted separate applications should be made for each variety. If the area is less than 25 acres under one variety but if the fields are scattered and separated by more than 50 meters separate applications should be made. On receiving the applications the seed certification agency verifies for the following conditions:
   1. Eligibility of the variety: Only those varieties that are notified by the central govt as per section 5 of the seed act 1966 are eligible for certification.
   2. Establishing the seed source: The seed producer should submit the tag, in-voice, and a copy of Form No2.)
   3. There should not be any difficulty in reaching the field for carrying out timely field inspection.
   4. Whether the required isolation and land requirement is followed or not.
   5. Whether the processing plant facility is available to the applicant.
   6. Whether the applicant has paid the requisite registration fee or not.

If all the six conditions are fulfilled then the seed producer has to pay the field inspection fees for different tests .

2. **Verification of seed source, class and other requirements**. The seed should be from authentic source and from appropriate class and should be in accordance with Indian Minimum Seed Certification Standards.
3. **Inspection of Seed Fields**. The certified seed producers should grow and harvest the crop as per the guidelines issued by the seed certification agency. They must

carefully and faithfully carry out the roguing and other operations as per the directive of the certification agency.

The certification staff conducts field inspections at appropriate stages of crop growth to ensure that minimum standards of isolation, preceding crop requirement, roguing and other special operations are maintained at all times. The inspection of seed crop is done at different stages of crop growth such as at the time of sowing (when new crop is introduced), vegetative stage or preflowering stage, flowering stage, post flowering or preharvest stages and at the time of harvest. The contaminants to be observed during field inspections are offtypes, pollen shedders, shedding tassels, inseperable other crop plants, objectionable weed plants and diseased plants. The field inspections are designated to ensure that the crop is up to the prescribed field standards. All the seed fields, which do not meet the required field standards, are eventually rejected.

a)Method of taking field counts: The method of taking field counts involves following steps:

i)Determine the number of field counts. For all crops a minimum of five counts are to be taken for an area up to two hectares, and an additional count is to be taken for each additional two hectares or part thereof as given below.

Area of the field in hectares	**Minimum number of counts to be taken**
Up to 2	5
2-4	6
4-6	7
6-8	8
8-10	9
Above 10	10

In any inspection, if the first set of counts show that the seed crop does not confirm to the prescribed standards for any factor, a second set of counts should be taken for that factor, if the percentage of first set of count for that factor is not more than twice the maxmimum permissible level. Two sets of counts are called as double counts. In hybrid seed production plots the number of counts must be taken separately for both the parents.

ii)Number of plants to be observed for completing one count. The number of plants to be observed for completing a single count varies from crop to crop. The number of plants/heads to be observed for completing a single count is given below.

Crop	**Number of plants/heads per count**
Wide spaced crops: Bhendi, brinjal, Bulb crops, Chillies, Cole crops, Cotton, Cucurbits, Groundnut, Maize, Potato, Redgram, Tomato, root crops, etc.	100 plants
Medium spaced crops: Beans, cowpea, gram, leaf crops, moong, urad, mustard, peas, sesame, sunnhemp, etc.	500 plants
Thickly sown crops: Berseem, jute, lucern, mesta, soybean Bajra, paddy, wheat, sorghum, etc	1000 plants 1000 heads

The required number of field inspections specified in the seed certification standards should be conducted. The purpose of these filed inspections is to properly guide and advise the seed producer, but at the same time to do the necessary inspections so that the ultimate buyer can be assured that the seed crop has met all the necessary standards.

iii) Taking of Filed Counts: The procedure for taking filed counts differs for different crops.

iv) Rejection of seed fields: All the seed fields, which do not confirm to the required standards for any of the factors should be rejected. The rejection letter should be immediately communicated to the seed grower stating the reasons for the rejection. As far as possible the seed growers should be convinced for rejecting the seed fields by showing the contaminants.

4..Post Harvest Inspection: The personnel from the seed certification agency should inspect the fields during harvesting or post harvesting, so that there are no mechanical mixtures and the seed is not handled badly during threshing or afterwards. Then the seed is sent to seed processing plant with a threshing certificate. The personnel from the seed certification agency will be inspecting the seed processing plant to avoid mechanical mixtures and damage caused to the seed during processing.

5.Seed Sampling and Testing: The representative from seed certification agency draws a representative sample from the seed lot at the time of processing or after processing and sends the sample to official seed testing laboratory for evaluation. In the seed testing laboratory the samples will be evaluated for seed standards such as pure seed, inert matter, other crop seed, weed seeds, germination percentage and moisture percentage etc.

6. Grant of certificate, tagging and sealing. After receiving a satisfactory report from the seed testing laboratory, tagging and sealing of bags will be done under the supervision of seed certification agency. Under special circumstances, advance tags will also be issued to the extent of 75 per cent of the seed lot. Tags and seals should be in accordance with general seed certification requirements. Affixing of tags and seals on the containers completes the process of certification of seeds.

Minimum Seed Certification Standards

In a seed quality control programme through seed certification, the minimum seed certification standards, in fact, are the minimum standard conditions which must be met. The minimum seed certification standards, thus are the standards required for the certification of seeds by the certification agencies.

The certification standards in force in India are called the 'Indian Minimum Seed Certification Standards'. These were published by the Central Seed Certification Board. As a general principle, these standards have been kept at the level, which demand scrupulous attention of the certified seed growers but at the same time practical enough that these can be met also.

The minimum seed certification standards can be broadly grouped into two groups.

A. General Seed Certification Standards
B. Specific Crop Standards

The two combined sets of standards constitute the minimum seed certification standards for seed certification.

A. General Seed Certification Standards: The general seed certification standard aims at outlining the general requirements for the production of genetically pure good quality seed. These standards prescribed the procedure for certified seed production so that maximum genetic purity and good quality of the seed this ensured.

B. Specific Crop Standards: Specific crop standard consists of Field Standards and Seed Standards Field standards consist of: -

1. The minimum preceding crop requirement have been specified to minimize genetic contamination from the disease, volunteer plants.
2. The minimum isolation requirement has been specified to minimize seed born disease contamination.
3. The number of feed inflection and specified stage of crop have been described to ensure verification of genetic purity and other quality factors.

Seed Standards consists of:

1. The minimum percentage of pure seeds and maximum permissible limits for inert matter, other crop seeds have been prescribed.
2. The maximum permissible limits for objectionable weeds, seeds infected by seed borne diseases have been prescribed to ensure goods seed health.
3. The maximum permissible limits for moisture content have been prescribed for the safe storage of seeds.

Seed processing – Seed drying – Methods – Seed Cleaning – Seed grading – Equipments used for grading – Seed treatment – Advantages – Types – Factors influencing seed storage

Seed lots received from the field are often at high moisture content and contain trash and other inert material, weed seeds, deteriorated and damaged seeds, off-size seeds, etc. Hence, seed processing is necessary in order

1. To dry the seeds to safe moisture level
2. To remove or reduce to the extent possible the various undesirable material, weed seeds, other crop seeds, deteriorated or damaged seeds
3. For uniform size grading and
4. For seed treatment to upgrade the overall seed quality.

Seed processing refers to all the steps necessary for preparation of harvested seed for marketing, namely, handling, drying, shelling, preconditioning cleaning, size grading, treating and packaging, etc.

Seed Drying

The process of lowering down the seed moisture content to safe moisture limits is known as seed drying. It is very important in order to maintain seed viability and vigor, which may otherwise deteriorate fast due to mold growth and increased micro-organism activity. The advantages of seed drying are it permits early harvest, so that land and manpower can be used efficiently, permit long term storage and maintains the seed quality.

Methods of seed drying

1. Sun drying
2. Forced air drying

1. Sun drying: The moisture of seed is generally reduced in the field before harvest and later by sun drying on the threshing floor. The system involves harvesting of crops when they are fully dried in the field, leaving the harvested produce in the field for a couple of days for sun drying and later spreading the threshed and winnowed produce in thin layer on threshing floors of sun drying.

If sun drying is done following precautions should be taken.

1. Do not spread the produce on wet, dirty and kaccha, threshing floors.
2. Only one crop variety should be handled at a time and care should be taken to avoid mechanical mixtures.

II. Forced Air Drying: In this system natural air is forced into seeds. The air passing through damp seeds pick up the water. The evaporation cools the air and the seed. The heat necessary for evaporating the water comes from the temperature drop of the air.

Drying methods of Forced Air Drying

There are three major drying methods for drying with forced air:

1. **Natural air drying** – Natural air is used in this type of drying method.
2. **Drying with supplemental heat** – In this method temperature of the air is raised to about 10 to 20 ^{o}F for reducing relative humidity of the air.
3. **Heated Air drying –** In this method the drying air is heated to 110^{o}F.

Seed cleaning refers to separation of undesirable materials such as inert matter, weed seeds, other crop seeds, light and chaffy seeds, deteriorated and broken seeds from desirable material on the basis of differences in physical properties of desirable seed and undesirable matter. Physical differences like seed size (length, width and thickness), shape, density, surface texture, weight, affinity to liquids and electric conductivity etc are common in crop species and they form the basis for seed cleaning operations.

Seed Cleaning of seeds involves three steps.

1. Pre-cleaning and pre-conditioning

2. Basic cleaning

3. Seed upgrading

I. Pre -cleaning & Pre -conditioning:

It refers to the operations such as shelling, debearding etc. that prepares the seed lots for basic cleaning and also for the removal of particles such as trash, stones, clods etc. larger than crop seed. Some pre-cleaners also remove particles that are lighter in weight and smaller in size than the crop seed. Pre-cleaning is not required for hand harvested and winnowed seed lots.

Equipment used for pre-cleaning and pre-conditioning are

1. Scalper or Rough Cleaner

2. Huller Scarifier

3. Debearder

4. Maize Sheller

II. Basic Seed Cleaning:

- It refers to actual cleaning and grading of seeds and is essential process in seed cleaning operation.
- The basic seed cleaning is done over an air screen machine commonly referred to as an air screen cleaner.
- It is the basic equipment in all seed processing plants.

Air Screen Machine

Principle: The separation of undesirable material from seed is done on the basis of differences in seed size and weight. The air screen machine uses three cleaning elements:

1. **Aspiration**: the light seed and chaffy material is removed from the seed mass through aspiration.
2. **Scalping**: Good seed are dropped through screen openings but large material (trash, clods etc.) are scalped off over the screen into a separate spout.
3. **Grading**: The good seed ride over the screen openings, while smaller particles (undersized, weed seeds, shrivelled) drop through the screen perforations.

III. Upgrading the quality of cleaned seed

In certain instances it is necessary to remove specific contaminants by precise size grading. The various processing operations conducted after basic cleaning to further improve seed quality are regarded as upgrading operations. The choice of upgrading operations however shall depend upon the type of contaminants and crop seed.
The various types of upgrading operation equipment, their principle of their principle of operation and specific uses are given below

I. Sizing and Grading
a. Width and Thickness**:** Horizontal flat screen separator (Clipper corn sizer, superior
cork-it-corn grader), Vertical ribbed screen separator (Dockins seed grader), Cylindrical screen separator

b. Length sizing and grading: Seeds are separated on pure length basis

1. Disc Separator

2. Cylinder separator:

II. Gravity or Weight separations:

a. Gravity separator
b. Stoners

III. Air separations:

a. Pneumatic Separator
b. Aspirator
c. Fractional Aspirator

IV. Surface Texture Separation

a. Roll Mill

b. Magnetic separator

c. Inclined Draper

V. Electronic separation

a. Electric color sorters

VI. Other Separators

a. Spiral separator

b. Polishers

c. Picker belts

SEED TREATMENT

Seed treatment refers to the application of fungicide, insecticide or both to the seeds to ***disinfect*** (deep seated) and ***disinfest*** (over seed coat) them from ***seed borne*** or ***soil borne*** pathogenic organisms and storage insects. It also refers to subjecting the seed to solar energy exposure or immersion in conditional water.

Seed treatment is a biological / chemical / mechanical / physical process or a combination of these, designed to reduce external or internal or contaminant seed borne infections and soil borne pathogens.

Benefits of seed treatment:

1. Prevention of spread of plant diseases
2. To protect seed rot and seedling blights
3. Improves germination
4. Provides protection from storage insects

Types of seed treatment

1. **Seed disinfection**:-
   It refers to eradication of fungal spores present ***within the seed coat*** or ***more deep seated tissues.*** For effective control the fungicide must penetrate into the seed to kill the fungus.

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

3. **Seed protection**:-
   To protect the seed and young seedling from organisms present in the soil whis may cause decay of the seed before germination.

Factors influencing the storage (life span) of seeds :

1. Genetic factors
2. Initial seed Quality
3. Seed moisture
4. Relative humidity and Temperature
5. Provenance
6. Pre and post harvest conditions
7. Oxygen Pressure during storage
8. Effect of storage conditions on the activity of organisms associated with seeds in storage
   a) Bacteria
   b) Fungi
   c) Insects and Mites
   d) Rodents and Birds

9. Other factors

Besides the above factors storage life is affected by number of times and kind of fumigation, effect of seed treatment etc.

Seed Testing - Seed Sampling- Seed Moisture, Seed Health, Physical purity, Genetic purity and Viability Tests

Introduction: The quantity of seed tested in the laboratory is very less, compared with the size of the seed lot which is intended to represent. Therefore every effort must be made to ensure that the sample sent to seed testing laboratory represents the seed lot. The objective of sampling is to obtain a representative sample of suitable size for the required test. A representative sample is one, which contains the same constituents which are present in the seed lot and in the same proportions. The different samples that are drawn are

1. **Primary sample**: A sample obtained by taking small portions from different places from a seed lot at a particular stage with the objective of forming a composite sample.
2. **Composite sample**: It is formed by mixing all primary samples taken from a seed lot and a part of this sample is sent to seed testing laboratory for testing.
3. **Submitted sample**: A composite sample is usually larger in quantity than what is required for testing. It has to be reduced in quantity. A composite sample, which is reduced in quantity and sent to seed testing laboratory, this is called as submitted sample.
4. **Working sample**; A small portion taken from the submitted sample for conducting quality tests are called as working sample.

There are three types of seed samples received by a seed testing laboratory. They are (1) Service (2) Certification (3) Official samples.

1.ServiceSamples

Service sample means a sample submitted to the central seed laboratory or to a state laboratory for testing, the results to be used as information for seeding, selling or labelling purposes. These samples must be tested promptly to provide the sender with immediate information about the quality of seed with which he is dealing.

2.Certification Sample

Certification sample means a sample of seed drawn by a certification agency or by a duly authorised representative of a certification agency established under section 8 or recognised under section 18 of the Act.

3.Official Samples

Official sample means a sample of seed drawn by a Seed Inspector to ascertain that the seeds meet minimum limit of specified quality.

Equipment used for sampling:

1. Stick or sleeve type trier:

2. Bin sampler

3. Nobbe Trier

Sampling in the laboratory

The submitted sample is divided in the laboratory to obtain the working sample required for various tests. For obtaining the working sample the analyst should take slightly more quantity than the required weight. Sampling in the laboratory can be done by one of the following methods;

Mechanical Divider Method: In this method the sample is mechanically divided by the seed dividers such as Boerner seed divider, Gamet seed divider or soil type seed divider. This method is suitable for all kinds of seeds those which are extremely chaffy types. The apparatus divides the sample passed through it into two approximately equal parts. The submitted sample can be mixed by passing it through the divider, recombining the two parts and passing the whole samples through a second time, and similarly third time, if necessary. The sample is reduced by passing .through reaptedly and removing one half on each time. This process of successive halving is continued, until a working sample of required size is obtained.

Random Cups Method: This method is particularly suitable for seeds requiring a working sample up to 10 grams provided .they are not chaffy and do not bounce or roll (like Brassica spp.). Six to eight cups are placed at random on a tray. After a preliminary mixing the seed is poured uniformly over the tray. The seed that falls into the cups is taken as the working sample.

Modified Halving Method: It comprises a tray into which . a grid of equal sized cubical cells, are fitted. They are at the top and every alternate one has no bottom. After preliminary mixing the seed is poured evenly over the grid in the same way as it is poured in the random cups method. When the grid is lifted, approximately half the sample remains on the tray. The submitted sample is successively halved in this way until a working sample of required size is obtained.

The Hand Halving Method: This method is restricted to specific genera of chaffy seeds. The seed is poured on to a smooth clean surface and thoroughly mixed into a mound. The mound is then divided into half and each half is halved again. The process is repeated a couple of times. The halved portions are arranged in the rows and alternate portions are combined and retained. The process is repeated until the sample of required working sample size is obtained.

Spoon Method: This is for small seeds. A tray, spoon and spatula are required. Pour the seed in a tray and collect the sample randomly with spoon

Sampling by hand: Bags should be emptied or partly emptied and collect the seed by hand

Ex. Chaffy and non flowing seeds.

Procedure for sampling

1. Sampling should be carried out only by trained and experienced persons in seed sampling
2. The seed lots should be so arranged that each individual container is easily accessible.
3. On request by sampler, the owner should provide full information regarding the bulking and mixing of the lot.
4. If there is any evidence of heterogeneity, sampling should be refused.
5. The size of the seed lot should not exceed the limits.

Sampling Intensity :

While sampling seed lots are in bulk, or in containers of different sizes, or from streams of seed entering containers. The following sampling intensity is the minimum requirement.

Lot Size	**Minimum number of primary samples to be taken**
Less than 50 kg	Three
50 – 500 kg	Five
501 – 3000 kg	One primary sample for each 300 kg but not less than a total of five primary samples
3001 – 20,000	One primary sample for each of 500 kg but not less than a total of ten primary samples
20,000 kg and above	One primary sample for each of 700 kg but not less than a total of forty primary samples

For seeds in bags or other containers of similar capacity that are of uniform size the following sampling intensity is the minimum requirement. Usually a 100 kg weight is taken as the basic unit, and small containers are combined to form sampling units not exceeding this weight. Eg. 20 containers of 5 kgs each. For sampling purpose each unit is regarded as one container.

Lot Size	Minimum number of primary samples to be taken
Up to 5 containers	Sample each container and always take five primary samples
6 – 30	Sample at least one in every three containers, but never less than five.
31 and above	Sample at least one in every five containers but never less than ten.

Weight of Submitted Sample

The minimum weight of submitted sample for various tests are as follows:

1. Moisture Test: 100 grams for those species that are to be grounded and 50 grams for all other species.
2. For verification of species and cultivars : as given in the table below

Table : The minimum weight of submitted samples for determination of genuineness of varieties

Crops	Laboratory tests only (g)	Field plot & lab tests (g)
Peas, Phaseolus, Zea, Vicia, Glycine and species of other genera with seeds of similar size	1000	2000
Oryza, Triticum, Hordieum, Avena, Secale and species of other genera	500	1000

with seeds of similar size		
Beta and species of other genera with seeds of similar size	250	500
All other genera	100	250
Seed potato, sweet potato and other vegetatively propagating crops	--	250 tubers/planting stakes/roots/corms

Physical Purity Test: The purity test is done with the objective of determining the composition of seed lot so as to issue the certification tag or lable. The various components that are present in the seed lot are

1. Pure seed
2. Inert Matter
3. Other Seeds

The quality of seed lot is judged by the relative percentage of various components. If the pure seed per cent is above 98 % and other crop seeds, weed seeds and inert matter is as low as possible, the seed is considered to be pure seed.

Seed Moisture Test: The moisture content of seeds is one of the most important factors influencing seed viability and general appearance. It is important to know the moisture content immediately after harvest, prior to storage or shipment, and at various times. Moisture in seeds has a strong influence on the length of time they remain viable. Moisture content of the seed can be defined as the loss in weight when the seed is dried or the quantity of water collected when distilled. It is expressed as a percentage of the weight of the original sample.

Seed Health Test: Seed Health Testing is a Science of determining the presence or absence of disease causing agents, such as fungi, bacteria and viruses.

Genetic purity Tests:

1. Laboratory testing of seeds

2. Testing of seeds in growth chambers

3. Grow Out Test

1. Laboratory testing of seeds :

1) Morphological tests

2) Physiological tests

a) Fluorescence test

b) Disease resistance test

c) Chemical methods

2. Testing of seeds in growth chambers

Knowing the color of coleoptiles and pigmentation in cereal grains

3. Grow Out Test

The main aim of grow-out test is to determine the genetic purity of the variety of the given sample. In grow-out test plant characters that are less influenced by the environment and which are highly heritable are observed by growing the plants in the field. The variety, which is to be tested for genetic purity, should be grown in the area for which it has been released so that the characters of that variety are fully expressed. Each sample should be sown with proper spacing by adopting the recommended cultural practices so that the differences between the varieties are fully expressed.

Depending on the longevity of seeds during storage, seeds can be divided into two categories;

1. **Orthodox Seeds**: Orthodox seeds are long-lived seeds. They can be successfully dried to moisture contents as low as 5% without injury and are able to tolerate freezing temperatures. Most orthodox seeds come from annual temperate species adapted to open fields. At physiological maturity they contain moisture content of 30 – 50%.
2. **Recalcitrant Seeds**: They are short-lived seeds, which cannot be dried to moisture contents below 30% without injury and are unable to tolerate freezing. They are difficult to store successfully because of their high moisture content encourages microbial contamination and results in more rapid seed deterioration. Storage of these seeds at subzero temperatures causes the formation of ice crystals, which disrupts cell membranes and causes freezing injury. These seeds are from perennial trees in the moist tropics such as coconut, coffee, cacao, citrus etc. This seed mature and exists in their fruits and are covered with fleshy or juicy ariloid layers and impermeable testa.

At physiological maturity they contain more moisture content (50-70%) than orthodox seeds, even though their embryos are only about 15 % of the size of an orthodox seed embryo. In general recalcitrant seeds never go into dormancy but instead continue their development and progress towards germination.

Seed viability is tested by the following methods:

1. Germination test
2. Membrane permeability test
3. Automatic Seed Analyzer (ASA)
4. Lipid peroxidation measurement
5. Alpha - tocopherol test

Seed Vigour- Different Tests - Factors influencing Seed Vigour and substances required for seed vigour tests

Seed vigour can be defined as "Sum total of all seed attributes that favour stand establishment under varying field conditions" or " those seed properties which determine the potential for rapid, uniform emergence and development of normal seedlings under wide range of field conditions". This operational definition suggests that vigorous seeds germinate and produce normal seedlings under adverse soil or environmental conditions. Such a concept distinguishes vigour from germination, in that germination test it is determined under favourable conditions.

Seed Vigour Tests: They are of four types.

1. Physical tests

2. Performance tests

3. Stress tests

4. Bio-chemical tests

1. Physical Tests:

a) Seed size

b) Physical soundness

c) X ray test

2. Performance tests:

a) **First count :** Seeds which express more germination in first count are treated as highly vigourous.

b) **Speed of Germination**: The simplest method to make preliminary germination counts at a standard time before germination is completed. The seed lots, which produce the largest number of germinated seeds at the preliminary count, will produce the fastest growing seedlings and the fastest stand establishment.

A refinement of the above technique is to make germination counts every day until germination is completed or a constant count is recorded for 3 days. An index of speed of germination is then calculated by adding the quotients of the daily counts divided by the number of days of germination.

Example: Sample A: 0/1 + 0/2 + 0/3 + 8/4 + 10/5 +24/6 + 28/7 + 24/8 = 15

Sample B: 0/1 + 6/2 + 12/3 + 24/4 + 45/5 + 7/6 = 23

c) Measurement of seedling growth rate: There are three basic methods of measuring seedling growth rate, namely, determination of dry matter production, speed of germination and measurement of seedling length. Each method has several variations, which may be adapted to suit a particular crop. All these methods are related and measure the same physiological characteristics of the seed.

i) **Dry Weight of Seedlings**: This method is particularly adapted to grasses. Seedlings are grown in a green house for a period of 5 to 6 weeks. The seedlings are cut off at the ground level with a razor blade dried at 100^0 C for 24 hours and weighed. Minimum of 2 to 3 replications are required with one hundred seeds planted per replication. If seed germination is low determination on a weight per seedling basis may be more meaningful than to hundred seed basis.

ii) Seedling Length Measurement: Seeds are planted in a single row in a desirable medium. (Corn seeds and cereal seeds are planted in rolled towels, small seeded grass on top of filter or blotter paper in plastic boxes). The tests are placed in germinators at an 45^o angle. After an appropriate period, the length of roots and shoots are measured with a ruler. The average length of seedlings per sample is calculated. Six replications of 25 seeds are desirable. It is important to have the tests inclined at an angle. In this position the roots grow straight down and are easy to measure. If the tests are in a flat position, the roots grow in many directions and become entangled and it becomes impossible to measure accurately.

3. Stress Tests:

1. **Cold test for Corn**:

   The cold test for corn measures the ability of corn seed to survive and emerge under adverse field condition such as low temperature condition after sowing of the seed. These adverse conditions prevent or retard germination, leaving the seed in vulnerable condition for invasion and destruction by soil microorganisms. In general, soil gathered from a cornfield and mixed with sand is used. Various types of containers such as plastic boxes, flats or paper towels are used. The seeds are planted in the soil and the soil moisture content is adjusted to 60-80 per cent of saturation. The test is then subjected to a temperature of 6.2 to 10.0 ^oC for a period ranging from 5 to 10 days. After the cold period, the tests are transferred to a warmer temperature (27^oC). After the seedlings have emerged the percentage emergence is determined.
2. **Brick Gravel test**:

This test is similar to the soil forming a crust or soil having clods. The test is conducted by using soil or sand as media and is covered by porous type of brick gravel of 2 to 3 mm size. In vigour tests for small grain crops, about 30-mm layer of moist gravel is placed above the seed. This layer impedes the emergence of weak and partially diseased and other seedlings with injured coleoptile tips. Minor differences exist in testing procedures in various laboratories. The brick gravel exerts certain pressure on the emerging seedlings. The seedlings that emerge through the layer of brick gravel are considered as vigorous.

3. **Paper Piercing Test**:

   The brick gravel was later replaced by paper piercing test. This method utilises regular testing sand plus a special selected type of paper disc through which the seedlings penetrate in order to be considered as vigorous. The test is used for cereal crops & involves placing the seed on top of approximately 1.25 cm of moist sand, (approx.) covering of seeds with a specially selected type of paper disc and then covering the paper with 3 cm of moist sand. The tests are held at 20ºC for eight days. The seedlings that emerge through the paper disc are considered vigorous.

4. **Accelerated Ageing Test**:

   In this test, prior to placing the seeds for germination tests, seeds are aged at high temperature and RH ranging from 40 to 45 ºC and 100 percent relative humidity, for periods ranging up to seven days.

   The differences observed in standard germination percentages and germination percentages after accelerated ageing reveals the actual physiological conditions of seeds. The deteriorated seed lots give higher differences than good seed lots.

4. Biochemical Tests:

1) GADA Test ((Glutamic Acid Decorboxylase activity)

Higher the activity of enzyme, more will be seed vigour.

Ex. Maize

2) TZ test:

Topographical tetrazolium or Tz test is very useful for rapidly obtaining an indication of germination potential and viability of samples and is in extensive use.

In this biochemical test, living cells are made visible by reduction of an indicator dye. The indicator used in the Tz test is a colorless solution of a tetrazolium salt imbibed by the seed. Although a number of tetrazolium compounds can be used most workers prefer 2,3,5-triphenyl tetrazolium chloride. Within the seed tissues, it interferes with the reduction process of living cells and accepts hydrogen from the hydrogenases. By hydrogenation of the 2,3,5-triphenyl tetrazolium chloride a red stable and non-difusable substance, triphenyl formazan is produced in living cells.

This makes it possible to distinguish the red coloured living parts of seed from the colourless dead ones. In addition to completely stained viable seeds and completely unstained non-viable seeds, partially stained seeds may occur.

3) Respiration and Respiratory quotient (RQ):

4) Membrane Permeability :

5) ATP level Test

Factors influencing seed vigour:

1. Seed ageing & deterioration
2. Imbibition & vigour loss

Seed dormancy-Types, causes and methods to overcome seed dormancy

Seed dormancy can be defined as the failure of mature, intact seeds to germinate under favourable conditions. Environmental conditions necessary for germination include sufficient water, oxygen, light, and an appropriate temperature. Dormancy occurs because some property of the seed prevents germination. When mature, healthy seeds are tested over a range of conditions and fail to germinate; they are described as dormant.

Types of dormancy :

a) **Primary dormancy (Primitive or innate dormancy) :** It is most prevalent dormancy and is due to inherent properties of the seed. The seed may possess an excess of inhibitor that must be removed or reduced prior to germination only the physiological changes such as rudimentary embryo maturation, response to growth regulators, changes in temperature, exposure to light will relieve this dormancy in seeds.
b) **Secondary dormancy (Induced dormancy) :** In this, mature, imbibed seed remain dormant due to unfavourable environmental conditions like, light, temperature, O_2, chemicals etc.
c) **Physiological dormancy :** The dormancy may be considered a result of the presence of growth inhibitors, the absence of growth promoters, or a combination of both. These are controlled by light and temperature.
d) **Embryo dormancy :** When embryo is dormant then it completely fails to germinate. Embryo dormancy can be complicated by other factors. Seeds with immature embryos can only be germinated after allowing sufficient time for the embryo to mature.

Methods to overcome seed dormancy :

Several workers have considered that the outer most region of the tests, particularly waxy cuticle is the major impermeable barrier.

All the methods of over-coming hard seededness depends upon some alternation of the physical integrity of the seed coat. In some way, the seed coat must be ruptured or punctured. Different methods of breaking seed dormancy are :

1. Use of solvents – Hot water, organic solvents. Hot water treatment is effective in legumes (Soak in Hot water 80^0C for 1-5 Minutes)
2. Scarification (Scratching or chemically weaking the seed coat to permit imbibition of water) :This is also to overcome hard seed coat dormancy.
   - Mechanical scarification : In electrical scarification helps to overcome dormancy in a number of legume crops. Minute scratches are done by rough surface in the seed coat. Cut or injury to seed coat or pricking of seed coat may also break seed dormancy.
   - Acid scarification : By treating with conc. H_2SO_4 for 60,120 seconds. H_2SO_4 helps to dissolve the hard seed coat which will improve water absorption.
3. Stratification : Pre-chilling hastens the post harvest maturation which may decrease germination inhibitor like ABA (Abscisic acid) and increase GA (Gibberelic acid) content. Extreme cold -50^0C to -100^0 C will cause fractures in the seed coat.
4. Pre-drying : Pre-dry at 40^0 C for 1to 4 weeks also helps in breaking seed dormancy.

Advantages

1. A degree of dormancy in certain crops is desirable since it prevents pre-harvest sprouting (vivipary) and helps in maintaining seed quality.
2. Impermeable seed maintain seed quality under adverse condition of harvest (Damp season) and storage (High humidity) particularly in cotton.
3. Since germination of many non-dormant seed types is greatly reduced after 1-2 years and in some cases after just six or fewer months, hence dormancy can increase storage life of seeds.

Disadvantages

1. Seed dormancy may be complex and puzzling challenge to the seed analyst and seed researcher.
2. When domesticated species exhibit dormancy, they become a problem to the Seedman, his customers and seed analysts.
3. Dormancy interfere planting schedule.
4. Dormancy create uneven and delayed field emergence. Hence, uniform population can not be maintained in the field.
5. Dormancy may cause seed of numerous species to remain ungerminated in the soil for many years.

Seed Health –Significance- Factors affecting seed health-Different Tests – Seed Packaging – Materials used for Packing

Seed health testing is essential in determining the presence or absence of disease causing agents, such as fungi, bacteria and viruses; and animal pests, such as eelworms and insects in the seed samples. The extent of presence of disease infected seeds or the infestation by insect pests determines the seed health status of a seed sample, and by inference seed lots.

Significance of seed health:

1. To determine the health status of a seed lot.
2. To know whether the seed lot meets the requisite certification standards or not.
3. To obtain objective proof of whether the lot meets the requisite quarantine requirements.
4. Occasionally, health test may also be made for tracing the cause of low germinating capacity or poor field emergence due to diseases or insect pests.

Until and unless we do not know the healthy status of the seed it is not possible to manage the disease. To know health of the seed, different testing methods for different pathogens/diseases of different crops have been developed.

Factors affecting seed health:

1. Crop management practices
2.S Harvesting
3.Drying
4.Storage etc.

TESTING METHODS FOR SEED-BORNE FUNGI / DISEASES

1. **Examination of dry seeds :**

   It is applied for detection of seed-borne fungal pathogens which cause discoloration of the seed or change the shape and size of the seed. Also applicable for detecting fungal structures present in, on or with seed.

   Procedure : Working sample – 2000 seed.

   All parts of seed sample are examined carefully by naked eye for the presence of discoloration and fungal structures and non seed material are removed and identified.

   Examples : Karnal bunt of wheat *Neovossia indica*
   Ergat of bajra *Claviceps fusiformis*

2. **Washing test :**

This method is used particularly for smut and bunt fungi in Graminaceous hosts except loose smut of wheat and barley. It can also be used for downy mildew (*Peronospora manshurica*) of soybean and tumour disease (*Protomyces macrosporus*) of coriander.

Procedure : Sample is taken by weight / number of seed and put in conical flask containing sufficient water. The flask is shaken for 5-10 minutes. Drops from the washing water are examined under microscope for identification fungal spores.

Examples : Flag smut of wheat *Urcystis agropyri*

Smut of pearl millet *Tolyposporium penicillariae*

3. **NaoH seed soak method :**

Applied for Karnal bunt of wheat and bunt of rice.

Procedure : Working sample – 2000 seeds.

Seeds are soaked in 0.2% NaoH for 18-24 h at 20-25^0 C. after this swollen seeds are spread over blotter paper to remove excess water/moisture. Infected seeds giving jet black appearance can be separated from healthy seeds.

4. **Blotter method :**

This method is widely used. All kinds of cereals, vegetables, crucifers, legumes, or namentals and forests seeds are tested by this method.

Procedure : Working sample 400 seeds usually.

Seeds are planted on well water soaked filter paper and incubated at 20$\pm$2^{0}C usually for 7 days in alternating cycles of 12 h light and 12h darkness. Then individual seed is examined under stereo-microscope and fungi are identified based on habit characters.

In fast germinating seeds 2,4-D (2,4 dechlorophenoxy acetic acid) @0.10 to 0.20% solution is used to check the growth of the seedlings.

This can be replaced by deep freeze blotter method (20^{0}C for 1st day, then at -20^{0}C for the 2nd day and 20^{0}C for 5 days).

Examples : Black and grey leaf spot of crucifers, *Ascodhyta* blight of chickpea

5. **Agar plate method :** This method is used for detection of same type of pathogens as in blotter method. Those fungi which are not easily detectable in blotter method can be detected by this method.

Procedure : Working sample 400 seeds

Seed are planted on aseptic medium after treating with 1 to 2% sodium hypochlorite and incubated in the same way as in blotter method. Fungi are identified based on colony characteristics. Colonies with doubtful identity should be examined under compound microscope.

Examples	Pathogen	Medium
	Alternaria triticina	Nutrient agar
	Fusarium oxysporum	Nutrient agar

6. **Seedling symptom test :** This test is applicable for those fungi which are capable of producing symptoms on the root and shoot of the young seedlings. This test for certain pathogens, provides information pertaining to field performance of the seed lot.

   Procedure : Seeds are sown in autoclaved soil or sand or any type of other media and incubated at 20^0C for 14 days under 12h of alternating cycles of artificial light and darkness. After incubation individual seedling is examined and per cent infection is calculated.

   Examples : *Alternaria* spp. In crucifers and wheat
   Fusarium spp. in a number of hosts

7. **Embryo count method :** This method is specifically used to detect loose smut of wheat and barley. Downy mildew, *Sclerospora graminicala* of bajra can also be detect by this method.

   Procedure : 2000 seeds are soaked in 5% solution of NaoH and 0-0.2% (200 ppm) trypan blue solution for 24h at 25-30^0C. Pass the material through different sieves of 3.5, 2.0 and 1.0 mm size along with showers of tap water. Dehydrate the embryos with methylated spirit or 95% ethyl alcohol for 2-3 minutes. Transfer the embryos in lactophenol and boil for 2 minutes and observe the embryos under stereomicroscope for the presence of mycelium. Calculate the per cent infection.

8. **Non destructive seed health test :** This test is conducted on high valued germplasm that can not be sacrificed as in conventional method. This test is easily applicable in large seeded crops such as corn, soybean and common bean, however, it can also be applied in small seeded crop like alfalfa, cabbage and lettuce. It consists of extracting tissue from dry seed with a metallic drill or cork borer (1 to 3 mm) and testing extracted tissue for the disease. This test does not decrease germination rate and also help in detection of the disease.

Seed Packaging: After processing and treating are completed, seeds are packaged into containers of specified net weight. Packaging or bagging is essentially the last operation in which seeds are handled in bulk flow. The packaging consists of the following operations:

1. Filling of seed bags to an exact weight.
2. Placing leaflets in the seed bags regarding improved cultivation practices
3. Attaching labels, certification tags on the seed bags, and sewing of the bags.
4. Storage/shipment of seed bags.

Equipment Used for Packaging of Seeds

A) Bagging

(i) Bagger–weigher: Bagger weigher and bagging scales used in seed packaging may be manual, semi-automatic or automatic.

ii) Manual weighing
iii) Semi-automatic
iv) Automatic scales
v) Platform scales
vi) Bag sewing machine

Packaging Material:

The choice of packaging materials and amount of seeds to be packed depend on kind of seeds to be packed, duration of storage, storage environment, the seed moisture content, the cost of seed, the cost of packaging material, the geographical area where the seeds will be stored.

Types of packaging material:

1. Moisture vapour permeable container, e.g., jute (burlap) bag, cloth bag paper bag, multiwall paper bag :
2. Moisture vapour resistant container, e.g., jute bag laminated with thin polythene film : and
3. Moisture vapour proof container, e.g, tin can, polythene bags, aluminimum foil pouches, glass bottles.

The packaging materials should protect most physical qualities of seed and should have sufficient tensile strength, bursting strength and tearing resistance to withstand the handling stresses. Such materials may not always protect the seeds against either insect pests or moisture regain.

Seeds act, 1966 - Features- Statutory bodies established under seeds act-GATT agreement – Plant Variety protection – Seed coating and pelleting – Intellectual Property Rights –Plant Breeders Rights

The seed act was passed in the parliament on **29.12.1966** with an object of regulating the quality of seed for sale. It came into force throughout the country on **2nd Oct, 1969**.

The main features of the seed act 1966 are

1. **Applicability** : **-** It is applicable to the seed and vegetatively propagating material seed for sowing
2. **Sanctioning Legislation:** – Authorises establishment or formation of ***Central Seeds Committee***, the ***Central seed Certification Board***, ***SSCA*** and ***Central and State seed Testing laboratory*** etc.
3. **Regulatory Legislation:** – Regulates the quality of seed sold in the market and includes establishment of suitable agencies for regulating the seed quality
   There are about ***25 sections*** in ***Seed Act –1966*** which are listed below

   1. Short title extent and commencement
   2. Definitions
   3. Central Seeds Committee
   4. Central Seed Laboratory and State seed Laboratory
   5. Power to notify kinds or varieties of seeds
   6. Power to specify minimum limits of germination and purity etc.
   7. ***Regulation of sale of seeds of notified kinds or varieties***
   8. Certification agency
   9. Grant of certificate by certification agency
   10. Revocation of Certificate
   11. Appeal
   12. Seed Analysts
   13. Seeds Inspectors
   14. Powers of seed Inspectors
   15. Procedure to be followed by seed Inspectors
   16. Report of Seed Analyst
   17. Restriction on export and import of seeds of notified kinds or varieties
   18. Recognition of seed certification agencies of foreign countries
   19. Penalty
   20. Forfeiture of property
   21. Offences by companies

22. Protection for action taken in good faith
23. Power to give directions
24. Exemptions
25. Power to make rules

Statuary bodies and agencies established in India under the Seeds Act 1966:

1. **Central Seeds Committee:-**
   It is the main source of advice to central government on administration of seed act and any other matter related to seeds. It consists of

   A chairman,

   2 representatives of seed growers,

   8 nominees from central govt. and

   1 representative from state government.

   The main ***functions*** are

   1. to advice central and state govt. on ***all matters related to seeds***
   2. To advice the govt. on ***notification*** of varieties
   3. To advice the govt. on the ***minimum limits*** for ***germination*** and ***purity*** of kind/variety
   4. To recommend ***procedure*** for seed certification, ***GOT*** and analysis of seeds
   5. To recommend on rate of ***fees*** to be charged for analysis of samples by central and state Seed Testing Laboratories and for Certification by certification agency.
   6. To recommend to central govt. regarding suitability of any seed certification agency established in ***foreign country*** for seed act.
   7. To advice central and state governments regarding suitability of ***establishing Seed Testing Laboratories.***
   8. To send recommendations on ***proposals*** related to seed act.
   9. To suggest ***clarification*** on any matters relating to seed act.

2. **Central Seed Certification Board**: **-** To deal with all problems related to seed certification and to co-ordinate the work of sate seed certification agency.

3. **State Seed Certification Agency**: – on the recommendations of Central Seeds committee, SSCA is established as a society having ***governing body*** and an ***executive wing.*** The governing body consists of Persons from state government, Seed producing agencies,Farmers, Subject matter specialists And seed law enforcement agencies.

The executive wing consists of seed inspectors, seed certification officers and seed analysts.

Functions:-

1. To ***certify*** the seeds of any ***notified variety***
2. Outline the ***procedure*** for submission of application and for seed production.
3. Maintain a ***list of*** recognized ***breeders***
4. ***verification*** of the application for certification
5. Take samples and inspect seed lots to ***confirm*** quality of seed lot as per the standards of certification.
6. To ensure ***production of quality seed*** by field inspection, seed processing plant inspection etc. to issue certificate i.e. tags, labels etc.
7. Undertake ***educational programmes*** to promote the use of certified seed.
8. Maintain ***records*** relating to certified seed production.

4. **Central Seed Testing Laboratory**:**-**
The ***Seed Testing Laboratory*** at IARI, New Delhi has been notified as **CSTL**. The functions assigned to this laboratory are

   1. Initiate seed testing program in collaboration with state seed testing laboratory to promote ***uniformity*** in test results.
   2. Collect data on the quality of seeds found in the market and make this data available to Central Seeds Committee.
   3. Carry out functions assigned by Central government from time to time.
   4. Act as referee laboratory in testing seeds.

5. **State Seed Testing laboratory** –
   1. To carry out ***seed analysis work*** of the state. To test the seed of dealers for physical purity, germination, inert matter, weed seeds, other crop seeds etc.
   2. To test the seed samples of farmers who wish to get their own seed tested before selling,

   3. to test samples sent by seed inspectors
   4. To test samples of seed for seed certification agency
   5. Testing required for ***revalidation*** and other purposes.
6. **Appellate Authority** –
   1. It is appointed by the state government to look into grievances of ***seed producers*** against ***seed a seed certification agency*** and
   2. To look into the grievances of ***seed traders*** against ***seed law enforcement*** officials.
7. **Recognition of SCA's of foreign countries:** –

   Central government may establish any seed certification agency established in an foreign country for the purpose of Indian Seeds Act 1966.

GATT Agreement :

The General Agreement on Tariffs and Trade (GATT), signed on October 30, 1947, by 23 countries, was a legal agreement minimizing barriers to international trade by eliminating or reducing quotas, tariffs, and subsidies while preserving significant regulations.1 The GATT was intended to boost economic recovery after World War II through reconstructing and liberalizing global trade.

The GATT went into effect on January 1, 1948.2 Since that beginning it has been refined, eventually leading to the creation of the World Trade Organization (WTO) on January 1, 1995, which absorbed and extended it.3 By this time 125 nations were signatories to its agreements, which covered about 90% of global trade.

Criteria for new plant variety protection and registration:

DUS tests are carried out to ensure that a new variety is Distinct from existing varieties, that its characteristics are Uniform, and that the variety is Stable with consistent phenotypic characteristics from one generation to the next.

1. Novelty : It refers to newness of a variety. A variety which has not been grown for more than one year prior to the application for registration can be protected.

2. Distinctness: The variety should be clearly distinguishable from other varieties for atleast one characteiristic.

3. Uniformity: It refers to same type of population.

4. Stability: The variety should give stable performance.

Seed coating: Seed coating is defined as the substance applied to seed that does not obscure its shape. It includes any process for the addition of materials to the seed. The major benefit of a seed coating is that the seed enhancement material placed on to the seed. Small amount of seed is needed as compared to broadcasting is one of the most economical approaches for improving seed performance.

Seed coatings can be done in different ways *viz.*, Chemical protectants (Captan, Apron, Vitavax, etc,), microorganisms (Rhizobium, Trichoderma), Slurry coating, Film coating and Temperature – sensitive polymers (Intellicoat).

Seed Pelleting: It is a process of enclosing the seed with a small quantity of inert material just large enough to produce a globular unit of standard size to facilitate precision planting. It is used to alter seed shape, surface properties, density and size to enable more precise seed singulation and placement in the planting tray or soil. Seed pelleting technology is also used to deliver a range of beneficial additives, including micronutrients and plant protection agents. The pellet contains chemicals, fungicides, polymers, dyes, filler material and adhesive.

Intellectual Property Rights:

The right on an invention to derive economic benefits for his invention (*i.e.* intellectual property) is called as intellectual property rights (IPR). The IPR however is recognized by the govt. only as long as it is not detriment to the society.

Protection of Intellectual Property Rights:

The protection of IPR may take several forms depending on the type of intellectual property and the type of protection sought. Each form of protection has its own advantages & disadvantages. The main forms of IPR protection are as follows.

1. Trade secrets
2. Patents
3. Plant Breeder Rights (PBR)
4. Copyright

Plant Breeder Rights:

These are the rights granted by the Govt. to plant breeder, or owner of a variety to exclude others from producing commercially the propagating material or that variety for a period of 15-20 years.

To qualify for PBR protection a variety has to be ***novel, distinct*** from existing varieties and ***uniform*** and ***stable*** in its essential characteristics. A person holding PBR title to a variety can authorize other organizations to produce and sell the propagating material of that variety.

PBR in India:

India had evolve a ***sui generis*** system of PBR Which means a system of their own. The essential features of UPOV - 1978 act are being considered for adoption. Some important features of the Indian *sui generis* system are

1. Farmers rights
2. Researchers right to use the material for research
3. Protection period of ***15 years*** for annuals and ***18 years*** for fruit trees
4. Compulsory deposit of the material in national gene bank
5. Establishment of National Authority for the protection of Breeders, farmers and researchers use rights.

Benefits of PBR:

1. Profits obtained by breeders through PBR will act as an incentive in promoting Plant Breeder research.
2. It encourages private companies to invest in Plant Breeding Research.
3. It will enable access to varieties developed in other countries & protected by IPR laws
4. Increased competitiveness among various organizations engaged in Plant Breeding is likely to benefit both farmers and the nation

Disadvantages of PBR:

1. PBR will encourage *monopolicy* in genetic material for specific use
2. It *suppress free exchange* of genetic material and encourage unhealthy practices
3. The PBR holder may produce less seed and *increase the price* for achieving more profit.
4. Farmers privilege to resow the seed produced by him may be gradually diluted
5. PBR may result in increased cost of seed and may be burden for poor farmers.