What is Seed?

Definition:

Seed is a mature integumented megasporangium or mature ovule consisting of embryonic plants together whit store food material covered by a protective coat (mega sporangium i.e. female gametophyte –the pistils are the female reproductive organs called megasporophylly in the flowering plants) the ovary of the carpel contains ovules (megasprorangia)

Definition of Seed technology:

Cowan (1973):

Defined as “That discipline of study having to do with seed production, maintenance, quantity and preservation

Feistritzer (1975):

Defined seed technology as the method through which the genetic and physical characteristic of seeds could be improved.
It involves such activities as variety development, evaluation and release seed production, seed processing, seed storage, seed testing, seed certification, seed quality control, seed marketing etc.

Role and Goal of Seed Technology in Crop Production

Role of Seed Technology:

Feistritzer (1975) outlined the few roles of improved seed.

1. Seed – a carrier of new technologies.
2. Seed – a basic tool for secured food supply.
3. Seed – The principle means to secure crop yields in less favorable production areas.
4. Seed – a medium for rapid rehabilitation of agriculture in case of natural disaster.

1. **A carrier of new technologies**:

The introduced of quality seed of new verities and combined with other inputs significantly increased yield level e.g. in cereals, yield increased up to 112%, in potato – 24% & sugar beet - 142% in U. S. A. & central Europe. In India the cultivation of high yielding verities have helped to increase food production from 52 million tones (1947) to nearly 200 million tones in 2000-2001

2. A basic tool for secured food supply:
The successful implementation of the high yield verities programme in India has led to a remarkable increase the production. As a result, food imports from other countries have been substantially brought down in spite of the rapid population increase.
3. The principle means to secure crop yield in less favorable area of production: The supply of good quality seed of improved verities, suitable to these areas is one of the crops. Immediate contribution that seed technology can make to secure higher crop yield

Goals of Seed Technology:

The measure role of seed technology is to increase agriculture production through the spread of good quality seed of high yielding verities.

1. Rapid Multiplication:

Increase in agricultural production through quickest spread of new verities developed (released) by the plant breeders.

2. Timely supply:

The improve seeds of new verities must be made available well in time, so that farmer is planned planting schedule (or showing time) without disturbed. They are able used good seed for planning (sowing) purpose

3. Assured high quality of seeds:

Is necessary to obtain the expected dividends from the use of seeds of improved verities

4. Reasonable price:

The cost of high quality seed should be within reach of the average farmer.

Seed Dormancy

Definition:

Non – germination of seeds due to absence of suitable conditions is termed as dormancy.

OR

A physical or physiological condition of viable seed, which prevents germination even in the presence of favorable conditions

The seed dormancy is divided in to three groups

1. Endogenous
2. Exogenous
3. Combined

Cause of seed dormancy/ factor responsible for seed dormancy

Genetical factor / cause:

1. Physiological
2. Embryo dormancy
3. Undeveloped cotyledon
4. Immature embryo

Coat imposed dormancy:

1. Seed coat factor:

a. Seed coat impermeable to water – i.e. water does not entered into seed coat
b. Seed coat impermeable to oxygen (0 is not entered in seed coat)
c. Mechanically resistant seed coat.

2. Embryo factor:

1. Dormant embryo
2. Immature/ Rudimentary embryo

3. Inhibitory factors:

Presence of germination Inhibitors in seeds i.e. presence of inhibitors or release of inhibitors.

Methods of Breaking Seed Dormancy

Various methods have been used by seed scientist and technologists to break the dormancy of seed.

Simple and widely used methods are

A. Scarification:

Any treatment i.e. physical or chemical that weakness the seed coat, is known as scarification. Scarification method is applied, when dormancy is imposed by hard seen coat e. g. in legumes- cajanus cajan, (tur), gram etc.
In this method there are various way to break hard seed coat such as:

1. Seeds are either rubbed on a sand paper manually. At the time of rubbing care should be taken that not to damage the axis of the seed e.g. Green gram & subabool.
2. When seed coat is too hard i.e. of woody nature, the seed coat has to be removing completely by breaking it. E.g. Rubber (Havea app) seed India teak wood seed.
3. Soaking treatment: Soaking hard seed coat in concentrated or diluted solution of sulphuric acid for 1 to 60 minutes, it remove seed coat impermeability. E. g. cotton seeds, India teak wood seeds etc.

B. Temperature Treatments:

1. When the dormancy is due to embryo factor i.e. the seed is incubating at low temp. (0- 5o C) over a substratum for 3 to 10 days placing it at optimum temp. Required for germination. E.g. mustard. – (Brassica campestrits)
2. Some seeds required a brief period of incubation (from a few hours to one to five days) at 40 to 50 oC before germinating at required temp. (in this method care should be taken that moisture content of the seed is not more than 15% e.g. paddy (Oryza Sativa)
3. Hot water treatment is also an effective method of breaking hard- seed ness in legumes. In this method the seeds are soaked in water at 80oC temp. For 1 – 5 minutes (depending up on the type of seed) before putting for germination.

C. Light Treatments:

Same seeds do not germinate in dark thus it provides continuous or periodic exposure of light is essential e. g. Lettuce (Lactuca Sativa) required red light (660nm) or white light is essential for germination to occur.

D. Treatments with growth regulators & other Chemicals:

Endogenous dormancy may be due to presence of germination inhibitors. Application of low level of growth regulators (i.e. Gibberellins, Cytokinins and Ethylene etc) may break the seed dormancy. Most widely used growth regulators are gibberellins and kinetics e.g. seeds of sorghum crop presoaking seed treatment with GA3 at the conc. Of 100 ppm have been used for breaking seed dormancy .Among other chemicals potassium nitrate (0.2%) and thio – urea (0.5 to 3%) are widely used for breaking seed dormancy in oat (Avena Sativa), barley (Hordeum vulgare), tomato (Lycopersicon spp). (For prepare 100 ppm solution of GA3, weigh 100 mg of GA3 & dissolve in a few drops of alcohol and make up the final volume (1000 ml) by adding distilled water). (50 ppm kinetin 5 mg dissolved in few drops of alkaline made with sodium hydroxide and makes the final volume 100ml it gives to final conc. Of 50 ppm)

Principles of Quality Seed Production

During seed production strict attention must be given to maintenance of genetic purity and other qualities of seed in order to exploit the full dividends sought to be obtained by introduction of new superior crop plant varities.

Genetic principles:

- ***Deterioration of varities***:

Genetic purity (trueness to type) of a variety can be deteriorating due to several factors during production cycles.

The important factor & real deterioration of varities listed by Kadam (1942) & these are

1. Developmental variations
2. Mechanical mixtures
3. Mutations
4. Nature crossing
5. Minor genetic variations
6. Selective influence of diseases
7. The technique of plant breeder

Mechanical mixtures, natural crossing and selective influences of diseases are most important reasons for genetic deterioration.

- ***Mechanical Mixture:***

Mechanical mixture may take place at the time of sowing, it more than one variety is sown with same drill or through different varieties grown in adjacent field. Two varities growing alongside each other the field are often mixed at the time of harvesting and threshing operation. Threshing equipments (i.e. threshing machine) is often contaminated with seeds of other varities. The gunny bags, seed bines are also quite responsible mechanical mixture with seeds of other varities. To avoid mechanical mixture, it must be necessary to rogue the seed fields and care should be taken at the time of harvesting, threshing and handling.

- ***Natural Crossing*:**

In sexually propagated crops, natural crossing is most important source of vertical deterioration.

The deterioration in varieties due to natural crossing is of three reasons

1. Natural crossing with undesirable type
2. Natural crossing with diseases plants
3. Natural crossing with off- type of plants

According to Bateman (1947) genetic contamination is seed field due to natural crossing depends upon the some factors and these are

a. The breading system of species
b. Isolation distance
c. Vertical mass
d. Pollinating agents.

As the isolation between varieties is increased the contamination decreases. Isolation of seed crop is a primary factor in the seed production of crop plants of cross pollinated by wind or insects and their activities, humidity and temp. at the time of anthesis etc.

- ***Selective Influences of Diseases*:**

New crop varieties often become susceptible to new races of diseases often caused by parasite.

Some vegetative propagated stocks deteriorate fast it infected by viral, fungal and bacterial diseases. It is very important to produce diseases free-seeds /stocks.

Genetic Purity during Seed Production

The various steps suggested by Hartmann and Kester (1968) for maintaining genetic purity.

The steps are

a. Providing adequate isolation to prevent contamination by natural crossing or mechanical mixtures.
b. Rouging of seed fields, prior to the stage at which they could contaminate the seed crop
c. Periodic testing of varieties for genetic purity
d. Avoiding genetic shift by growing crops in areas of their adaptation only.
e. Certification of seed crops to maintain genetic purity & quality seed.
f. Adopting generation system. (the seeds produced is restricted to four generation only i.e. starting from breeders seeds.) and the seeds can be multiplied up to three more generations i.e. foundations, registered and certified.
g. Grow-out – tests: The important factors / safeguards for maintaining genetic purity during seed production are

Control of seed source:

For raising a seed crop the seeds should be required from an approved source and from an appropriate class is necessary.

Four classes of seeds are generally recognized in seed certification namely breeder seed, foundation registered and certified. These classes are recognized by **AOSCA** i.e. ***Association of official seed certifying agencies***.

1. **Breeder's seed:** Is a seed or vegetative propagating material which is directly controlled by sponsoring breeder of institution & which provides increases of foundation seeds.
2. **Foundation seed**: is a seed stock so as to maintain specific genetic identity and purity and may be designated or disturbed by agriculture experiment station. Production must be carefully supervised by representatives of the station. Foundation seed is the source of all other certified seed classes, either directly or through registered seed.
3. **Registered seed:** Registered seed is the progenies of foundation and it is handled so as to maintain genetic identity and purity and that has been approved by and certified by certifying agencies.
4. **Certified seed:** Is the progeny of foundation, registered or certified seed, that is handled to maintain genetic identity and purity and that has been approved by and certified by certifying agencies.

Preceding Crop Requirements:

Preceding Crop Requirements has been fixed to avoid contamination through volunteer plants and also from soil borne diseases. (Volunteer plants mean plants grown in the field from previous crops).

Isolation:

Isolation is required during seed crop production to avoid contamination due to natural crossing and diseases infection by wind and insects from neighboring field and also during sowing, harvesting, threshing and handling of seeds to avoid mechanical mixtures. The isolation distance is different from crop to crop and from different classes of seeds. i.e. certified seeds & foundation seed plots

Rouging of seed fields:

The off time plants i. e. plants offering in their characteristic from those of the seeds variety is another source of genetic contamination. Their continued presence would certainly deteriorate the genetic purity of the variety. The removal of such type of plant is referred as "rouging".

There are *three* main sources of off- type

1. The off-type plant may be arises due to presence of recessive genes in heterozygous condition at the time of release of variety. (The recessive genes may also arise by mutation).
2. Off-type plants are due to volunteer plants or from seed produced by earlier crop.
3. Mechanical mixtures also constitute the major source foe off- type plants.

Seed certification:

The genetic purity in commercial seed production is maintained through a system of seed certification. The objective of seed certification to maintain and make available crop seeds, tubers, bulbs, etc. which are of good seeding value and true to variety for seed certification purpose well experienced and qualified personal are required from seed certification agency & they carry out field inspection at appropriate stage of crop growth. They also make seed inspection variety the seed crop/seed lot is of the requisite genetic purity and quality. After harvest crop they variety the quality and at the processing plants they take samples for seed testing and also for grow-out-test.

Grow- out – test:

Varieties being grown for seed production should periodically be tested for genetic purity by grow – out – test, to make sure that, seed being maintained in their true form.

Seed Purity

When a farmer buy a seed from any recognized institute or company, he expect to receive a good quality seed and not a mixture of other crop seed, weed seeds, straw etc. It is not possible to remove all these admixtures completely with the use of cleaning machine is & some seeds always remain present and there is necessary to take purity test or analysis, to determine how much % of the admixture is present in the seed. To avoid admixture in seed of a particular variety or crop the buyer can be protected by the seed regulation laws or acts in many countries, for this purpose in many countries “seed testing stations or seed testing laboratory” are set up & these stations or laboratory are associated with ISTA (International seed testing association)

Stages of Seed Multiplication

The benefits of an improved variety are not released unless enough true seed has been produced for its commercial spread. The initial amount of pure seed which is limited in quantity is multiplied under various stages or classes or seed these are:

a. Nucleus seed b. Breeders seed c. Foundation seed
d. registered seed e. certified seed

Nucleus seed:
It is the initial amount of pure seed of an improved variety available with plant breeder who has involved it. The nucleus seed is sent per sent pure genetically as well as physically and is very limited in quantity.

Breeder’s seed:
It is the seed obtained from the progeny of nucleus seed. It is directly supervised by a breeder concern with the crop. Its genetically and physical purity to be 100 per cent.

Foundation seed:
It is seed obtained from nucleus or breeder’s seed. It is produced on seed multiplication farm of a state govt. or grill. Universities. Foundation seed plots are jointly inspected by the SCA (seed certification agency), it is not as pure as the nucleus and breeder’s seeds are. The bags are sealed with white colored label.

Registered seed:
It is raised from nucleus, breeders or foundations seeds. Registered seed growers are selected from progressive farmers. The maintenance of purity from time to time. The purity is maintained through field inspections by seed certifying agencies and seed tests. The bags are sealed with purple colored label.

Certified seed:
It is progeny of registered or foundation seed. When the amount of seed registered seed id supposed to be inadequate to meet farmers agency. The bags are scaled with purple colored label.

Seed Certification

Seed certification is a legally sanctioned system for quality control of seed multiplication and production and which consists the control measures are

1. It is an administrative check on the origin of propagating material for the purpose of trueness to purity (genetic purity).
2. Field inspection: At the time of growing a crop for seed production purpose. The data should be obtained on trueness to varietals purity, isolation of seed crop to

prevent crops- pollination, mechanical admixtures and diseases dissemination, objectionable weeds and admixtures.

3. Supervision on agricultural operations i.e. intercultural operations, harvesting, storage, transport and processing etc. for identity and quality of lots.
4. **Sample inspection:** For quality and to maintain genetic purity, a lab test of representative samples drawn by the S.C.A. for determining,% of germination moisture content, weed seed content, admixture and purity.
5. **Bulk inspection:** For checking homogeneity of the bulk as compared with the sample inspected.
6. **Control Plot Testing:** Samples drawn from the source seed and the final seed produced can be grown in the field along with standard samples of the variety.

The purpose of seed certification is to maintain and make available high quality seed and propagating materials of notified plant varieties.

Phases of Seed Certification

Seed certification has five phases of these are:

1. Verification of seed source.
2. Inspection of seed crop in the field.
3. Supervision at post-harvest stages including processing and packing.
4. Seed sampling and analysis.
5. Grant of certificate, certification tag, tables and sealing.

Concepts of Seed Certification

The **AOSCA** (association of official seed certifying agencies) have given some fundamental concepts of seed certification & these are:

1. Pedigree of all certified crops must be essential.
2. The integrity of certified seed growers must be recognized.
3. Field inspection must be made by through qualified field inspectors.
4. Verification trials to establish and maintain satisfactory pedigree of seed stock.
5. For keeping proper records to establish and maintain satisfactory pedigree of seed stock.
6. Standard should be maintained for purity and germination.
7. The principles of sealing seeds to protect both grower and purchase must be approved.

Steps Required for Organizing Seed Certification

The various steps are required for organizing seeds certification are:

1. Establishment and operation of seed certification agency.
2. Establishment of minimum seed certification standards.
3. Establishment of procedure for field inspection, seed processing, seed sampling and testing, tagging and sealing etc.

Seed Certification Agency

The broad principles for forming a seed certification agency are:

a. Should not involve in production and marketing seeds.
b. It should have a autonomy body.
c. The seed certification standards and procedure adapted by S.C.A should be uniform. The same standard and procedure should be adopted through out the country.
d. It is closely associated with technical institute. Its relationship with other institute should be clearly defined.
e. Should be operating on a no-profit-no loss basis.
f. Technique staff (adequate) trained in seed certification should be maintained.
g. Prevision for creating adequate facilities and timely inspections.
h. It should be served in the interests of seed produces and buyers.

Structure of Seed Certification Agency

a. **Director**: The director is responsible for the all over functioning of the company. He should be the member of secretary of the board of director and also the chairmen of various committees framed time to time with specific problem.
b. **Supervisors (seed certification officers):** For each group of related species under certification e.g. cereal seeds, vegetable seeds etc. He should the put in charge of supervising the field inspector’s work and observes the rules and regulations, minimum standers are met or not. He should trained seed inspectors and other personal involved in inspection.
c. **Seed Certification Inspectors:** He should be a trained and technical based of the seed certification system. During field inspection season, he must be willing to work long hours during peak period. He should be encourage and pursuable seed growers and seed producer to adopt new techniques and scientific finding. He should be good at public relation and also to guide and lead farmers by his devotion to work.

Duties and responsibilities of Seed Certification Agency

1. To arrange for suitable application, inspection and report forms.

2. To identify source of breeders seed. That can be used as the basis for further multiplication.
3. Through field inspection, that prescribes the minimum standard for isolation, planting ratio, raguing etc.
4. To assists seed growers and producers in obtaining suitable planting seed. This is especially in case of H.S.P.
5. To assists seed producer at the time of harvesting, drying & processing.
6. To draw a seed sample and inspect seed lots & submit such sample to the seed testing laboratory for maintaining the prescribed seed standards.
7. To issue appropriate seed certification tags for seed lots.
8. To maintain adequate records. So that the eligibility of specific lot can be determined in subsequent years.
9. Close working relationship between seed growers, dealers, research personals government's officials, etc.
10. To take appropriate corrective actions against rigorously any violation of prescribed standards or complaints from uses of certified seeds.

Meaning of Seed and Its Importance

Seed:

Any plant part used for raising the crop is seed. Seed include true seed seedling cutting, rhizome, grafts, roots etc used for Propagation.

Botanically seed is matured integument mega sporangium. Seed is also defined as matured ovule consisting or embryonic together with store of food surrounded by protective coat.

Importance of Seed in Crop Production:

Seed is crucial and basic input to increase crop yields per unit area. The importance of seed in crop production is known to human being since Vedic period. There is clear mention in ancient literature yajarveda "May the seed viable,may the rains plentiful and may the grains ripe days and nights"

History of agriculture progress from early days is also the history of seed of new crops and varieties. The progress was very fast from last three decades. The green revolution was only possible with production of generally pure seeds possessing other qualities namely high generation, high vigours high physical purity and sound health. Hence green revolution is in fact seed revolution.

Only seeds of assured quality can be expected to respond to fertilizer and other inputs in expected manner, otherwise see of hope may turn into seed of frustration. Among the inputs used by farmers seed in the cheapest input. It is basic inputs and forms small part of the total cost of cultivation. The good seed also increase the efficiency of the factor of crop production.

Difference between Seed and Grain

The difference between seed and grain is given as below:

Sr.No	Seed	Grain
1	Any plant part used for propagation is seed. It includes seeds category , rhizome , grafts etc.	It is final produce of grain crops used for consumption.
2	Can be treated with fungicide, pesticide.	Not treated with fungicide and Pesticide.
3	Embryo is important.	Endosperm is important.
4	Viability is important.	Viability never considers.
5	Genetic purity must.	Genetic purity not necessary
5	Genetic purity must.	Genetic purity not necessary
6	Comes under preview of seed acts.	Comes under preview of food acts.

Concept of Seed Technology

Seed is biological industry. Being seminal importance to agriculture seed is strictly speaking an “Embryo“ a living organism embedded in supporting food storage tissue. The business of seed technology is to protect this biological entity and look after its welfare. Good agricultural depend upon good quality seed. The progress in agriculture depends upon production and marketing of good quality seed of high yielding varieties. The science, seed technology takes care of all these aspects.

Seed Technology:

Seed technology is the science dealing with the methods of improving physical and genetical characteristics of seed. It involves such activities as variety development, evolution and release of varieties, seed production, seed processing, seed certification and storage. Thus seed technology is interdisciplinary science which includes broad range of subjects. It also includes seed quality control, seed marketing, seed distribution and research on above aspects of seed.

Seed Technology includes following Branches.
1) Seed Production
2) Seed Processing
3) Seed Certification
4) Seed Testing
5) Seed Biology
6) Seed Storage
7) Seed Entomology
8) Seed Pathology
9) Seed Marketing.

Role of Seed Technology

The role of Improved Seed Technology is Given Below:

1) Improved Seed is Carrier of New Technology:
Introduction of quality seed of new varieties wisely combined with other inputs significantly increases the yield level. In India cultivation of high yielding introduced dwarf wheat varieties helped to increases the production from 12 million tones making country self sufficient with in span of 10 years.

2) Improved Seed is Basic Tool for Secured Food Supply:
Due to successful implementation of high yielding variety programme in India crop productivity is significantly increased as a result import is substantially reduced. The export is increasing in majority of crops in spite of rapid population increase.

***3) Improved Seed is a Principal Means to Secure Crop Yields in Less Favourable Areas of Production*:**
Good quality seed of suitable varieties helped in securing higher crop yields. In disaster region E.g M-35-1 drought resistant variety in Jawar served as a boon in drought prone area in rainy season.

***4) Improved Seed is a Medium for Rapid Rehabilitation of Agriculture in case of Natural Disaster*:**
In the wide spread droughts and floods, it is much economical if government had National Seed Reserve Stock (NSRS) at their disposal. NSRS plays two fold roles. i) It

provide improved seed in emergency period in production areas, and ii) To supply seed for resowing in disaster region (Normally which is not available with farmer in time).

Goals or Objects of Seed Technology

Major goal of seed technology is to increase agricultural production through spread of good quality seed of high yielding varieties developed by the plant breeders, well before the planting season at reasonable cost. Following are important objectives of seed technology.

1) Rapid Multiplication:
It is the quickest possible spread of new high yielding varieties and hybrids developed by the plant breeder.

2) Timely Supply:
The improved seed of available well in time, so that the planting schedule is not disturbed and they are able to harvest the good crop.

3) Assured High Quality Seed**:**
The expected divided in agriculture from use of improved seed is possible with use of good quality seed.

4) Reasonable Price**:**
The cost of quality seed must be within reach of average farmer. The cost of the seed must be cheap and farmers should able to purchase it.

Seed Demand Forecasting

The assessment of effective seed requirement is critical to any planned seed programme. The underlying principle in making demand forecasting should be that the seed supply keeps place with seed demand (both present and future) in terms of quantity , quality, price, place and time. The outcome of such approach would be planned seed production and marketing would also avoid shortage and gluts and as well as ensure stable price and profits.

In Making Demand Forecast, the following Factors must be Considered Carefully:
a) Total cultivated acerage, seed rate, quantity replacement period and assessment of total potential seed requirement of each important crop.
b) Impact of extension efforts on the introduction of improved production techniques and future plans for promotion.
c) Current acerage under high yielding varieties and amount of seed sold in last year.

d) Cultivar preference for varieties, package, kind of packing, quality and price.
e) Number and size of competition.
f) Kinds of publicity and sales promotion those are most effective.
g) Climate of the area where seed is being marketed.
Assessment of potential effective seed demand of the market based on total seed requirement is very little value, since the demand for high quality seed normally exists for crop area which is under good fertility and irrigated condition. The requirement for the remaining crop area covered by uncontrolled production material obtained from the preveious crop production. Further more, experience shows that the varietal purity and the yield potential of high quality seed of self pollinating varieties can be maintained by farmers during reproduction processes, without significant deterioration for three to four generation. Therefore individual farmers not only need to replace seed of self pollinated varieties every third year or fourth year. Thus demand for high quality seed of self pollinated crop is not higher than 25-30 percent of total requirement for area under crop. A rather different approach must be taken 19 n marketing of hybrid seed, in which case new seed is needed by the farmer each season. Although, the critical period may be rather difficult the subsequent planning is easier, particular after sales statistics are seen to point in certain direction. The dealers need to make periodic surveys of the market areas to determine market potential, at least one season in advance. Dealer advance orders should be treated as information material to aid production sector in organizing an effective production programme.

General and Genetic Principal of Seed Production

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 of Seed Production:
Genetic purity of a variety can deteriorate due to several factors.
Important Factors Responsible for Deterioration of Genetic Purity of Crop Variety

1) Developmental Variation:

When varieties are multiplied outside area of normal cultivation. There is danger of developmental variation and genetic change or shift may appear in the varieties. Sometimes it becomes necessary it raise the seed crop outside their area of adaptation to maintain steady supply of good quality seed. E.g Seed production of flowers there should not be rains during harvesting period; hence seed production needs to be taken outside the normal area of cultivation, where there are no rains in post flowering period. Similarly seed production of rainfed cotton varieties can be taken under irrigated conditions which reduces land requirement significantly as productivity of material as irrigated crop is high. Disease free potato seed production is always taken at hilly region of simala though potato is extensively cultivated in plain regions. The extent of developmental variation increases with

1) Number of generation out the area of adaptation.
2) Condition of adaptation – The varieties bred for extreme condition i.e disease resistance, drought resistance against cold, show greater deterioration.
3) Mode of pollination –the cross pollinated crops varieties deteriorate faster than self pollinated.
4) Stability of genotype-Unstable genotype deteriorates fastly.

2) Mechanical Mixture:

This is dangerous source of variety deterioration. It occurs commonly when

1) More than one variety is sown in same piece of land.
2) When same drill used for sowing number of varieties.
3) It occurs when numbers of varieties are threshed on same yard.
4) It also occurs when same threshing machine is used for threshing number of varieties.
5) It also occur when gunny bags and storage bins are reused for storage of seed.

It happens when proper care is not taken during different operations. To avoid mechanical mixture to keep sufficient isolation is always desirable.

3) Mutation:

This is not serious factor for varietal deterioration. Minor mutations are difficult to identity. To avoid deterioration due to mutation minute observations and timely roughing is essential.

4) Natural Crossing:

It depends upon natural cross fertilization it may be due to

1) Natural cross with undesirable types
2) Natural crossing with diseased plants.
3) Natural crossing with off types.

Once the natural cross fertilization taken place the deterioration take place at cellular level and such deterioration is can not be rectified. In self pollinated crops the natural crossing is not serious factor of source of contamination and deterioration but it is serious in cross pollinated /Crops. The extent of cross pollination depends on varies factors

Precautions for Maintaining Genetic Purity in Seed Production

a) ***Control of Seed Source***:

Appropriate class of seed purchased from approved source should be used for raising the seed crop. Breeder seed used for raising foundation seed plot and foundation seed used for raising certified seed plot. Seed must purchased from approved sources like Agril University, Agril. Research Station or Maharashtra State Seed Corporation. (MSSC).

b) Crop Requirement**:**

There should not be same crop in the preveious season to save genetic contamination from volunteer plants. They are unwanted plants of the same crop growing in the seed field from the seeds that remain in the field from preveious year crop.

c) Isolation**:**

It helps to avoid natural crossing with undesirable plants, as well as to avoid mechanical mixture during sowing and harvesting.

There are two types of isolations.

a) Space Isolation:

Space between seed field and contaminant.

b) Time Isolation**:**

The flowering of contaminant and seed field should not coincide with each other. In certified seed production programme time isolation is not permitted and space isolation must be followed as per crop standards.

c) Rogueing**:**

Removal of undesirable plants from seed production field is called rogueing. It includes removal of 1) Volunter plants

2) Offtypes plants

3) Diseased Plants

4) Other crop plants

5) Objectionable weed plants.

Rogueing is responsibility of seed grower. The rogue plants are removed before they caused contamination for cross pollinated crops every days rougeing during flowering.

Stage of Seed Multiplication Agencies Involved in Production

1) Nucleus Seed:
Original breeder who has developed the variety or hybrids.

2*) Breeder Seed*:
Original breeder sponsored breeder.

3) Foundation Seed (Stage I and Stage II):
State Agril.Universities.
(Stage I and Stage II) Taluka Seed Farms, State Farms, Private Seed Companies, State Seeds Corporation, N.S.C and (National Seed Corporation)

***4) Register Seed*:**
Progressive farmers or registered seed Growers.

***5) Certified Seed (Stage I and Stage II*):**
State seeds corporations, private seed companies and individual seed producers N.S.C (National Seed Corporation)

***6) Truthful Seed*:**
Any individual.

Quality Seed should have following Criteria

a) It should meet minimum genetic purity.
b) It should have good germination.
c) It should be free from infection of seed borne disease and stored grain pests.
d) It should not contain impurities like other crop seed, trash material beyond permissible limits.

What is Nucleus Seed

It is the initial amount of pure seed of improved variety or parental lines of a hybrid produced under supervision of the plant breeder who has evolved that variety of hybrid. The nucleus seed is genetically cent percent pure and does not contain other physical impurities. The nucleus seed is produced strictly under isolation so as to avoid both genetically and physical contamination. Nucleus seed should retain original vigour of the variety or parental line. About 500 to 1000 individual plants (IPS) which are vigorously growing and healthy are selected from the nucleus bulk-plot before flowering starts. Observations are recorded on each IPS for all the important morphological characters viz plant height , stem colour, hairiness, pigmentation, growth habit, colour and shape of different plant parts, days to flowering and maturity. The IPS which are a) Off types or b) affected by seed borne disease are removed and discarded. The individual IPS selected are harvested and threshed separately and their seed produce is dried, cleaned and stored in separate cloth bags or paper bags with proper labeling. The seed of each IPS is examined for seed characters and for oil content if it is an oil seed crop. The seed produce of each IPS is weighed. The seed yield per IPS , 1000 (or 100) seed weight and data on other quantitative characters more than mean+ S.E are retained as source for raising next year's nucleus seed and of rejected IPS is bulked with general produce. Seed produce of IPS selected during preveious year is grown as plant to row progeny during subsequent year. Observations are recorded in all the plants form each IPS for important characters. The IPS which shows off types are discarded and harvested before flowering so as to avoid contamination. 500 to 1000 vigorous growing healthy and true to type IPS are selected from remaining progeny rows and their produce is subjected to harvesting, processing and statistical analysis as described earlier. The produce of selected individual (IPS) is utilized for raising plant to row progenies in the next year. The selected plant to row progenies are harvested and processed in individual bulks. Their seed is examined, weighted and subjected to statistical analysis for mean and S.E. The progenies which show seed yield more than mean+ S.E are bulked together which becomes source for breeder seed. In case of cross pollinated crops it is essential to self IPS as well as each plant from every bulk before flowering for preveious cross pollination.

What is Breeder Seed?

It is the progeny of nucleus seed. Generally breeder seed is produced in one stage. But if there is greater demand for breeder seed and there is low seed multiplication ratio then breeders seed can be produced in two stages, viz Breeder stage I and II. In such cases breeder seed, stage I becomes source for breeder Stage II. Breeder seed can be produced by original breeder, sponsored breeder on Agricultural University farms and rarely on government farm. Breeder seed plots are subjected to joint inspection by a team consisting of crop breeder from other Agricultural Universities in the State, representative of All India Coordinated Research Projects of the crop, National Seeds Corporation, State Seeds Corporation and Divisional Seed Certification Officer. Breeder seed produced should meet all prescribed standards viz. genetic purity (99.9 % more), physical purity (98%) . Germination (as per crop) moisture content (less than 12%). After passing the seed lot, breeder seed tags in buff colour or Golden Yellow are signed by the concerned breeder and tagged to the breeder seed bags size of tag 12X 8 cm.

Foundation Seed and Registered Seed

Foundation Seed:

It is the progeny of breeder seed and can be produced in two stages viz. Stage I and Stage II. Foundation seed is produced on the farms of State Agril. Universities, Taluka Seeds Farms, other Govt. farms, State Seeds Corporations and Private seed companies. Foundation seed plots are required to be registered for certification with state seed certification agency. They are jointly inspected by a team consisting of Divisional Seed Certification Officer, concerned crop breeder and District Seed Certification Officer when foundation seed meets minimum seed certification standards including field tests. It is certified as foundation seed and after processing and testing of seed completed bags are tagged with white coloured tag and label together and sealed the bag by using lead seal size of foundation tag is 15 X 7.5

Registered Seed:

It is progeny of foundation seed produced by progressive formers or registered seed growers according to technical advice and supervision provided by NSC. It is inspected by representative of seed certification agencies from DSCO office. The registered seed is genetically pure. It is labeled with purple colour tag.

Certified Seed and Truthful Seed

Certified Seed:

It is the progeny of foundation seed. Plots of certified seed are offered for certification with seed certification agency which inspects the plots during crop growth and at harvesting. After processing seed samples are drawn by seed certification officer and sent to STL seed for seed testing. When seed lot meets certification standards prescribed for the crop. Then It is processed, bagged, tagged with blue colour tag and label together and sealed by using lead seal. Size of tag 15X 7.5 cm.

Truthful Seed:

It is the category of seed produced by cultivators, private seed companies and is sold under truthful labels. But field standard and seed standard should maintain as per seed act and certified seed stage. Under the seed act, the seed producer and seed seller are responsible for the seed.

Source of Seed and Stages of Seed Multiplication

Sr.No	Stages of Seed Multiplication	Source of Seed
1	Nucleus , IPS	Nucleus
2	Breeder-Stage I	Nucleus
3	Breeder-Stage II	Breeder
4	Foundation Stage I	Breeder I or II
5	Foundation Stage II	Foundation Stage I
6	Certified Stage I	Foundation Stage I or II
7	Certified Stage II	Certified Stage I
8	Truthful Seed	Breeder to Certified Stage II.

Principles of Quality Seed Production of Foundation and Certified Seed

Use of quality seed of improved variety of notified variety of hybrids is a basic input in cultivation of any crops as it ensures high crop stand, vigorous and healthy crop growth and thereby it ensures high productivity of that crop. Use of certified seed assures the cultivators in getting quality seed, as certified seed production is subjected to the process of seed certification, and as per provisions of the seed Act only those seed lots which are offered for certification and which meet minimum certification standards are certified and other lots are rejected from certification. Production of certified seed of any notified variety or hybrids or parental lines of hybrids requires technical knowledge of the principles involved and timely adoption of provisions of seed certification. It is therefore essential for the seed producer to acquaint with the principles of certified seed production. Certified seed production can be undertaken for foundation stage (for varieties, and inbreds or parental lines of hybrids) and for certified stage for only notified varieties and hybrids.Before undertaking certified seed production either of foundation or certified stage, it is necessary to get well acquainted with the basic principles of seed production and formalities required to be completed.

Requirements of Certified Seed Production

1*) Source of Seed*:

Appropriate / proper class of seed need to be obtained from approved source according to stages of seed multiplication. In case of foundation seed, breeder seed with yellow or buff coloured tag is to be used for sowing while for certified seed production, certified foundation seed with white tag is to be used. While purchasing the breeder or foundation seed, following precautions are to be taken.

a) The bags containing breeder seed or foundation seed should intact with lead seals not tampered or removed.
b) Certification tag i.e yellow tag for breeder seed and white tag for foundation seed should be stitched to the bag and intact. It should be signed by seed certification officer / crop breeder.
c) While procuring the seed, period of validation or revalidation noted on the tag be checked. If the validity or revalidation period of the tag is expired, the seed should not be used for seed production. The source of purchased seed should be verified by SCA before sowing.
d) The empty bags and the tags should be preserved properly till the seed is certified. It helps in giving documentary evidence if legal dispute arises. The tags are also required to be produced at the time of field inspections. Generally seeds of notified varieties are multiplied in four tier system i.e nucleus seed, breeder seed, foundation seed and certified seed.

2*) Registration of Seed Plot:*

When the seed plot is to be offered for certification, it is necessary to register the said plot for certification with District Seed Certification Officer. For this an application is to be made in prescribed form (Form A) and is to be submitted to District Seed Certification Officer along with agreement bond on stamp paper of Rs.100/ duly notarised or registered with Taluka magistrate. The registration fee is to be paid in the treasury on challans as per following rates.

Sr.No	Stage	Type	Fees to be Paid
1	Certified	Varieties	Rs.80.00 per acre seed plot area
2	Certified	Hybrids	Rs.160.00 per acre seed plot area
3	Foundation	Varieties Inbred Parental lines	Rs.160.00 per acre seed plot area

4	Form fee	-	Rs.10.00 per form for (F/S and C/S)
5	Application fee	-	Rs.30.00 per grower for F/S and C/S
6	Late registration fee	-	Rs.50.00 per grower for (F/S and C/S)

The Application form with agreement bond are to be handed to seed certification office along with a copy of **challans.** It is necessary to adhere to the last date prescribed for registration of seed plots. In any case, if the seed plot is not registered within 15 days after sowing or last date and late registration date prescribed by director of SCA. It is likely that the seed plot may not be accepted for certification.

3*) Land Requirement:*

a) The land selected for seed production should be suitable for that crop. It should be medium to deep and well drained light soils, sandy soils or waterlogged soils should not be selected for seed production as such lands affect crop growth and thereby reduce the seed yields.
b) The land selected for seed production should be comparatively free from soil borne diseases, insect pests and noxious weed seeds.
c) As far as possible the land selected for seed production should not have same crop grown in the proceeding season. However, if same crop is grown in the proceeding season, then it should be irrigated three weeks before sowing so that seed of preveious crop that had fallen the soil will start germination. The land should be harrowed for removing seedlings of volunteer plants, weeds, other crop plants.
d) It is desirable to have protective irrigation source.
e) The selected land should meet isolation requirement.

4) Isolation Requirement:

Isolation is the separation of seed field from the fields of
a) Other varieties or hybrids of same crop.
b) Same variety of hybrids which do not conforming to varietal requirements.
c) Other related species which are readily crossable and
d) Fields affected by designated diseases prevent genetic and disease contamination.

When a seed plot is grown in isolation, it ensures that no cross pollination takes place. Plants from the seed plot and plants of same species or closely related species thereby help in maintaining the genetic identity of the seed plot. Isolation of seed plot can be maintained by two ways i.e

a) Time isolation and
b) Space isolation.

In case of **time isolation**, sowing of seed plot is adjusted in such a manner that the seed plot does not came to flowering at the same time with the neighbouring crop of same variety or other variety of the same crop or related species. Sowing of the seed plot is usually carried 15 to 21 days before or after emergence of the neighbouring crop. This time isolation helps is preventing the genetic contamination of the seed crop as seed plot comes to flowering either before or after the neighbouring crop completes its flowering time isolation is not allowed in certified seed production.

Space Isolation:
Space isolation is the minimum distance kept between the seed plot and neighbouring plot of same crop which prevents natural cross pollination and physical contamination. During pollination, pollens are carried from one plant to other either through air or insects. The pollens remain viable for some period before they reach stigma of female flower for pollination. The viability period of pollens which varies according to the species depends upon the size and weight of pollens, and climatic conditions viz. air temperature and air humidity. In case of cross pollinated crops, pollens are liberated in air and are carried thought air to some distance before they reach stigma. The distance upto which pollens are carried in viable conditions varies according the species which in turn, varies according to weight of pollens. E. g In case of highly cross – pollinated crops the isolation distance is much higher as the pollens of these species can travel longer distance in viable condition. In case of self pollinated crops as pollination occurs before opening of the flowers, isolation distance is less to prevent physical contamination.

Sr.No	Crop	Mode of Pollination prescribed (mtrs)	Foundation Distance	Certified Distance
1	Rice, Wheat, groundnut, soybean	Self Pollinated	3	3
2	Jowar (Open pollinated varieties), Tur , sunflower	Often cross pollinated	200	100

3	Cotton, Jute	Often cross pollinated	50	30
4	Jowar hybrids	Cross pollinated	300	200
5	Maize a) Inbreeds and single crosses b) Hybrids c) Composites	-	400	-
6	Mustard, Sunflower	-	400	200
7	Bajara (Hybrid)	-	1000	200
8	Lucerne , Berseem	-	400	100
9	Cole Crops	-	1600	1000
10	Gram	Self Pollinated	10	5

It is necessary to maintain prescribed isolation distance on all sides of the seed crop throught the cultivation of seed crop. The seed producer should visit all areas surrounding the seed plot which lie within the isolation distance and see that no plants belonging to the crop of seed plot of its closely related species comes to flowering. Such plants should be removed before they set flowers.

5*) Cultivation Practices and Plants Protection:*

Cultivation practise recommended for the crop are required to be adopted timely so as to get good stand of seed crop and thereby higher seed yields. It consists of
a) Good land preparation.
b) Use of optimum seed rate with timely sowing.
c) Application of FYM and fertilizers at recommended doses and as per schedule of split application.
d) Timely weeding and Interculturing.
e) Timely control of pests and diseases.
f) Timely application of irrigations.
g) Watching the seed plots from birds, stray animals.

***6) Roughing*:**
Rouge is an undesirable plant or off type growing in the seed plot. Roughing is the removal of individual plants which differ significantly from the normal type of the variety. The most important object of the seed production is to maintain genetic purity of the variety or hybrids seed plot. For this purpose it is necessary to follow rouging vigorously.

Rouging consists of removal of

a) Off types
b) Volunteer plants
c) Pollen shedders in female (A) lines,
d) Plants of noxious weeds and other crops,
e) Diseased plants affected by seed borne diseases growing in the seed plot and
f) Tassels from plants in the female rows of seed production of single hybrids and double hybrids in maize.

It is necessary to carry rouging vigorously and punctually throughout the crops growth i.e till harvesting. Rouging is to carried in three phases. i.e a) Pre Flowering, b)During Flowering and, c) Post flowering or before harvesting. During pre-flowering period plants which are morphologically distinguishable from true characters of the variety should be removed. Similarly volunteer plants, other crop plants, weed plants should also be checked. During flowering period which lasts for 15 to 30 days rouging should be carried more critically and all off types, volunteer plants, and pollen shedders in M.S lines should be removed before shed pollens. Timely rouging during flowering helps in preventing natural cross pollination and also reduces the proportion of off types. Simultaneously isolation area on sides of seed plot be checked for removing volunteer plants before they flower. Plants affected by seed borne diseases, other crop plants and tall growing weed plats should also be removed. In case of seed plots of both single and double hybrids of maize work of detasseling should be carried in female lines before they shed pollens. Roguing should be continued during seed development stage and before harvesting for removing visibly distinct off types other crop plants and diseased plants. Post flowering rouging is admissible in seed production of self pollinated crops.

***7) Field Inspection*:**

As per provisions of seed certification, the seed plots offered for certifications are subjected to field inspection by the staff of seed certification agency. The number of field inspections is usually carried without prior intimation to the seed producer. It is the responsibility of the seed producer to follow the instructions given by the field inspector. For this purpose seed producer or his responsible representative remain present on the field during each inspection. During the field inspection, source of seed used with tag isolation planting rouging are checked and counts of off types, shedders etc are taken. A copy of inspection report is handed over to the producer. Seed producer should see that all operations required to maintain prescribed genetic and physical purity of seed plot are carried before each inspection, otherwise carelessness on part of the seed producer may result in rejection of seed plot from certification.

***8) Harvesting, Threshing, Drying and Sealing of Raw Seed*:**

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

***9) Seed Processing*:**

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

***10) Bagging, Tagging*:**

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

***11) Release of Seed Lot*:**

The certified seed lot is released to the seed producer for sale. But foundation seed lot is released after getting FT report.

Rs…………only

Seal

Seed Certification Agency

Maharashtra State

Application for Certified Seed Production Programme

(Use Separate Application for Different Crop/Variety)

1. **Full Name**:

2. **Location**:

a. Address:……………….

b. Village Name:…………

c. Post Office:……………

Pin code:………….

d. Taluka:………….

e. District:…………
f. Ref. Phone No:…………
g. Near by S.T Stand:…………..km……..
h. Near by Railway Station ……..km………..

3. Crop Details:
a. Crop Name:……..
b. Variety:………….
c. Hybrid /Improved:…….
d. Male Seed:……..
e. Female Seed:……

4. Seed Source Details :
a. Name of Product:……….
b. Source Seed:…………….
c. R.O Number:……………
d. Lot. Number:……………
e. Other Information:………

5. Load Details:
a. Survey / Gut Number: ………..
b. Local Name:…………..
c. Area Hectare…………….
Acre:……………

6. Farmers Name:
(North):…………
(South):…………
(East):………….
(West):………….

7. Seed to be Produced : Found I/ Found II/ Certi I/ Certi II

8. Sowing Date: …………..

9. Name of Agency :…………

10. Fee Details:
a. Registration Fee:………..
b. Inspection Fee:……..
c. Challan No:………..
d. Late Fee:…………..
e. Total:………
Date :…../……… Application’s Signature

For Office Use Only:
Registration No:…………..
District Code : …………..
No of Units:…………..
Taluka Code:………….
Field Inspection: Two inspections I at flowering and II before harvesting.

Harvesting:

1) The seed crop should be taken from seed certification officer for harvesting the seed plot.
2) The crop is harvested by taking care to ensure that there will be no physical contamination with neighbouring crop.

Drying:

The initial moisture content of freshly harvested seed is usually high in between 15 to 25% .It is therefore necessary to dry the seed produce to bring its moisture content to safe level of 12% or less. For this purpose , the harvested material is dried in sun light for 4 to 6 days. During drying , the produce should be turned over frequently so that all portion of the produce is exposed to sun and also it facilitates free air circulation.

Threshing:

After proper drying the seed produce is to be threshed by using bullocks, tractors, or suitable thresher. The thresher should be thoroughly cleaned from inside for removing seed of preveious crop. The speed of the thresher should be adjusted by choosing appropriate size of pulley so as to prevent mechanical damage to the seed.
After threshing, the produce should be winnowed for removing husk, bhusa and other trash material. In case of groundnut, pods are removed from the plants by twisting with hands or by beating the plants on wooden plank. All dry leaves, twigs and soil pieces etc should be removed. Then the pods are sieved for removing shrivelled and undersized pods. When the seed produce is properly dried, threshed and cleaned, raw seed is filled in gunny bags and after putting the threshing slip inside the gunny bags, these gunny bags are sealed by seed certification officer and marked the gunny bags with all details of seed information. The sealed seed produce is transported to the seed processing plant for further processing along with threshing certificate, if the produced seed is to be transported to other district processing plant to obtain interdistrict transport certificate from district seed certification officer and submit the same to the seed processing plant, it is subjected to processing which consist of following steps. All seed processing done under the supervision of Agril Officer of S.C.A.

1. Drying if seed moisture content is more than 12%
2. Precleaning
3. Grading
4. Seed Treatment
5. Weighing, Bagging
6. Tagging and Sealing
7. Release the seed lot

Seed Yield (Q/ha):

1. Rice= 20-25
2. Wheat=20-25
3. Soybean=10-12
4. Groundnut=8-10 Rainfed

Groundnut- 20-25 Irrigated

5. Gram= 15 -20 Irrigated

Foundation and Certified Seed Production in Sorghum

Notified **Varieties**:
Jowar (Kharif): CS-3541, SPV-465, SPV-465, SPV-475, SPV-86, PKV-801.
Jowar (Rabi): M-35-1, Swati, Selection-3.

Land Requirement:
The land selected for seed production of any of these crops should be medium to deep, well drained and have irrigation facility. The land selected for seed production should not have been used for raising same crop during preveious growing season.

Isolation Requirement:
The isolation distance prescribed for seed production of different crops is as under.

Crop	Isolation Distance (m) Foundation	Isolation Distance (m) Certified
Jowar	a-200	100- For other Jowar Variety
	b-400	400- For Johnson Grass
	c-400	200- For forage sorghum

Season Sowing Period of Seed Production:
As in other crops, seed production of often cross pollinated crops should be taken during proper season and during optimum period as detailed below:

Sr.No	Crop	Season	Optimum Sowing Period

1	Jowar	Kharif	Immediately after commencement of Monsoon and not later than I week of July.
2	Jowar	Rabi	II Fortnight of Sept.

Source of Seed:
Breeders seed and foundation seed should be used for raising foundation and certified seed crops respectively. Before sowing of these breeder seed and foundation seed source verification must be done from seed certification agency.

Production Technology:
Package of practices recommended for cultivation of these crops should be adopted viz, seed rate, spacing, proper sowing , fertilizer , application , Interculturing, weeding, plant protection, irrigation, etc.

Sr.No	Crop	Major Pests	Major Disease
1	Kharif Jowar	Shoot fly stem borer	Grain mold, grain smut.
2	Rabi Jowar	Shoot fly , aphids	Grain smut, sugary disease.
3	Tur	Pod borer, pod fly	Pod borer, pod fly, fuserium wilt, and sterility mosaic.
4	Cotton	Bollworms, aphids, red cotton bug, dusky cotton bug	Alternaria leaf spot, Bacterial leaf blight.
5	Safflower	Aphids	Alternaria leaf blight.

Roguing:
Roguing should be carried vigorously from early stage of crop and continued till flowering completed. During rouging, off types, volunteer, other crop plants and diseased plants should be removed from the seed plot and from the areas within isolation distance on all sides. Off types and volunteer plants should be rogue before they come to flowering. Seed plot should fulfill minimum field standards. (Appendix VIII).

Field Inspections:
2 to 3-1 inspection at pre-flowering stage and remaining during flowering to harvest.

Harvesting:
In case of Jowar, tur and safflower when more than 50 percent leaves turn yellow, the seed crop has reached the stage of maturity. In cotton when 30 percent or more balls are

fully opened, the crop is ready for picking. If Jowar seed plot is caught in the rains before or during harvesting, the seed is likely to get affected by grain mold which reduces the germination. In such cases the ear heads of the standing crop be sprayed with Thirum at 1 kg/ha in 500 litres of water.

Drying:

1) The produce brought to the threshing yard is spread in thin layers on threshing floor and exposed to sun drying for 4 to 6 days.
2) In case of cotton, seed cotton should be dried by putting it on gunny bags or tarpaulins so as to avoid contamination with soil and trash.

Threshing:

1) Seed produce of Jowar, is threshed by using tractor or a thresher and the seed is precleaned by winnowing. The raw seed is filled in clean gunny bags with marking sealed by seed certification staff and taken to the recognized seed processing plant with T.C.

Processing:

Steps Involved in Processing:

A) Jowar, Tur, Safflower:
a) Drying if need,
b) Precleaning
c) Cleaning and Grading
d) Seed treatment
e) Release of seed lot

B) Cotton:

a) Drying, if needed
b) Precleaning
c) Ginning,
d) Hand grading or grading followed by delinting (acid or gas)
e) Seed treatment
f) Bagging, tagging and sealing.

Seed Yield (Q/ha):

1) Jowar-30 to 40
2) Tur- 15 to 20

Foundation and Certified Seed Production in Bajara

WCC-75, ICTP- 8203, ICMV-870901, RHR-1 (SANGAM) , I.C.M.S. 7703

Land Requirement:

The land selected for seed production of any of the cross pollinated crop varieties should not have same crop grown in the preveious season or year. In case of castor and sunflower, preveious crop should not have been grown in two successive seasons unless the preveious crop was grown from certified seed of the same variety.

The land should be medium, levelled and well drained. If the seed production of sunflower is taken on deep soils then crop is likely to be affected heavily by the disease, Rhizoctonia wilt. In case of castor, it will produce more vegetative grown on heavy soils.

Isolation Requirement:

In case of cross pollinated crops, pollination is mainly carried through wind and by honey bees, it is therefore necessary to observe isolation requirement more scrupulously.

Crop	Minimum Isolation Distance (M)
Bajara Varieties	Foundation-400, Certified-200

Season:

Seed production of Bajara, Maize and Sunflower can be taken during Kharif, Rabi, as well as summer seasons. However, seed production should not be taken during summer seasons as high temperatures creates problem of poor seed setting in Maize and Sunflower. In areas where late rains are received in September when Sunflower crop is in flowering stage sunflower seed production should not undertaken during Kharif season, because late heavy rains during flowering helps in development of the disease, Rhizoctonia wilt which kill almost all sunflower plants standing in the field. Optimum period for sowing of seed plots of Bajara, is upto 15 th July in Kharif season.

Source of Seed:

Breeder seed and certified foundation seed be used for production of foundation and certified seed of those crops respectively.

Cultivation Practices:

Recommended package of practices viz. seed rate, spacing, fertilizer application , plant protection, irrigation, weeding, hoeing should be carried timely so as to get maximum seed yield.

Roguing:

Roguing should be started from Pre-flowering stage and continued vigorously during flowering. During Roguing off types, volunteer plants, other crop plants, tall weed plants should be removed before they come to flowering from the seed plot as well as from areas within isolation distance on all sides of the seed plot.

Field Inspections:

In case of maize, sunflower and castor varieties, minimum two field inspections are carried out while in Bajara seed plots are subjected to three field inspections. First inspection is carried before flowering for checking source of seed, isolation and remaining inspections during flowering when isolation, off types etc. are checked.

Harvesting, Drying, Threshing :

When more than 50 percent of leaves turn yellow, the crop has reached to the stage of maturity. After seeking the permission of seed certification officer, the cobs of maize ear heads of Bajara are cut and brought to threshing yard where they are spread in thin layers for drying. In case of castor , plants are cut and brought to threshing yards in bundles. The seed produce is exposed to sun for drying for 5 to 6 days. The cobs of maize are shelled by using maize Sheller while seed produce of sunflower and Bajara is threshed by thresher. In case of castor threshing is done by beating with sticks. The threshed produce is cleaned by winnowing and raw but clean seed produce is filled in clean gunny bags, sealed and are transported to seed processing plant for processing.

Seed Processing:

Steps involved in processing of the seed of Bajara, Maize, Sunflower, and Castor are

a) Pre-drying if needed

b) Precleaning and Grading

c) Seed Treatement

d) Bagging, tagging, and Sealing

Seed Yields (Q/ha) :

Bajara: 10 to 15 q/ha.

Seed Production in Hybrid Jowar and Bajara

Special techniques related to commercial seed production of hybrids.

Terminology Used:

1) ***Cytoplasmic Genetic Male Sterility***:

Male sterility due to interaction between cytoplasmic factors and nuclear factors is termed as cytoplasmic genetic male sterility. Now days, this is used in Jowar, Bajara, Maize, Cotton and Rice crops.

2*) Male Sterile Line (A line):*

It is the female parent of the hybrid which does not produce functional (fertile) pollens. It is designated as A line or M.S. line, E .g 2077A, 296A,CK-60A, AKMS14A, 27A.

3) *Male Fertile Line (B line):*

It is the isogenic line of male sterile line with only one difference that it produces functional (Fertilized) pollens. It is designated as a b line or maintainer line E. g 2077B, 296 B, CK-60B.

4) *Restorer line (R line):*

It is the male parent of hybrid and when it is crossed with male sterile line it restore fertility in the resulting hybrid. It is designated as R line E.g IS84, CS-3541, AKR150, RS-29, RS-585, C43.

5*) Pollen Shedders:*

These are the plants of B line present in the A line in hybrid seed production.

6) *Synchronization*:

It is simultaneous flowering of male and female parents in seed production is known as synchronization. It is essential for commercial large scale production of hybrids in different crops.

7) *Nicking*:

The synchrony in flowering of male and female parent is termed as nicking.

8) *Planting Ratio*:

It refers to the optimum number of female parent rows to the number of row in male parent in hybrid seed production plot for cent percent seed setting in female / seed parent in crossing block. It depends upon nature of pollination, pollen viability, and stigma respectively, wind velocity, height of male parent in crossing block.

9) *Border Rows*:

In hybrid seed production plot, minimum male parent rows, are grown ground the seed plot in order to supply continuous ample pollens to seed parent and also to avoid natural cross pollination and mechanical mixture etc these rows are termed on border rows.

Stages of Seed Production in Sorghum and Bajara Hybrids:

Sr.No	Stage	Parents Involved
1	Breeder Multiplication	A line, B line, A X B programme for of 'A1'
2	Foundation	A line, B line, R line B X B Programme for multiplication of B line and R X R programme for multiplication of R line.
3	Certified Multiplication	A X R lines (hybrids) A X R programme for multiplication.

Notified Jowar hybrids and their parents of Hybrid (F1) which is harvested from A line,
Jowar:

Sr.No	Jowar Hybrid	Female Parent (A line)	Male Parent (R line)
1	CSH-1	CK-60A	IS-84
2	CSH-5	2077 A	CS-3541
3	CSH-6	2219 A	CS-3541
4	CSH-8R	36A	PD-3-1-11
5	CSH-9	296A	CS-3541
6	CSH-10	296A	SB_1085
7	CSH-11	296A	MR-750
8	SPH-201	296A	PVR-10
9	CSH-12R	296A	M 148 -138
10	CSH-12R	296A	Rs 29
11	CSH-14	AKMS-14A	AKR150
12	CSH-15 R	104 A	Rs-585
13	CSH-16	27A	C43

Bajara:

Sr.No	Hybrid	Female Parent (A line)	Male Parent (R line)
1	Shradha	RHRB 1 A	RHRBI138
2	Saburi	RHRB-5A	RHRBI-458
3	MH-179	821-A	ICP-451
4	MH-169	841-A	D-23

5	MH-143	841-A	ICMP-243
6	MH-208	81-A	H-90/4-5

Selection of Land:
The land selected for seed production of Jowar/ Bajara hybrids should have medium to deep and well drained soils. The land should be more or less uniformity leveled. The land selected for hybrid/Bajara/Jawar seed production should not have preveious crop of Jawar / Bajara. In case, Jowar/ Bajara. In case, Jowar, Bajara crop is taken during preveious season or year, the land should be irrigated at least 3 weeks before sowing of seed plot and germination Jowar/Bajara seeds should be removed by harrowing.

Isolation:
Isolation distance prescribed for foundation and certified by Jawar, hybrid Bajara seed production is as detailed below:

Category	Isolation Distance for Jawar (m)	Isolation Distance for Bajara (m)
1. Fields of other varieties and hybrids	Foundation-300, Certified-200	Foundation-1000, Certified-200
2. Fields of same varieties or hybrids not confirming the varietal purity requirement.	Foundation-300, Certified-200	Foundation-1000, Certified-200
3. From forage sorghum	Foundation-400, Certified-200	-
4. From grassy sorghums and Johnson grass (Sorghum halepense)	Foundation-400, Certified-400	-

No Jowar plants or Johnson grass plants be allowed to grow within isolation distance on all sides of the seed plot.

Seasons:
As Jawar crop is well adopted to Kharif, Rabi and Summer season, the hybrid seed production can be taken during any season. However on the basis of past experience , the hybrid seed production should be taken during Kharif season and it should be avoided during rabi and summer seasons because-
1. Climate condition viz. Temperature, relative humidity, in Kharif season are congenial for pollination and good seed setting.
2. Some of the parents of Jawar hybrid are thermosesitive i.e R lines like CS-3541 fail to dehisce pollens during winter at low temperature. During summer seasons, pollens

desiccate rapidly at high temperature and loose their viability. Similarly receptivity of stigma in some female parents is badly affected due to low temperatures. This causes very poor seed setting.

3. Growth of either male or female parent of hybrids is slower as compared to other parent as a result of which there is a problem of nicking which thereby results in poor seed setting.

Certified Seed Production of Hybrid Jowar and Bajara (AXR Line)

Production Technology:

1. Preparatory Tillage:

Ploughing, clod crushing, 2 to 3 harrowing and collection of stubbles.

2. Source of Seed:

Certified / Foundation seed of A line and R line.

3. Seed Rate:

Jowar:

a) Male Parent- 5 kg/ha (R line)

b) Female – 7.5 kg/ha (A line)

Bajara:

a) Male Parent: 0.75 kg/ha

b) Female Parent: 1.50 kg/ha.

4. Spacing:

45 cm between rows and 15 cm between plants. Sowing by dibbling 3 to 4 seeds per hill. In case of Bajara 90 cm X 22.5 cm row and plant to plant distance.

5. Seasons and Sowing Period:

Kharif seasons, Sowing should be completed immediately after commencement of monsoon season and should not be delayed beyond 10th July. Delay in sowing of seed plot favours heavy attack by shoot fly which affects crop growth resulting in delay in harvesting and in low seed yields. Sowing of seed plot should be adjusted in such a manner that the seed crop should not be caught in late rains before harvesting.

6) Planting Ratio:

As the planting of hybrids jowar seed plot involve planting of both male and female parents, it is necessary to sow them in separate lines. This facilitates harvesting of male parent and seed parent separately. When sowing of Jawar hybrid seed plot is started, four rows on all borders of the seed plot are sown with seed of male parent. This ensures adequate supply of pollens for pollination. The remaining area of seed plot is sown with male and female parents in alternate and separate lines in the ratio of 4 female lines: 2 male lines. At both ends of every male line 3 to 4 seeds of sannhemp or Dhaincha are dibbled which helps in distinguishing male lines from female lines.

7) Synchronization of Flowering:

The male and female parents of the Jowar hybrid are heterogenic and usually have different flowering period. It is necessary to adjust sowing of male and female parents is such away that both parents come to flowering at the same time i.e Synchronization of flowering. On the basis of experience schedule of staggered sowing of both parents of different hybrid in kharif season is as under.

Sr.No	Hybrid	Kharif Season
1	CSH-1	Sow all the male and female lines at the same time
2	CSH-5	a) Sow all female lines ,b) Sow half of male lines after 3 to 4 days and remaining half after 5 to 7 days.
3	CSH-6	a) Sow all Male lines, b) Sow half of female lines after 5 to 7 days and remaining half after 10 to 14 days.
4	CSH-8	a) Sow all female lines, b) Sow all male lines after 3 to 4 days.
5	CSH-9,CSH-11	a) Sow all female lines; b) Sow all male lines after 4 to 6 days.

Even if staggered sowing of male and female parents is carried, sometimes , both parents do not come to flowering same time due to unfavourable weather. For this, when seed crop is about 30 days old, some plants from male and female rows be randomly examined for floral primordial initiation. In case, one parent has not started floral primordial initiation or has slow in growth and will take more days to flowering. In order to boost up the growth of slow parent, urea is given to that parent either by 50 kg/ha or by giving foliar followed with light irrigation to the slow growing parent if required.

8) Fertilizer and Manures:

a) 25 to 30 C.L of FYM or Compost before last harrowing.

Time of Application	Jawar (Fertilizers (kg/ha)	Bajara Fertilizers (Kg/ha)
At sowing	N:P:K-40:60:60	N:P:K-30:30:30
50 days after sowing	N:P:K-40:0:0	N:P:K-30:0:0
Total	N:P:K-80:60:60	N:P:K-60:30:30

9) Post Tillage:

a) Thinning 10 to 15 days after sowing. One seedling is retained at each hill.

b) 2 to 3 hoeing and 2 to 3 weedings.

c) Removal of late tillers which will not mature along with main ear heads.

10) Irrigation:

During kharif seasons one or two protective irrigations be given if dry spell prolongs particularly during floral initiation and flowering period. During rabi season, the seed crop be irrigated at an interval of 15 to 20 days.

Roguing:

Roguing should be initiated before seed crop comes in flowering and should be continued every day vigour sally during flowering period. During roguing, volunteer Jawar plants from isolation distance on all sides, pollen shedders in female rows, off types in both male and female lines, plants whose ear heads are affected by grain smut, other crop plants, tall weed plants, should be removed by cutting at ground level before they flower.

Plant Protection:

a) Major pests: Shoot fly

b) Major Disease: Grain smut, grain mould and D.M and ergot in case of hybrid Bajara. It any other pests or a disease is noticed, they should be timely controlled by following recommended plant protection schedule.

Harvesting, Threshing and Drying:

The seed plot is harvested only after permission is accorded by seed certification officer. Whenever majority of leaves become yellow, the crop is ready for harvesting. In the presence of seed certification officer male lines are harvested first and threshed separately. Harvesting of female lines is carried thereafter. Ear heads are cut and placed in small heaps in the field for drying for 2 to 3 days. Then the ear heads are brought to threshing yard and spread in thin layers for sun drying for another 4 to 5 days. The ear heads are threshed and clean unprocessed raw seed is filled in gunny bags in the presence of seed certification officer who seals the seed gunny bags. Sealed bags containing seed should be taken to seed processing plant for processing.

Seed Processing:

Seed processing of hybrid Jawar consist of following steps:
a) Pre-drying if needed
b) Pre-cleaning and grading
c) Seed treatment
d) Bagging, tagging and sealing.

Seed Yield:
1) Hybrid Jawar- 8 to 15 q/ha depending on season and hybrid.
2) Hybrid Bajara – 6 to 8 q/ha depending on season and hybrid.

Seed Certification Standards:
1. Field inspections: Minimum 4 1st before flowering IInd , IIIrd – during flowering IV th- prior to or during harvest.

Foundation and Certified Seed Production in Tomato (Varieties, Hybrids)

Notified Varieties of Tomato:
1) Pusa Rabi
2) Dhanshri
3) Bhagyshri

i) Land Requirement:
The land selected for tomato seed production should be fertile, well drained and having good texture. It should be free from volunteer plants. The PH of soil should be between 6 to 7.

ii) Sowing:
The breeder / foundation seed should be obtained from approved source by seed certification agency. Seeds should be sown on raised beds in nursery in rows 3 to 4 cms apart. The size of raised bed should be 2 to 3 meter long. 1 to 1.25 meter wide with 15 to 20 cms height. The tomato, seedlings raised on such 25 beds will be sufficient for an area of one hectare.

iii) Seed Rate:
500 gm/ha.

iv) Transplanting:
The seedlings with 7.5 to 10.0 cms height are selected and transplanted in the field preferably during evening and given irrigation immediately.

v) Spacing:
1) Winter crop 75 X 60 cm 2) Spring, summer crop 75X 40 cm.

vi) Roguing:
Plants with off types foliage should be removed before they start flowering in order to reduce the possibility of cross pollination, similarly, diseased plants affected by early blight, leaf spot and mosaic should be removed as and when noticed.

vii) Harvesting and Extraction of Seed:
The ripe fruits of proper size are harvested/ picked. The seeds can be separated from pulp by following methods.
i) Juice and seed extraction.
ii) Ordinary seed extraction.
iii) Separation by fermentation.

viii) Washing:
After extraction, seeds are washed with water to remove the pulp etc. until they are clean.

ix) Drying:
After washing seeds are dried immediately. Seeds may be spread on screen bottom trays or cloth and placed in open where maximum exposure to sun and dry air is attained. The moisture level should be 8 % before storing.

x) Seed Yield:
The average yield is about 100 to 120 kg/ha.
Hybrid seed production.:
There are number of hybrid combination which give good yields. For hybrid seed production hand pollination carried out with or without emasculation. Where emasculation is used bunds are first emasculated and then enclosed in butter paper bags, fastened with pins or threads the day before flowering. Flowers are hand-pollinated with camel hair brush, then flowers are rebagged, four or five days later, the bags are removed where fertilizable is assured. The time taken for hand pollinating each flower is about fifty to sixty seconds. In hybrid seed production of tomato foundation class seed shall consist of an approved male sterile line to be used as female parent and an approved parental line to be used as a male parent for the purpose of producing hybrid seed.

Certified class seed shall be the hybrid seed to be planted for any use except seed product.

Foundation and Certified Seed Production in Onion

Notified Varieties of Onion:
N-2-4-1, N-53, B-780, AFLR,AFDR.

i) Climate:
It is biennial crop and takes two full seasons for producing seeds. Bulbs are formed during first year. While flower and fruiting take place during second- year. It requires cool climate during early development of bulbs and also during early growth of the head stalk (Flowering). Blotting takes place between 10 to 15 0C. During early stage, temperature should be cool with good moisture supply. Seed production is undertaken in temperate and subtropical region.

ii) Land:
Select the field for onion seed production in which the onion crop was not taken in the preveious year. Soil should be rich in organic matter with good water holding capacity.

iii) Isolation:
It is highly cross pollinated crop with 93 % cross pollination brought by honey bees. Field should be isolated by 1000 meters. For foundation and 400 meters for certified seed production plot from other fields.

iv) Methods of Seed Production:
There are two methods as below
a) Seed-to Seed. In this method first season bulb crop is kept in the fields up to winter so as to produce seed in the next season.
b) Bulb-to –Seed method. Bulbs produced in the preveious season are selected , stored and replanted in next year for production of seed . It is most common method.

v) Sowing:
The seeds from approved source is produced and sown at the rate of 8 to 10 kg/ha in the nursery for raising seedlings. Sowing is done in the month of October or November. Seedlings of 8 to 10 weeks old are ready for transplanting. Such seedlings are transplanted in small beds 10-15 cms apart.

vi) Harvesting:
Well matured bulbs should be harvested when tops are druped and leaves are still green. After harvesting , bulbs should be thoroughly selected for curing. The time required for curing. The time required for curing depends on weather condition i.e 3 to 4 weeks.

vii) Storage:
Well matured , dried and cured bulbs are taken for storage. Such bulbs are stored in well ventilated storage. The shallow trays with performed bottoms are used. The temperature range should 0 to 5 0 C for 3 to 4 weeks prior to planting and may be increased upto 10 0C thereafter.

Seed Production (Bulb-to Seed) :

i) Sowing:
The bulbs of proper size (2.5 to 3.0 cm dia) are selected for planting. About 15 quinatal of bulb are required for one hectare and planting is done in second fortnight of October. The selected bulbs are planted at a distance of 45 to 30 cms with 8 to 10 cm depth. The sprouted bulbs are directly used for planting while upper portion of unsprouted bulbs is cut and disc like portion is used for planting.

ii) Roguing:
Off types plants having different foliage colour, late maturing bulbs etc are removed during first year and at the time of harvest also, bulbs having different colour, neck thickness and doubleness are rejected. During second year, the plants differing and not conforming to varietal characters are removed.

iii) Harvesting:
First formed seeds in the head get blacked harvesting is done. Two to three picking are necessary to harvest the heads at right stage, heads are cut by keeping small stalks and after proper drying, threshing is done with sticks. Seeds are cleaned by dipping in water for 5 to 10 minutes followed by sun drying.

iv) Yield:

The average yield of 850 to 1000 kg/ha is obtained from good crop.
Cultivation Practices of Seed Production of Often Cross Namely Cotton and Jawar

Sr.No	Particulars of Cultivation Practices	Crop Cotton (High Yielding Varieties)	Crop Cotton Hybrid
1	Selection of land	Free from Wilt	Free from Wilt
2	Sowing Time	June (Rainfed), Second fortnight of May and June (Irrigated)	June (Rainfed), Second fortnight of May and June (Irrigated)
3	Sowing Method	Drilling	Dibbling
4	Spacing (cm)	Deshi 45 X22.5 , American 60X 30	Female 150 X 120 Male 90 X 60
5	Planting ratio-Female : Male	-	on Area basis 3/4 : 1/4 or 1/5:4/5
6	Seed rate (kg/ha)	Deshi-10-12 , American -8 to 10	Female -3.75, Male-2.75
7	Fertilizers doses (NPK kg/ha) with splitting of N except tur crop.	100:50:50 plus two foliar sprays of Urea /DAP (15-20 gms/lit. i.e 2% during boll formation.	100:50:50 plus two foliar sprays of Urea /DAP (15-20 gms/lit. i.e 2% during boll formation.
8	Isolation Distance (mtrs)	F-50, C-30 (5 mtrs between parents of hybrids and field of other varieties.	F-50, C-30 (5 mtrs between parents of hybrids and field of other varieties.
9	Field Inspection	2	4
10	Off Types(%)	F-0.10,C-0.20	F-0.10,C-0.50
11	Pollen shedders (%) When ms line s used	-	F-0.05,C-0.10
12	Objectionable Weeds(%)	Ranbhendi, Holley hock.	Ranbhendi, Holley hock.
13	Objectionable Disease (%)	-	-
14	Seed Yield (Q/ha)	Seed cotton Deshi , seed cotton - 8 to 10 American 2 top 3 ,10 to 12	Seed cotton Deshi , seed cotton - 8 to 10 American 2 top 3 ,10 to 12
15	After Harvest Seed Moisture (%)	10	10
16	Germination (%) minimum	65	65

17	Seed Borne Disease	-	-
18	Other Disease	Fusarium wilt, Antrac nose	Fusarium wilt, Antrac nose
19	Major Pests	Boll worms (Pink, American and sported jassids and aphids, trips)	Boll worms (Pink, American and sported jassids and aphids, trips)
20	Improved Varieties and Hybrids	Deshi-Y1,Savatra, American ,LRA5166, JLH168 ,Rajat,AKA5,AKA-4. Hybrids: HXH,H6,H10,NHH44,PKV hy4, HXB- NHB12, HXA - DH9.	Deshi-Y1,Savatra, American ,LRA5166, JLH168 ,Rajat,AKA5,AKA-4. Hybrids: HXH,H6,H10,NHH44,PKV hy4, HXB- NHB12, HXA - DH9.

Note: Minimum pure seed (98%) and maximum inert matter (2%) is recommended as physical purity standards for all above crops.

Abbreviations used

HYV- High yielding Varieties , **HYB**-High Yielding hybrids, **F** and **C-** Foundation and certified stage of seed production , **K-** kharif , **R-**Rabi, H-G hirsutum B-G barbadense H'G Herbaceum, A-G arboretum.

Cultivation Practices of Seed Production for Vegetables Namely Tomato, Okra, Onion and Potato

Sr.No	Particulars of Cultivation Practices	Tomato	Okra(Bhendi)	Potato
1	Sowing Time	July (K) September/October	June /July (k), September ,January	-
2	Sowing method	Transplanting	Hand Dibbling	Transplanting
3	Spacing(cm)	90X 30 (K) , 60 X 60 (S)	60 X 30 (K), 45X 30 (R and S)	30 X 20
4	Seed rate (kg/ha)	0.5 kg on 20 raised beds of 2.00 X 1.25 mts)	8-10 kg (K) , 10-15 kgs (S)	8-10 kgs on raised beds

5	Fertilizers doses (N.P.K kg/ha)	50:50:50 during sowing 50:0:0 -one month after sowing	50:50:50 during sowing 50:0:0 -one month after sowing	00:160:80:before sowing.
6	Isolation (mts)	F-50, C-25	F-400, C-200	F and C-5
7	Field Inspection	3	3	2
8	Off Type(%)	F-0.10,C-0.20	-	-
9	Objectionable disease(%)	F-0.10, C-0.50,Early blight, lef spot, tobacco mosaic, virus.	Yellow vein mosaic	
10	Seed Moisture (%)	8	-	-
11	Pure Seed (%)	98	99	98
12	Insert Matter (%)	2	1	2
13	Germination (%)	70	65	70
14	Seed Yield (Q/ha)	1 to 1.2	10	15-20 Q/ha of bulbs
15	Improved Varieties	Pusa Rabi, Marglob	Pusa Savani, Parbhani Kranti, Hissar Unnat	Red Coloured: B coloured, Phule coloured : Phule.

Abbreviation Used:
K-Kharif Season, R-Rabi Season, S-Summer season, F-Foundation stage, C-certified stage.
HYV- High yielding Varieties
HYB- High Yielding Hybrids.

Seed Certification Procedure

Good quality seeds refer to seeds having optimum genetic and physical purity , high germination procedure percentage and seed with optimum moisture content. It also includes seeds free from noxious weed seed and other crop seeds and free from seed borne diseases. To meet these criteria there is a need of certification.

Seed Certification:

Seed certification is a legally sectioned system for quality control of seed during seed multiplication and production. Seed certification is a scientific and systematically designed process to secure, maintain, multiply and make available seeds of notified and released varieties to the farmers.

Object of Seed Certification:

1) To ensure genetical identity of a variety.
2) To ensure high degree of physical purity.
3) To ensure high degree of germinability.
4) To ensure freedom from all designation seed borne disease, weeds and other crop seeds.

According to statutory rules and regulation of seed act (1966), autonomous government organization such as state seed certification Agency is established. Procedures for registration, field inspection, seed processing, release sampling, seed testing , issue of seed certification tags and seals and release of seed lots are established.

Phases of Seed Certification:

1) Receipt and security of application with notarized agreement for registration of seed plot for certification.
2) Verification of seed source, class used for raising the crop by checking certification tags, lablels, seed containers , cash memo or bills.
3) Field inspections of the seed plot to verify conformity to prescribed field standards.
4) Post harvest supervision of seed crop including sealing raw seed , issue T.C . supervision during seed processing at registered seed processing plant.
5) Seed sampling and sending sample to STI for analysis to verify conformity to prescribed seed standards as well as genetic purity(field test).
6) Grant of certification, tagging and sealing of the containers – Release of seed lot for seed multiplication or marketing for commercial.

Field Inspection in Seed Production

It is a key method in the whole process of certification for the verification of the seed quality when the crop is standing in the field and is subjected to the vagaries of weather and exposed to other known and unknown factors affecting its quality. Field inspections are done by the seed certification inspector (Field inspector) from SSCA by examining seed crop in the field right from sowing upto harvesting. They verify key factor like, genetic purity, physical purity, seed health, which deteriorate seed quality in the field.
Inspection of Seed Crop in Standing Field is Field Inspection in Broad Sence:

Field Inspection is defined as inspection of standing crop in seed field by the seed certification officer or field inspection of SSCA to confirm isolation, genetically purity and timely rouging of contamination and other agronomical seed production practices for their fulfilment of prescribed standards (or) norms of SCA.

Objective of Field Inspection:

1) Verification of seed source.
2) Verification of cropping history of land for processing season or year.
3) Verification of Isolation.
4) Checking of planting method followed i.e planting ratio, border rows, in case hybrid seed production.
5) Rougeing of off types, diseased plants and other mechanical contaminants.
6) Guidance to seed growers.

Crop Stage for Field Inspection in Seed Technology

The number of field inspection required to be conducted depends upon the nature and pollination behaviour of the seed crop.

1) Self pollinated crops – 2 inspections.
2) Often crops pollinated crops 2 to 3 inspections.
3) Cross pollinated crops. Hybrids – 4 inspections.

The appropriate stages for field inspection of seed plots are

1) Pre-flowering stages.
2) Flowering stages (may be II,III or IV)
3) Pre-harvest stage and
4) Post harvest stage.

Any additional field inspection conducted over and above the minimum number will be beneficial the key points to be observed at each inspection, are as under.

Stages of Crop	Inspection Number	Key Points to be Observed
1) Sowing to Pre-flowering	I	1. Varietals eligibility for verification.2. Verification of source of seed.3. Land Requirement.4. Isolation distance.5. Planting ratio and border rows in case of hybrid seed plot. 6. Area of seed plot.

2) Flowering Stage	May be II,III,IV	1. Check of factors which were noticed during pre-flowering, inspection.2. Confirm isolation from the source of contamination and plot and calculation of area rejected if any on account of isolation requirement.3. Confirm observation on planting rations, border, rows, rougeing of off types, diseased plants, pollen shedders, detasseling made during preveious inspection. 4. Taking field counts for different specific requirements for prescribed for crop being inspected.
3) Post flowering and Pre-harvest Stage	May be III, IV, or V	1. Confirm the correctness of observation made in earlier inspection.2. Rougeing and taking field counts.3. Issue of instruction to seed grower for harvesting, drying, threshing, bulk packing, storage and transportation to seed processing plant. 4. Estimate seed yield.
4) Post harvest stage	Last	1. Verify in seed crops involving two parents that male parent rows have been separately and completely harvested and removed from the field and to seal if necessary the harvested male row produce. 2. Verify that the crop from the area rejected due to inadequate isolation or poor rougeing has been separately and completely harvested and removed from the field and to seal if needed the produce so harvested. 3. Avoidance of admixture of any type of contaminant at field stage threshing yard etc. 4. Sealing of threshed produce after initial cleaning and drying. 5. Instruction to the seed grower for sale storage and transportation.

Field Counts in Seed Technology

It is a representative sample of plants taken at random from a seed plot for recording the observation on off types, pollen shedders, diseased plants, insprable other crop plants. As per provision of seed certification it is necessary to examine each and every plant in the seed plot for contaminant. It is however impracticable to do so. During each field inspection field counts are taken randomly covering of the seed plot and observations are made on the plants from each selected field counts.

The number of counts taken varies according to the area of the seed plot. Minimum five counts are required to be taken for seed plots having a 2.0 ha and one additional count is to be taken for every additional area of two hectare or part thereof.

Area of Seed Field (ha)	No of Counts to be taken
1. upto 2	5
2.2 to 4	6
3.4 to 6	7
4.6 to 8	8
5.8 to 10	9
6.10 to 12	10

Number of plants/heads or tillers to be included in one count depends upon the type of crop involved.

Crops	Number of Plants /heads per Count
1. Castor , Cotton, Groundnut, Maize, Tur, Sunflower, Bulb Crops, Tuber Crops, Broad Spaced Vegetables.	100 Plants
2. Beans , Pulses , seasamum , mustard,	500 Plants
3. Lucerne , Berseem, Jute, Soybean	1000 Plants
4. Cereals other than Maize	1000 Heads

Procedure for Taking Field Count:

A) For Thickly Sown Row Crops:
E.g Wheat, Jawar, Soybean.
1) Enter the seed plot from a randomly selected site.
2) Count the number of plants or heads in a row in one step.
3) Count number of plants or heads per step at randomly selected five locations ad work out the average number of plants/ heads per step.
4) Calculate the number of steps required to complete a count.
5) Select at random any row and start from any point in that row. Take required number of steps in that row to complete one count or take few steps in that row to inspect few heads/plants say 1/10th of count, then cross over 2 or 3 rows and take few steps in next

row for inspecting another few plants or heads. Repeat this till required number of plants/ heads of one count are inspected.
6) Repeat this till required number of counts are taken.
7) Record number of contaminats observed in each count in the inspection report.

B) For Broadly Spaced Crops E. g Chillies, Cotton, Castor, Maize
1) Enter the seed plot from a randomly selected site.
2) Inspect 100 plants in any row or inspect half the plants of one count in one row and remaining half in 2 nd or 3 rd row.
3) Move across the seed field covering all portions and take requisite number of counts on the basis of area of the seed plot.
4) Record the number of contaminant observed in each count in the inspection report.

C) For Female and Male Rows in Seed Plots of Hybrid Jawar and Hybrid Bajara:
a) Size of one count is 1000, calculate the number of steps required to inspect 1000 heads.
b) Start inspection the heads from any point in any row and inspect 100-200 heads in that row. Shift over to 3 rd or 5 th row and again inspect 100-200 heads. In this way cover part of seed plot for one count.
c) Repeat this procedure for taking required No of counts separately for female and male rows.
d) Count contaminants separately for male and female rows for each count and record them in inspection report.

For Female Rows:
Off types , pollen shedders, diseased plants for male rows offtypes, diseased plants.

Procedure for Field Inspection

1) Note that field inspections of seed plots be carried without pre intimation to the seed grower so as to ascertain whether the seed grower is regularly carrying rougeing and other essential items of work.
2) During 1st Inspection check all information of about species, variety stage source of seed used, (tags, labels, seed bags, cash memo) area of the seed plot registered for certification , cropping history of the seed plot.
3) Visit the seed plot, Move on all sides of the plot for confirming whether the seed plot meets isolation requirement. In case of doubt, measure the area of seed plot and also distance between seed plot and contamination field.
4) Draw a rough map of the seed plot showing location.

5) During every field inspection , every part of the seed plot should be covered. For this walk across the seed plot while taking the field counts in all directions. Inspect adjacent fields, wastelands for isolation requirement.
6) Count off types, volunteer plants and other contaminants observed during each count and record them.
7) While taking count, barren rows or long gaps if noticed need not be included in the count.
8) Give guidance to seed producer or his representative about Rogueing, off types plant protection, harvesting.
9) At the end of each inspection field inspector fill inspection report. (In prescribed proforma in appendix II) in Quadruplicate and handover send green copy to seed producer or his represented and yellow copy to Div SCO office and pink copy to district seed certification office. Retain white copy as record.

Field Inspection Report – In Seed Technology

Maharashtra State Seed Certification Agency   Division /…..No.
(Seed certification report for ………………Ha.area)
1. Name of seed grower / Producer …………..Report No………
Village……………… Taluka………. District………Date of Inspection…….
2. Survey No of seed plot …………Time…………… From………. To………
3. Location of Farm…………..
4. Preveious Crop: Kharif……… Rabi…………… Summer………..
5. Name of Crop ………..Variety………..
6. Sour of Seed………..Class and Quantity of Seed…………….
7. Total acreage under seed production……………..
8. Acreage of field Inspection.
9. Sowing Date…………….
10. Spacing……………..
11. Stage of seed crop during inspection…………
12. Isolation distance (mts) : a) North ……….. b) South……………. c) East…………
d) West…………
13. Name and stage of growth of contaminants………………..
14**. Field count** (No of plants / heads – 100/500/1000):

Count No.	Off types	Other Crops	Weeds	Affected by seed borne diseases	Remarks i.e Names of Contaminants
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
Total					
Average					
%					

15. Crop Condition…………………………….
16. Quality of Seed Production work……………………..
17. Thus this crop confirm the standards of seed certification……………..
18. Estimated seed yield(Qtls/ha)……………….
19. Remarks………………………………………
20. Was the seed grower or his representative was present at inspection time……………….

Signature of Seed Grower/His Representative.

Signature of Inspector

Name :

Designation:

Charges for Different Operations during Seed Certification

Sr.No	Operating During Seed Certification	Unit	Rates (Rs)
1	Application form for seed certification	1	10
2	Registration fee	1 per seed grower	30
3	Field inspection charges: a) Hybrid Cotton	Per acre its part there of	150

	b) Hybrid Crops, Foundation seed plot, Vegetable crops.	Per acre /its part there of	160
	c) Other crops	Per acre / its part there of	80
	(Note: Same charges for repetition of field inspection)		
4	Seed processing charges (for precleaned seeds)	-	-
	a) Hybrid Cotton	Kg	3.5
	b) Improved Cotton Varieties	Quintal	50
	c) HYV and Hybrids of Jawar, Bajara, Wheat, Rice, Gram and Soybean.	Quintal	20
	d) Other crops	Quintal	35
	e) Supervision charges of seed processing plant (If processing less than target)	Per Agricultural Officer/ 8 hours working period.	350
5	Revalidation of charges : a) Hybrid Cotton	Quintal	75
	b) HYV of Cotton	Quintal	50
	c) Other crops	Quintal	35
6	Grow out test	Per Sample	200
7	Seed testing charges	Per Sample	40
8	Charges for seed certification tags	Per Tag	1.5
9	Registration and renewal of seed processing plant/ ginning centre.	Per centre Reg-Renew	3000
10	Export Certificate	Per Certificate	1000
11	Sealing Charges	Per gunny bag	0.5
12	Inspection of Seed source	Per Bag	-
13	Duplicate copy of seed certification	Per Copy	5
	Note: (Same charges for repetition of grow out test/ other seed tests.)		

Seed Production Techniques in Castor

Land Requirement:

Land to be used for seed production shall be free of volunteer plants. In addition the field should be well- drained and soil well aerated.

Isolation Requirements:

Castor is an often cross- pollinated crop. Cross-pollination by wind varies from 5 to 36 percent according to the prevailing climatic conditions. For pure seed production , the seed field must be isolated from other variety fields and of same variety not conforming to varietal purity requirements of certification at least by three hundred meters for foundation seed class, and one hundred and fifty meters for certified seed class.

Brief Cultural Practices:

1) Preparation of Land:

Castor is a deep-rooted crop. Therefore, deep ploughing has been found very useful. One deep ploughing followed by two to three harrowings is sufficient to bring the field to the desired tilth.

***2) Time of Sowing*:**

The sowing time in most of the states is June to July. In Bihar (Rabi Crop) castor sown in September to October. In Gujarat , planting is done in August to September and in Karnataka it is sown in April.

***3) Source of Seed*:**

Obtain nucleus / breeder's foundation seed for planting from source approved by a seed certification agency.

***4) Method of Sowing*:**

The crop is planted in rows either by drill, or behind the plough in furrows. The depth of seedling is 7.5 to 10 cm.

***5) Spacing*:**

Row to Row – 90 cm (annual varieties)

Plant to Plant – 45 to 90 cm.

***6) Seed Rate*:**

11 to 18 kg per ha , varies upon spacing, seed size and method of sowing. For rainfed crops a seed rate upto 33 to 44 kg is also practised.

***7) Fertilization*:**

The crop responds well to organic manures. The rate of fertilizer application varies considerably in different states and ranges from 20 kg to 80-100 kg per hectare for nitrogen , 10 to 40 kg Phosphorous and 10 to 40 kg Potash.

***8) Irrigation*:**

The number of irrigations required varies with the rain. Usually two to three irrigations during the entire crop season may be required. Adequate moisture in soil at the time of flowering is necessary.

***9) Interculture*:**

The castor field must be kept weed-free for the first sixty days after planting. Two to three weedings / hoeings are sufficient to keep the field clean. Application of 2-4,D or triflurelin (3 to 4 kg per ha) is also recommended for controlling annual dicot weeds.

***10) Nipping*:**

Nipping of auxiliary buds of all the branches gives increased seed yields, besides reduction in maturity period and uniformly maturity.

***11) Plant Protection*:**

For control of semilooper , spray 0.35 percent thiodan or 0.03 percent Dimecron, for castor pod borer , spray thiodan (1200 ml per ha) and for caterpillar, dust 5 percent BHC dust or spray 0.04 percent Malathion solution. For control of Phytophthora blight and Cercospora, spray Bordeaux mixture (4:4:50) at 15 days intervals or spray 2 to 3 times o.25 percent Dithane M-45.

Roguing:

Remove all off types before flowering. The diseased plants affected by Phytophthora blight and Cercospora leaf spot should be rogued out as soon they are noticed, and preventive plant protection measures adapted immediately to check further spread.

***Harvesting ad Threshing*:**

The fruit are ready for picking in November. The picking continues until April, because the capsules mature unevenly due to sequential development of racemes. The fruits should be gathered when they start turning light yellow and placed in piles to dry in the sun until they blacken. Later the seeds are beaten out with sticks, winnowed and screened to remove husks, dry skins and soil pebbles. Before storage, the seed must be dried to eight percent moisture content.

***Seed Yield*:**
8-10 q/ha. High yielding varieties if managed well may give 15-20 qtl/ha seed yield under irrigated condition.

Production of Hybrid Castor Seed:
For production of single cross hybrid seed, lines giving a 1:1 ratio of pistil late and heterozygous monoecious plants are used. In the crossing plot the latter are rogued out one to five days before flowering begins. Female plants are then cross-pollinated by a selected male pollinator line, planted in every sixth or eighth row. As many as six roguings may be necessary to keep self- pollination to a minimum.
The hybrid seed can also be protected by the use of 90 to 100 percent pistil late lines, this estimates Roguing but hybrid seed so produced would not be entirely uniform.

Seed Production Techniques in Sunflower

Land Requirements:
Select fields in which sunflower was not grown in the preveious year unless they were of the same variety and were of equivalent or higher class and were certified. In addition, the selected field should be well-drained and the soil deep, fertile and with neutral PH.

Isolation Requirements:
Sunflower is partially self-pollinated. The extent of cross –pollination varies from 17 to 62 %, according to insect activity. The seed fields must be isolated at least by 400 m for foundation seed class and 200 m for certified seed class from fields of other varieties, same variety not conforming to varietal purity requirements and wild sunflower.

I) Brief Cultural Practices:
1) Preparation of Land:
Usually one deep ploughing , two to three harrowings followed by levelling are adequate to prepare the field to the desired tilth.

2) Time of Sowing:
Sunflower, unlike most other crops are not season bound. Barring the periods of extreme freezing temperatures the sowing time can be adjusted as per availability of land for planting. However, sowing should be so adjusted that the maturity of the crop does not coincide with the rains. Since rains during maturity period adversely affects the seed quality.

3) Source of Seed:
Obtain nucleus/ breeder’s / foundation seed from the source approved by the seed certification agency.

4) Method of Sowing:
The crop should be sown in rows. The depth of seedling should be 2 to 4 cm.

5) Spacing:
Row to Row: 60cm
Plant to Plant: 20 cm.

6) Seed Rate:
8 to 10 kg per hectare.

7) Fertilization:
The fertilizer required for raising a good sunflower crop is 80 kg nitrogen, 40 kg phosphorus and 40 kg potash per ha. At the time of planting 50 kg nitrogen and the full amounts of phosphorus and potash should be applied as a basal dose and the remaining 30 kg nitrogen at the time of earthing i.e after 40 to 45 days of crop growth.

8) Irrigation:
Pre-sowing irrigation is necessary in the spring to summer season, and desirable for rabi sowing for uniform germination and better stand. Sunflower is comparatively drought tolerant and yields higher than oilseeds crops under moisture stress conditions.
In rabi and zaid planting two and four irrigations respectively, are necessary for higher yields. In kharif , if rainfall distribution is favourable, no irrigation may be required. One irrigation between the flowering and grain filling stages must be applied.

9) Weeding and Interculture:
One to two weedings during the first six weeks after germination are necessary. Thereafter growth rate is high and the crop covers the ground and smothere most of the weeds.

10) Earthing:
The sunflower plants may root lodge because of large heavy heads. Earthing, preferably before and, if needed , after irrigation around 48 days after sowing is highly desirable. 10 to 15 cm high earthing is sufficeient.

11) Supplementary Pollination:
Placing of bee-hives on the field periphery or on blank strips approximately at 200 meter intervals has been found beneficial for cross-pollination and seed set.
Hand pollination may also be resorted to Sunflower heads are gently rubbed with bare plant or covered with muslin cloth during the animals period between 7Am to 11Am an alternate days of about two weeks.

II) Plant Protection:
Diseases:
Alternaria blight may assures serious proportions in the rainy season and may reduce yields drastically. The dark brown and black coloured spots, if seen on any plant part, should be immediately sprayed with 0.25 % spray of Dithane M-45 or Dithane Z-78 at one to two weeks intervals.
Other diseases of minor importance are: Sclerotium wilt in July and August plantings. Sclerotinia wilt in winter, and charcoal rot in March plantings. The affected plants should be uprooted and burnt. Growing of sunflower in longer duration rotational cycles is recommended.

Pests and Birds:
Insect:
No serious pest of sunflower has been noticed. The crop should be watched against attack by cut worms during the seedling stage, for head borer damage at the bloom stage and for jassid attack all the time. Mixing of 5% heptachlor dust in soil at 15 kg per hectare will control cut worms and one to two sprays of 0.025 % metasystox (25 E.C) will take care of the other two insects.

Bird Damage:
In lonely maturing fields of sunflower , birds may cause extensive damage, particularly when no other seasonal crop is in the grain stage. Bird watching in such cases is imperative. In plantings with or after the seasonal crops the bird damage is minimal.

Roguing:
Generally two roguing are needed. The first should be done at the pre-flowering stage and the second at crop maturity. Before flowering, tall, very early, very late, branched as well as weak, wild and diseased plants should be rogued out. At the time of 75% crop maturity , wild , ornamental, diseased, damaged and all those plants which do not conform to the characteristics of the variety under seed production, should be rogued out

in addition to these , plants affected by wilt, charcoal rot, blight , etc should also be removed from time to time as required.

Precautions in Roguing:

1. Sunflower head continues to develop and shed viable pollen even after removal from stalk. It is therefore, important that the heads after removal from stalks are turned down (Face down on the soil) while throwing them on ground.
2. Sunflower is phototropic until the early stage of flowering. After ray flowers are fully developed, the heads generally faces the east. This features makes roguing inefficient , if the row direction is east-west. If the direction is north-south, this problem is eliminated. It is therefore important that roguing is always done looking westward at the heads.

Harvesting and Threshing:

The crop is ready for harvest when top leaves are dry and flowers are shrivelled. Heads may be removed with shears or knife. Heads after cutting are sun dried on the threshing floor. Hand threshing can also be done by rubbing seed heads on a metal sheet or beating with sticks. Threshed seed must be dried to eight to ten percent moisture before storage.

Seed Yield:

A good crop may given an average yield of 15 qtls per hectare.

Production of Hybrid Sunflower Seed

Principle of Hybrid Seed Production:

Hybrid sunflower is produced by using cytoplasmic male sterility and genetic fertility restoration system. The male sterile line (A line) contains sterile cytoplasm and recessive genes for fertility restoration. This is maintained by a male fertile counterpart (Line B) which also contains recessive genes, but has fertile cytoplasm.

For production of hybrid seed male sterile line (A line) is crossed with a fertility restoring line (R line) which has the dominant genes for fertility restoration, but may have either sterile or fertile cytoplasm. The restorer line (R line) should nick well with A line to produce F1 hybrid seed.

1. Production of Male-Sterile Line (A line) Seed:

Land Requirements:

Land requirements are the same as for open – pollinated varieties.

Isolation Requirements:
Seed fields must be isolated form other sunflower fields, same line increase fields not conforming to varietal purity requirements of certification and wild sunflower spp. at least by 600 meters.

Planting Ratio:
The proportion of female line (A line) and male line (B line) should be 3:1. However, the first two border rows on either side may be sown with the male line (B line) seed to ensure enough pollen supply.
Seed Rate:
A line: 7.5 kg/ha and
B line: 2.5 kg/ha
Other cultural practices are the same as described for open pollinated varieties.

Roguing:
The male-fertile plants in the female parent lines should be removed each day during nbchm the entire flowering period. This is best done in the morning hours before the bees have removed the pollen. Roguing for off types should be done in the similar manner as described for open pollinated varieties.

Supplementary Pollination:
For supplementary pollination (Hand Pollination) the palm is first gently rubbed on the male parent flowers and then on the stigmas of the female line to transfer the pollen.

Harvesting:
The male parent rows should be harvested prior to harvest of female rows to avoid contamination. No male parent heads should be left intermingled with the female parent rows. Other aspects of harvesting are similar as described earlier for open pollinated varieties.

2. Production of Maintainer line (B line) and Restorer line (R line) seed:
The seed is produced in an isolated field in the manner similar to that described for open pollinated varieties. The isolation requirements however are higher and shall be same as given for production of "A" line seed above.

3. Production of Hybrid Sunflower Seed:

Land Requirements:
Land requirements are same as for open pollinated varieties.

Isolation Requirements:
Seed fields must be isolated at least by 400 meters from the fields of other varieties, commercial hybrid of the same variety, fields of same hybrid seed production not conforming to variety purity requirements of certification.

Planting Ratio:
The proportion of female parent (A line) : Male line (R line) should be kept at 3:1 however, the first two border rows on either side may be sown with the male parent seed to supply enough pollen.

Seed Rate:
A line : 7.5 kg per ha
R line 2.5 kg per ha.

Method of Hybrid –Seed Production

Hybrid –rice can be produced in the following ways.
1. Three –line system. The hybrid seed production involves multiplication of cytoplasmic – genetic male sterile line (A line) , maintainer line (B line) and a restore line (R line) and production of F1 hybrid seed (AXR).
2. Two-line system. The hybrid seed production involves the use of photo-period sensitive genetic male sterile (PSMS). Any normal line can serve as a restorer.
3. By using chemical emasculators. Chemicals that can sterilize the stamen, with little or no effect on the normal functioning of the pistil, can be used to emasculate female parents for hybrid rice production. The advantages are obvious, no special development of male sterile or restore lines is required and extensive varietal resources are available.
Chemical emasculators such as male gametocide 1 (ME1) and male gametocide 2 (MG2) were developed in China and have been successfully used in hybrid rice production.
In chemical emasculation, physiological male sterility is artificially created by spraying the rice plant with chemicals to induce stamen sterility without harming the pistil. In hybrid seed production , two – varieties are planted in alternate strips, and one is chemically sterilized and pollinated by the other.

Hybrid- Rice Seed Production Technology (Three –Line System)

In the years to come location- specific specialised seed production technology for the released /commercial hybrids would have to be developed for obtaining maximum seed yields and ensuring good seed quality. Good crop management is necessary for raising a hybrid –rice seed production crop. Hybrid- rice production technology described below may be used as a guideline.

1) Choice of Areas and Growing Season for Seed Production:

The areas of seed production should be chosen so as to provide the best possible conditions at flowering and the pollen shedding period. The most suitable condition are, 24-28 0C day light average temperature, the relative humidity 70-80 percent , the temperature difference between day and night 8-10 0 C and good sunshine. An average day temperature of more than 30 0C or less than 230C, continuous rains, or strong wind are generally harmful to flowering, pollination and cross- fertilization. As a rule , in high temperature with low humidity or in low temperature with high humidity some glues will not open. This lowers the seed yields. The growing of hybrid seed crop should be so adjusted that flowering takes place after the end of high temperature period but before the start of low temperature period.

2) Selection of Seed Fields:

The selection of prime field plots is necessary. The seed fields should be free of volunteer plants, well levelled, should have fertile soil with good physical and chemical characteristics and well drained.

3) Isolation:

The hybrid paddy fields should be isolated from the other paddy fields, including commercial hybrid of same variety, and same hybrid not conforming to varietal purity requirements for certification at least by 200 meters for foundation seed class (A,B and R line Production) and by 100 meters for hybrid seed production (AX R production).

4) Brief Cultural Practices for hybrid (AXR) Production Nursery:

Raising of vigorous seedlings is an important factor for obtaining high seed yields. The root system of vigorous seedlings are flourishing, leaf sheaths have high carbon content and all this contributes to produce green growth and tillering at the lower nodes so that more dry matter is accumulated, leading to more panicles and a high seed setting rate per panicle. It has been observed that tillering at the lower nodes gives more and bigger panicles which helps to achieve the goal of 100 kernels per ear.

Prepare the seedling bed with basal manure. Seed at 150 kg/ha for the female parent and 100-150 kg/ha for the male parent. At present the appropriate methods for raising seedlings are either to sow under plastic film in the field or in a green house.

5) Sowing Time:
The proper sowing time is dictated by the number of days required from sowing time to panicle formation. The sowing should be so adjusted that the crop comes to panicle stage soon after the end of high temperature period.

6) Transplanting:
Seedlings with healthy tillers are the basis for increased panicle size. For hybrid seed production, the seedlings of both parents should be standardized. Seedlings of the male parent for short duration varieties should be 20-30 days old with 5.5-7 leaves and 2-3 tillers and for long duration varieties 30-35 days old with 5.5-7 leaves and 2-3 tillers.

7) Planting Ratio:
The ratio of female and male lines is generally kept at 2:10-12, and row spacing 10X10 cm for male parent and 20X 15 cm for female parent. Two seedlings are planted per hill.

8) Row Difference:
Both parents should receive good aeration and equal amounts of sunlight. Row direction should be nearly perpendicular to prevailing winds at flowering to ensure more cross-pollination.

9) Fertilization:
Adequate fertilization in necessary. In general a seed field with moderate fertility should be treated with 200 kg N, 50 kg P, and 150 kg K per ha, 90 percent applied as a basal dose and 10 percent after panicle differentiation.

10) Water Management :
Good water management is very important for regulating water, fertilizer , air and temperature of soil. Give shallow irrigation at the transplanting and tillering stages. In soils where water permeability is poor the field must not be allowed to remain under water for too long so that root growth could be drained the booting stage. During heading, if the air temperature is above 35 0 C , water should be applied during the day and drained – off at night so as too decrease soil temperature. Other cultural practices are the same as described for conventional (Open Pollinated) Varieties.

11) Synchronization of Flowering :

Synchronizing the flowering of both parents is the key to increased yields. Technical measures such as staggering seedling dates of the male and females parents, sowing the male parents three times to extend the time pollen is available , and predicting and adjusting flowering dates may be adopted. Actual practices would have to be standardized for each hybrid and the locations selected for the hybrid seed production.

i) Staggered Sowing of Male Parents:
Seedling date is usually determined by leaf age, effective accumulated temperature (EAT), and growth duration. In general, the period from initial to full heading of a CMS line is 4-6 days longer than for a restorer line. The first sowing of the male parent establishes the dates for second and third sowing. The second sowing is done when the leaf emergence on the first sowing is 1:1 the third sowing when the leaf emergence is 2:1 . The second sowing is the main parent. The planting ratio for sowing at different dates is 1:2:1.

ii) By Fertilizer Application:
Beginning about 30 days before heading. 3 or 4 random samples of the main culm of both parents are taken every 3 days. Young panicle development is compared under magnification. During the first three stages of panicle differentiation, treat the earlier developing parent with quick releasing N fertilizer, and spray the later developing parent with Potassium dihydrogen phosphate. This adjusts development differences of 4-5 days.

iii) By Water Management:
During later stages of panicle differentiation, draining water from the field will delay male parent panicle development, higher standing water will speed panicle development.

Methods of Improving Seed Setting:

i) Supplementary Pollination (Rope Pulling) :
On calm days during anthesis, supplementary pollination can be carried out. Panicles of the restorer lines are shaken by pulling a long nylon rope (5mm diameter) back and forth every 30 minutes until no pollen remains on the restore line. This method if often used on even topography and regularly shapped plots. In hilly , uneven topography with small, irregular plots, a bamboo pole may be used.

ii) Leaf Clipping :
Leaves taller than the panicles are the main obstacles to cross pollination. Clipping leaves 1-2 days before initial heading increases the probability of pollination and out crossing rate. The blade of flag leaf is cut back ½ to 1/3 from the top. GA3 spray. Spraying seed

parent with 75 gm GA3/ha 60 ppm or more 2 or 3 times increases panicle exsertion and help increased seed setting.

iii) Roguing:
The seed field should be free of rogues. Remove off- type plants in both the parents first before the onset off flowering stage and then soon after emergence of the panicle. Rogue out the plants of maintainer line, if any and the semi-sterile plants in the seed parent as often as necessary.

iv) Harvesting of Seed Crop:
Harvest male rows first to avoid chances of mechanical admixture.

v) Seed Yields:
5-15 Q/ha.

The Seeds (Control) Order, 1983

Government of India
Ministry of Agriculture
(Department of Agriculture and Cooperation)
New Delhi Dated the 30 th December, 1983.
Order:
GSH 932 (E) – In exercise of the powers conferred by section 3 of the Essential commodities Act. 1955 (10 of 1955). The central Government herby makes the following order namely.

Notification:
The following notification of the government of India, Ministry of Civil supplies, dated 24.2.1983.
S.O 140 (E **) –** In exercise of the powers conferred sub-clause (xi) of clause (a) section 2 of the essential commodities Act, 1955 (10 of 1955). The central Government herby declare the following seeds used for sowing or planting (including seedlings and tuber, bulbs, rhizomes, roots, cuttings and all types of graft and other vegetatively propagated material of food crops or cattle fodder) to be essential commodities for the purpose of the said Act, namely.

a) Seeds of food crops and seeds of fruit and vegetables.
b) Seeds of cattle fodder and
c) Jute seeds.

Preliminary:
1. Short Title and Extent:
This order may be called the seeds (control) order, 1983.
It extends to the whole of India.
It shall come into force on the 30 th December of 1983.

2. Definitions:
1. Act means the Essential Commodities Act. 1955 (10 of 1955).
2. Controller means a person appointed as Controller of seeds by the Central Government and includes any person empowered by the central Government to exercise all or any functions of the controller under this order.
3. Dealer means a person carrying on the business of selling, exporting or importing seeds, and includes seeds, and includes an agent or a dealer.
4. Export means to take or cause to be taken out from any place in India to a place outside India.
5. Form means a form appended to this order.
6. Import means a form appended to this order.
7. Inspector means to bring or cause to be brought to any place in India from outside India.
8. Registering Authority means a licensing authority appointed under clause.
9. Seeds mean the seeds as defined in the seeds Act. 1966 (54 of 1966).
10. State Government in relation to a union Territory means the Administry thereby whatever designation known.

3. Dealer to Obtain License:
1. No person shall carry on the business of selling exporting or importing seeds at any place except under and in accordance with the terms and conditions of license granted him under this order.
2. Notwithstanding anything contained in sub-clause (1) the state Government may by notification in the Official Gazette, exempt from the provisions of that sub-clause such class of dealers in such areas and subject to such conditions may be specified in the notification.

4. Application for License:

Every person desining to obtain a license for selling, exporting or importing seeds shall make an application in duplicate in form A together with a fee of ruppes fifty for license to the licensing Authority.

5. Grant and Refusal of License:

1. The licensing authority may after making such inquiry as it think. It grant a license in form B to any person who applies for it under clause for provide that a license shall not be issued to a person.

A. Whose earlier license granted under this order is under suspension during the period of such suspension.

B. Whose earlier license granted under this order has been cancelled within a period of one year from the date of such cancellation.

C. Who has been convicted under the essential Commodities Act. 1955 (10 of 1955) or any order issued there under within three years proceeding the date of application.

2. When the licensing authority refuse to grant a license to a person who applies for it under clause 4, the shall record his reasons for doing so.

6. Period of Validity of License :

Every license granted under this order shall unless previously suspended or cancelled remain valid for three years from the dare of its issue.

7. Renewal of License:

1. Every holder of license desiring to renew the license shall before the date of expiry of the license, make an application for renewal in duplicate, to the licensing authority in form C together with a fee of rupees twenty for renewal. On receipt of such application , together with such lee the licensing authority may the license.

2. If any application for renewal is not made before the expiry of the license, but is made within one month from the date of expiry of the license, the license may be renewal on payment of additional fee of rupees twenty- five in addition to the feel for renewal of license.

8. Dealers to Displays Stock and Price List:

Every dealer of seeds shall diaply in his place of business.

A. The opening and closing stocks, on daily basis of different seeds held by him.

B. A list indicating prices of rate of different seeds.

9. Dealers to Give Memorandum to Purchase:

Every dealer shall give a cash or credit memorandum to a purchase of seeds.

10. Power to distribute Seeds:
Where it is considered necessary to do so in public interest the Controller may by an order in writing direct any producer or dealer to sell or distribute any seed in such a manner as may be specified therein.

Enforcement Authority:

11. Appointment of Licensing Authority:
The State Government may after notification in the Official Gazatte appoint such number of persons as it thinks necessary as the inspectors and may in such notification define the local area within each such Inspector shall exercise his justifications.

12. Inspection and Punishment:
1. An inspector may with a view to securing compliance with this order-
A. Require any dealer to give any information in his possession with respect to purchase storage and sale of seeds by him.
B. Enter upon and search any premise where any seed is stored or exhibited for sale to ensure compliance with the provisions of this order.
C. Draw samples of seeds meant for sale, export and seeds imported and send the same in accordance with the procedure laid down in Schedule I to a laboratory notified under the Seeds Act. 1966 (54 of 1966) to ensure that the sample conforms to standard of quality claimed.
D. Seize or detain any seed in respect of which he has reason to believe that a contractive of this order has been committed or is being committed.
E. Seize books of accounts or document relating to any seed in respect of which he has to believe that a contravention of this order has been committed or is being committed.
Provided that the inspector shall give a receipt in respect of the books of accounts or document seized to the person from whom they have been seized.
Provided further that the seized books of accounts or documents shall be returned to the persons from which the same had been seized after copies there of extracts there from as certified by such person have been taken.
2. Subject to the provision of paragraph of sub-clause (1) the provision of section 100 of the code of Criminal procedure 1973 (2 of 1974) relating to search and seized shall so far as may be apply to searches and seizures under this clause.
3. Where any seed is seized by an inspect under this clause, he shall forthwith report the fact of such seizure to a Magistrate where upon the provisions of sections 457 and 458 of the code of criminal procedure 1973 (2 of 1974) shall so far as may be applied to the custody and disposal of such seed.

4. Every person , if so required by an inspector shall be bound to offer all necessary facilities to him for the purpose of enabling him to exercise power under this clause.

13. Time Limit for Analysis:
The laboratory to which a sample has been sent by an inspector for analysis under this order shall analysis the said sample and send the analysis report to the concerned inspector within 60 days from the date of receipt of the sample in the laboratory.

14. Dispensation / Cancelation of Licence:
The licensing authority may after giving the holder of licence an opportunity of being heard suspend or cancel the licence on the following grounds.
A. That the licence had been obtained by misrepresentation as to the material particular
or
B. The any of the provision of this order or any condition of licence has been contravened.

15. Appeal:
Any person aggrieved by an order:
A. Refusing to grant amend or renew the licence for sale export or import of seeds.
B. Suspending or cancelling any licence may within sixty days from the date of order, appeal to the authority as the state Government may specify in this behalf and the decision of such authority shall be final provided that an application for appeal shall accompany an appeal feel of rupees fifty.

16. Miscellaneous:
Amendment of Licence:
The licensing authority may on receipt of a request in writing together with a fee of rupees ten from a dealer amend the licence of such dealer.

17. Maintenance of Records and Submission of Returns etc:
Every dealer shall maintain such book accounts and records relating to his business as may be directed by the state Government.
Every dealer shall submit monthly returns relating to his business for the preceding month in form D to the licensing authority by the 5 th day of every month.

Plant Breeder’s Rights (PBR)

Plant breeder’s right (PBR) are granted by a government to the breeder, originator or owner of a variety. These rights empower the breeder to exclude others from producing or commercializing the propagating material of the protected variety for a period of at least 15-20 years. A person holding the PBR title to a variety can authorize other party parties to produce sell the propagating material of that variety. He is expected to set reasonable terms for the transfer of PBR title or for the sale of the propagating, materials, otherwise the government can grant license of the right in the public interest (this is called compulsory licensing).

In PBR, the variety is the subject of protection. The genetic components and the breeding procedures are not protected. PBR systems also contain some form of breeder's exemption and farmers' privilege.

Historical:

An act to grant patents on plants was first introduced in Germany in 1866 subsequently. Similar acts were passed in U.S.A and other countries. In 1938, the International Organisation for plant Variety protection (ASSINEL) was established to persuade governments of different countries to introduce plant variety protection. The first UPOV (Union International pour la Protection des obstentions vegetables. International Union for protection of New Plant Varieties was signed in 1961 in Paris. UPOV had 24 members in September 1993 (Australia) , Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany , Hungary, Ireland, Israel, Italy, Japan, the Netherlands, New Zealand, Norway, Poland, Slovakia, South Africa, Spain, Sweden, Switzerland, U.K and U.S.A. The member states of UPOV adopt PBR systems conforming to the broad framework agreed upon in the adopt PBR systems conforming to the broad framework agreed upon in the convention. In addition, nationals of one member state have rights in other member countries. India has recently developed its own PBR system.

Need for Plant Breeders Right

The consideration that prompted the development of PBR system in the developed world were as follows:

1. It encourages breeders by provide economic incentives.
2. It encourages private sector to invest in plant breeding activities.
3. The development of a variety is an innovation. There fore's, a plant variety is an intellectual property, which should be protected.

Initially, it was proposed to patent plant varieties. But this was not favoured, especially, in Europe due to following considerations.

1. Industrial patents are applicable to inanimate objects.
2. Plant varieties are not absolutely stable.
3. An exact description of plant materials is not possible.
4. There is a lack of repeatability in breeding plant varieties.

5. Plant varieties do not fulfil the criterion of inventiveness for patents since they contain only new combinations of pre-existing alleles/ genes.

Comparison among UPOV Acts and Patents

The member countries of UPOV were following UPOV Act (UPOV, 1978). This has now been modified as UPOV Act (1991). The essential features of these acts are summarized and are briefly described below.

1. Coverage extended from the nationally defined plant species (UPOV, 1978) to all plant genera and species (UPOV, 1991).
2. Requirement of novelty is added (UPOV, 1991).
3. Duration of protection increased to 20 yr (UPOV, 1991) from 15 yr in UPOV.
4. Protection extended to all materials (UPOV, 1991) in the place of reproductive material UPOV, 1978)) of the protected variety
5. Breeder’s exemption withdrawn (UPOV, 1991) from essential derived varieties.

Thus UPOV (1991) has strengthened PBR protection in comparison to the UPOV Act (1978) so that it is now more comparable to a patent. Most of the member states had signed UPOV Act, 1991 but it is yet to be ratified.

Requirements for Plant Breeder Right

As per the provision of UPOV Act (1991) , a plant variety must satisfy the following criteria for protection : 1) Novelty 2) Distinctiveness 3) Uniformity and 4) Stability.
Novelty:
The variety must not have been exploited commercially for more than one year before granting of PBR protection.

Distinctiveness(D):
The new variety must be distinguished from other varieties by one or more identifiable morphological, physiological and other characteristics.

Uniformity(U):
The variety must be uniform in appearance under the specified environment of its adaption.

Stability(S):
The variety must be stable in appearance and its claimed characteristics over generation under the specified environments.

Extent of Protection by Plant Breeders Right

The UPOV Act (1991) offers the following protections to the concerned variety.
1. Production for commercial purpose, offering for sale and selling all material of the protected variety is the exclusive right of the holder of PBR title.
2. A grower may be allowed to use a part of his harvest for planting his next crop without any obligation to the holder of the PBR title. This privilege is dependent on the provisions of the national laws.
3. Exchange of propagation material of protected cultivars between farmers is not allowed.
4. The minimum period of protection is 20 years. Some UPOV member states provide protection for upto 25 years or even 30 years (Maize in breeds in France).
5. The protected variety can be freely used for scientific as well as breeding purposes (Except for essentially derived varieties).

Breeders Exemption

A PBR regime ordinarily allows breeders to use a protected variety (called here initial variety) in breeding programmes without any obligation to the party holding the PBR title of this initial variety, this is called breeder's exemption. The UPOV Act (1978) allowed breeder exemption for all varieties evolved form a protected variety. But UPOV Act (1991) has limited the scope of breeder's exemption, essential derived varieties developed from a protected variety are now subject to the PBR protection granted to the initial variety. In other words, the breeder of the initial variety has a claim in the PBR title of the essentiality – derived variety. An essentially – derived variety is a variety predominantly – derived from the genotype or combination of genotype of the initial variety. For example – a variety produced by mutation in or transfer through back cross of a single gene will be regarded as an essentially derived variety. However, a decision on whether a variety is essentiality derived or not is not likely to be a straight forward one. But parental inbreds lines of a hybrid variety are also protected materials and as such are not available for use as breeding materials.

Farmers Privilege and Farmers Rights

Farmers Privilege:
Generally, a PBR system allows farmers to use a part of the material produced on his farm, from a protected variety, for planting his own fields without any obligation to the PBR title holder, this is called farmers privilege. The UPOV Act (1978) had a provision for farmers privilege , which was withdrawn from UPOV Act (1991). But due to a strong

opposition from various corners, it has now left to the member states of UPOV to make a provision for the farmers privilege. Farmers privilege allows a farmers to use his own produce as seed (= propagules) , but does not allow him to exchange seeds with other farmers. Farmers privilege is a very important provision for countries like India where > 90 % of the land is planted with the seeds produced by the farmers themselves as the availability of new quality seeds is limited to < 10% of the total requirements. In addition, a majority of the farmers are poor, and forcing them to pay royality on their own produce would be adjust and even , cruel.

Farmer's Rights:

Agriculture began some 10,000 years ago. During this period, the genetic resources of crops have been selected, developed and conserved by farmers' families and farming communities, particularly in the developing countries. These resources have been collected and used as the basic raw material to develop high yielding varieties by seed corporation of the developed countries. The seeds of these new varieties are earning huge profits to these corporations. It is only just those farmers/ farming communities who arise from past, present and further contribution of farmers in conserving, improving and making available plant genetic resources, particularly in the centres of origin / diversity.

The key questions relating to farmer's rights remain as to whom to reward, to what extent and in what manner. It has been suggested that tribal people, rural communities and traditional farming families be rewarded. The quantum of suggested reward is around 5% of the profits. However, farmers rights are yet to be legalized in any country, it will be a happy day when they are actually implemented.

The Protection of Plant Varieties and Farmer's Rights Act, 2001

Most developed countries have a PBR system in force. The situation in India differes from that in the developed countries in the following respects.
1. Plant breeding activity is mainly carried out by the public sector.
2. Private sector is not yet a major contributor.

There have been arguments that the situation is not ripe for a PBR system in India, but the arguments appear as artificial and are unconvincing. Some have suggested that Asian countries must evolve their own PBR systems with the following provisions.

1. Recognition of community interests, E. g Informal systems of open-pollinated varieties, etc.
2. Extension of the concept of essentially – derived varieties to the unprotected varieties. In any case, India is obligated, under TRIPs to adopt UPOV Act (1991) , allow patents or enact a sui generis PBR system that affords protection equivalent to UPOV Act (1991) or a patent. India had been trying to develop a sui generis system of PBR (Rana, 1995). A sui generis system simply means a system of their own. E. g Designed by them, in this case, India. These efforts have culminated in the passage of 'The Protection of plant varieties and Farmers Rights Act, 2001 (PPVFR Act, 2001) on August 9, 2001 by the Lok Sabha. The Act aims to provide for the establishment of an effective system for protection of plant varieties, the rights of farmers and plant breeders and to encourage the development of new varieties of plants.

Futures of Protection of Plant Varieties and Farmer's Rights Act, 2001

The main features of this Act are briefly summarised below:

1. Registration of farmers' varieties, extent varieties and new varieties of such genera and species as notified in the official gazette by the central government. A farmer's variety is a variety that has been traditionally cultivated and evolved by farmers, or is a wild relative or land race in common knowledge of farmers. An extant variety is a notified variety, a farmers variety, a variety about which there is common knowledge, or any other variety that is in public domain. Registration of the extant varieties will be done within a specified period and subject to their meeting the criteria of distinctiveness, uniformly and stability.
2. A new variety shall be registered if it meets the criteria of novelty , distinctiveness, uniformity and stability. The criterion of novelty requires a variety to be in commercial use for less than one year in India, or 4 years (6 years in case of trees and vines) outside India.The variety must be distinguishable for at least one essential characteristic from any other variety whose existence is a common knowledge in any country (distinctiveness). Essential characteristic is a heritable trait that contributes to the principal feature, performance or value of the plant variety. Further a variety in ' common knowledge 'means any variety for which an application for grant of PBR or for entering the variety in the official register of varieties has been filed in any convention country. The criteria of uniformity and stability are essentially comparable to those for UPOV (1991).
3. Any variety that involve any technology including 'genetic' use restriction and terminator technologies, which is injuries to the life or health of human beings, animal or plants shall not be registered.
4. A variety that has been 'essentially – derived from an 'initial variety' can be registered as a new variety. The breeder of such a variety must obtain authorization from the

breeder of the initial variety. The definition of an essentially – derived variety is comparable to that given for UPOV Acts with an additional clarification that such a variety must be distinguishable from the 'Initial variety' and otherwise conform to the latter in the expression of heritable essential characteristics.

5. The duration of protection of the varieties will be 15 yr for the extant varieties, 18 yr for varieties of trees and vines and 15 yr for varieties of other crops.

6. Registration of a variety confers on the breeder of that variety or his successor or his agent or license an exclusive right to produce, sell, market , distribute import or export the variety. Apparently, the protection is not limited to seed or propagules and extends to all material of the protected variety, this feature of PPVFR Act (2001) is similar to that of UPOV Act (1991).

7. The provision for researcher rights allows any person to use any registered variety for research and for creation of new varieties, except essentially – derived varieties, without paying any royalty to the PBR holder.

8. The Act recognize the farmer's rights in the following **respects.**

i) Registration of farmer's varieties.

ii) Reward from the 'national gene fund' for those farmers who are 'engaged in the conservation of genetic resources of land races and wild relatives of economic plants and their improvement through selection and preservation' provided that the 'materials so selected and preserved have been used as donors of genes in varieties registered under this Act'.

iii) Freedom of farmers ' to save , use , sow , resow, exchange, share or sell' their 'farm produce, including , seed (except for 'branded seed') of a variety protected under this Act in the same manner' as they were 'entitled before the coming into force of this Act'.

iv) Requirement for the breeder to disclose to the farmers the expected performance of the variety under given conditions; farmers can claim compensation if this expectation is not fulfilled.

9. The procedure for making a 'claim attributable to the contribution in the evolution of any variety' and seeking reward from the 'gene fund' has been specified.

10. The central government is to constitute a National Gene Fund from the earnings of benefit sharing of registered varieties, annual fee paid to the authority by the breeder's of registered varieties, compensation deposited in the fund, and contributions form National and International Organisation. The gene fund shall be used for paying compensation to communities for their contribution to the development of a variety for benefit sharing (as determined under the provision of this Act) and for 'conservation' and sustainable use of genetic resources' and for ' strengthening the capability of Panchayat in carrying out such conservation and sustainable use'.

11. Compulsory license may be granted after three years of registration of a variety if seeds of the variety are not available to the public either in adequate quantity or at a reasonable price.
12. The central Government shall establish the Protection of Plant Varieties and Farmer's Rights Authority. It shall be the duty of the authority to promote the development of new varieties of plants and to protect the rights of the farmers and breeders.
13. The central Government shall establish a Plant Varieties registry for the registration of plant varieties. The registry shall maintain a ' National register of Plant Varieties' containing names of all registered varieties, names and address of their breeder's and other relevant details.
14. The breeder shall be required to deposit specified quantities of seeds/ propagules of the registered variety as well as its parental line in the National Gene Bank as specified by the Protection of Plant Varieties and Farmers Right's Authority.
15. Citizens of convention countries will have the same rights as citizens of India under the Act. A convention country is a country that is member of such an international convention for protection of plant varieties to which India is also a member , or a country with which India has agreed to grant PBR to citizens of both the countries.
16. Applications for registration of a variety may be made in India, within, 12 months from the date of application for registration of the same plant variety made in convention country. If such a variety is registered, the date of registration in India shall be the date of application in the convention country.
17. The rights of PBR holder 'shall not be deemed infringed by a farmer who at the time of such infringement was not aware existence of such right'.

Procedure for Registration of Seed Variety

The application for registration of a variety is made in the specified form to the Register of plant varieties. Each such variety must be given a single and distinct name consisting of either letters or a combination of letters and numbers. The application must 'contain complete passport data of the parental lines from which the variety has been derived, the geographical location in India from where the genetic material was taken must be disclosed. The application must state the contribution, if any , of any farmer, village community, institution, or organization in breeding, evolving or developing the variety'. The application must contain ' a brief description of the variety bringing out its characteristics of novelty, distinctiveness, uniformity and stability'. The applicant must also submit and affidavit that the variety does not contain any gene or gene sequence involving terminator technology. A declaration must also be made that the genetic material used for developing the variety has been lawfully acquired. The applicant shall provide to the registar of plant varieties the specified quantity of seed of the varieties to the register. The seed shall be used to conduct tests to ascertain whether seeds of such variety along with its parental material conform to the specified standards. The application is then examined and the Registar of Plant Varieties may accept, reject or ask the application to the suitably amended. When an application is accepted, the application along with the photographs / drawings is advertised calling objections from interested persons / parties within 3 month from the date of advertisement. Objections can be made on the following grounds: 1) a claim of entailment for the breeder's rights, 2) the variety being not registrable, 3) the registration being against, the public interest, or 4) the variety having adverse effects on the environment. The objections will be intimated to the applicant, who will then submit his response to them. The persons(s)/party (ies) who had filed the objections will be given a copy of the response from the applicant.

Air Distribution System in Seed Drying

1. Main Duct and Laterals Air Distribution System:
This type of air distribution system is shown in .In this system, the main duct can be located in the centre of the bin, or it can be located at one side of the bin. When the central duct is located outside the bin, under the floor, it can also serve to empty the bin. Side located main ducts can be built inside the bin, or built on to the wall outside the bin. An interior side located main duct or outside located main ducts, have the advantage of not obstructing the floor as much as an interior central main duct.

2. Single Central Perforated Duct System:
This type of air distribution system is illustrated. It is fabricated for special seed storage structure. For this air distribution system there must be an equal thickness of seed, not exceeding 6 feet, around the duct, which is made of perforated metal. For drying, the air should be forced upward thorough the seed. The side walls of the bin must be either slatted or perforated, so that air can flow laterally thorough the seed. This air distribution system is more commonly used for drying ear corn than for seed of small grains.

3. Perforated False Floor Air Distribution System:
Generally speaking, this is most satisfactory and most commonly used air distribution system for heated air drying. In this air distribution system, air is introduced under the perforated false floor, passes up through perforations and thorough the seed.
The false floor can be made of hardware cloth and screen or perforated metal. The metal false floors are more durable and convenient to use. The metal sheets are lapped when installed. It is recommended that this flooring be supported on concrete blocks, laid so that open areas in blocks are horizontal. Typical farm loading conditions requires 90-120

cm spacing of the blocks. When these recommendations are followed the floor will support loads up to 500 pounds per square feet. Adequate clearance and arrangement of support chambers between the regular bin floor and the false floor must be provided, so that entering air moves freely and is uniformly distributed. The channels and the opening for the flow of air must be carefully designed to carry air stream satisfactorily. The air inlet opening must allow one square foot of cross-section for each 100 CFM of air. When perforated metal flooring is used, the total area of all the openings in the steel sheet should not be less than 8 to 10 percent of the storage floor area. This requirement is especially important when the drying floor does not extend completely to the side walls.

Multiple Bin Storage for Drying

The storage structure for drying (bins) should be so build that they are arranged in multiple bins. Multiple bin storages enable the drying of several lots of seed simultaneously, using the same drying fan or fans. Alternatively, different lots of seeds could be dried successively, with sliding air gates controlling the flow of air to the respective bins. Thus, multiple bin arrangements are particularly advantages when two or more kinds of seeds being are being grown.The main ducts and laterals, or perforated false floors , may be constructed as previously discussed. When ducts are used the cross-sectioned area of the main duct must be computed on the basis of total volume of air flow. If secondary ducts lead from the main duct, the cross-sectioned area of each secondary duct must be computed just as if it were a lateral. Thus if two ducts lead from the main duct, the cross –sectional area of each must be one half that of the main duct. The cross- sectioned area of the laterals for each bin must be based on the expected volume of air flow to that bin. Thus, if in multiple bin storage, all the bins will be dried at the same time, then the cross-sectioned area of each lateral will be based on the total number of laterals, in all the bins, since all will participates at the same time in carrying the air streams. However, if bins will be dried individually, then the cross-sectioned area of the laterals must be based on the fact that the laterals in each bin alone may carry all the air output from the fan or fans. A particularly interesting multi-bin arrangement is to have a double-walled partition between bins, with the space between partitions serving as the main duct. When the partition wall serves as the main duct, it may be necessary to use two more fans at each end to provide adequate volumes of air. This is particularly true for lage bins involving large quantities of seed to be dried at one time.The two bin system permits a minimum investment for fan, duct, heater, etc. arrangements involving more bins are convenient in that the fan need not be moved. However, the cost of a main duct can become a very considerable item. If additional bins are added, it is usually preferable to use an additional fan at the other end of the main duct, rather than trying to use one very large fan to dry all the bins at once.

Crop Dryers

Dryers for heated air drying are complete units, incorporating both a heater unit where fuel is burned, and a fan to force the heated air thorough a canvas connecting duct and into the air distribution system of the drying bin. Safety features are also included such as automatic thermostatic high limit temperature control, which cuts off the burner flame if the air temperature exceeds a certain safe maximum; and a flame failure control which automatically cuts off fuel flow to the burner if the flame should go out. It is also highly desirable to have a thermostat which will automatically maintain the air temperature at a desired setting. Such thermostat are either included as a standard feature in many dryers, or can be purchased as an option.

Dryers come into two main types, according to manner in which heat is supplied to air:

1. Direct Fired
2. Indirect Fired

1. Direct Fired:

In a direct fired dryer, the fuel is burned and the hot combustion gases are thrown directly into the air stream which goes into the air distribution system. The use of heat is highly efficient, but there is possibility of blowing soot, unburned fuel and the objectionable flumes into the seed. This happen if the burner is allowed to gate out of adjustment so that fuel is not completely burned. With some fuels there is danger of blowing small sparks into the seed.

2. Indirect Fired**:**

In an indirect fired dryer, the hot combustion gases pass into a chamber. The drying air circulates around this chamber, thus heat exchanger and picks up heat just as in a hot air fumes. Thus, drying air can include combustion gases , sparks, soot or fumes. Indirect fired dryers are less efficient in the use of heat, than direct fired once, but are safer.

The dryers are also designed to burn various fules, E .g Liquid propane(LP) or butane , natural gas, fuel oil, and coal (coal is now really used as a fuel).

The liquid propane and natural gas which are readily burned, with minimum possibility of soot, are best for direct fired dryers, and fuel oil (Kerosene oil) for indirect fired dryers.The fan of the dryer may be driven by either an electric motor or gasoline engine and power take off (PTO). Electric motors are the most efficient, economical and most commonly used.Several makes of crop dryers are available and could be chosen as per requirements of the operation.

Factors Determining the Selection of Dryers

In calculating dryer requirements, two separate factors must be considered:

1. The required air flow volume for drying at the necessary rate.
2. The heat capacity required for drying at the necessary rate, measured in BTU per hour.
The fan requirements are computed by computing the total air flow needed at the static pressure of the grain at drying depth.
Heater requirements are estimated by calculating the amount of water to be removed from the grain per hour.
Water Content per Bushel of Seed at Different Moisture Percentages:

Pounds of Water per Bushel of Seed at Different Moisture Content Percentage:

Seed Moisture Dry Matter/Bushel	Soybeans , Wheat 51.6 lb	Grain Sorghum 48.2 lb	Com 47.3 lb	Oats 27.6lb
35	27.8	26	25.4	14.8
30	22.1	20.6	20.2	11.8
28	20.1	18.7	18.4	10.7
26	18.2	16.9	16.6	9.7
24	16.4	15.2	14.9	8.7
22	14.6	13.6	13.3	7.8
20	12.9	12	11.8	6.9
18	11.4	10.6	10.4	6
16	9.8	9.2	9	5.2
14	8.4	7.8	7.7	4.5
12	7	6.6	6.5	3.8
10	5.8	5.4	5.3	3.1
8	4.5	4.9	4.1	2.3

1. Figured at following weights per bushel soybeans, wheat – 60 pounds at 14 percent.

Grain sorghum, shelled corn – 56 pounds at 14 percent
Oats- 32 pounds at 14 percent.
2. To figure pounds of seed required to make a bushel at any one moisture percentage listed. The pounds of water given for that particular moisture content and pounds of dry matter.

Calculations of Heat Capacity for Seed Drying

When a seed dryer is operated at recommended temperatures, it requires about 2000 BTU of heat output to evaporate one pound of water. The required hourly heat capacity of the dryer in BTU per hour can be computed by the following formula:

Heat Capacity = lbs water removed per bushel
X bu to be dried per hour
X 2000

We can now consider an example of how to estimate dryer requirements:

Example: A farmer wishes to dry 1200 bushel of wheat per day from 22 percent to 14 percent.

a) What is the recommended drying depth?

b) What air flow rate should be recommended and what will be the total air flow required?

c) What will be the static pressure?

d) What actual hourly output must the dryer provide?

e) Select the proper crop dryer.

Answers:

a) The recommended depth for heated air drying of wheat is 20 inches. For the sake of easy calculations let us take it as two feet.

b) Air flow rates for heated air drying in batch bins or wagons are from 15 to 40 CFM/bu. The higher the air flow rate, the faster and more uniform the drying. For a starter, an air flow rate just above the minimum may be recommended, with the understanding that is highly desirable that the dryer selected be able to provide more air than this. For a starter an air flow rate of about 20 CFM/bu may be recommended.

c) To estimate the static pressure, the static pressure curves will have to be used in manner described earlier and repeated here.

Step I. Air flow in CFM/sq ft = grain height X CFM / bu X 0.8
= 2 X 20 X 0.8 = 32

Step II. Using read horizontally across on the 32 CFM/sq ft line until the wheat cur is contacted. This is done almost exactly at the vertical line which shows that the pressure drop per foot of speed depth is one inch.

Step III. Multiply this figure by grain depth to get static pressure. Since the seed depth is about 2 ft the static pressure will be 2 inches (2 X 1).

d) To estimate the hourly heat capacity, it is necessary to know the actual hourly per bushel and the quantity of water to be removed per bushel. For twenty- four hour operation, the required capacity shall be 75 bushels (average hourly capacity i.e 1200/24 = 50 X 1.5 to get actual hourly capacity) per hour, the quantity of water to be removed per bushel to dry seed from 22 to 14 percent shall be about 6 pounds. The required heat capacity according to formula described earlier will be

Required heat capacity = 6 X 75 X 2000
= 900,000 BTU / hr

e) Select suitable crop dryer to provide a minimum required air flow (bin capacity in bushels X recommended air flow rate) at 2 inch static pressure and 900,000 BTU/hr. in estimating dryer requirements, it is always better to consider the possibility of increased future demands.

Types of Seed Dryers for Heated Air Drying

The heated air drying can be further broken in the following categories.

1. Layer- in- bin dryer
2. Batch- in – bin dryer
3. Batch dryer
4. Continuous dryer

1. Layer- in – bin dryer:

In this method, the bin is filled to a specific depth depending upon seed moisture, the drying unit and bin sizes. This depth is dried down to a state moisture content for storage, before the next layer is added. The drying air is usually controlled by a humidistat set at 55 percent to prevent over drying of the lower layers. Although this method of drying is fairly slow, the seed is uniform dried between the top and bottom of the bin. The compounds that make a bin perform as a dryer are fan, heater, operating and safety controls , transition , duct, foundation, ring , false floor , seed leveller, sweep unloaded and unload auger. The layer-bin- dryers range from 21 to 40 feet diameter and 5 to 20 horse power. It is the most efficient but slowest drying method. After the initial layer, fills must be separated by three to four days while each new layer dries.

2. Batch- in – dryer:

In this method of drying, the quantity of seed at a given moisture content can be dried with a given drying unit. The high moisture seed is placed in a drying bin, dried and cooled and removed to a storage bin. The drying equipment used as similar to that of layer drying; the main difference being in higher capacity heaters and fan, grain levellers, sweep unloaders and unload auger equipment. Seed depths are typically 2.5 to 4 t; the deeper , the seed , depth , the lower the air flow and the slower the drying.

3. Batch Dryers:

Batch dryers are bins with an inner air chamber surrounded by two parallel perforated steel walls to contain a designed thickness of seed. The fan heater unit is connected to one end, or side of the plenum as heated air for drying and natural air cooling can be forced through the seed. Batch dryers, generally rectangular or cylindrical, are usually described by the volume in bushes that a dryer will hold per fill e.g. 300 bushel dryer. Fan power ranges from 3 to 30-40 horse power. The number of batches per day may be eight to ten for small dryers but only two or three for large units. Dryer capacities are rated on average moisture removed of ten points. All batch dryers depend on fast handing. Wet holding capacity is needed to avoid seed receiving, dry seed transfer, and dryer operating cycles.

4. Continuous Dryers:

Continuous flow dryers move seed through heating and cooling sections of the column continuously. Seed flow is controlled by volume metering devices at the lower side of the seed column. Heated air is forced through the upper 2/3 to 3/4 of the seed column at 100 to 150 CFM/bu. Continuous dryer sizes are usually given in bushel/hour capacity at 10 points moisture removal. Power needs are from 7 ½ horse power to 60 horse power. Some dryers use multiple sequence start fan motors to keep starting loads low. Wet holding is necessary for both one and two leg system. With one leg, seed from the dryer is accumulated in a dry holding bin for periodic manual transfer. With two legs a low capacity elevator leg moves dry speed to storage continuously.

Use of Stirring Devices in Seed Technology

The stirring devices keep the seed in a loose fill condition, allowing more air to flow through bottom layers and thus help alleviate the problems of over- drying. They also break up pockets of fires and trash, and blend the seed by the mixing action they perform. Caution is urged when using stirring devices because of the possible damage to bin side walls. Be sure that the auger is always near the centre of the seed bin when starting, to minimize concentrated pressure and possible damage to side- walls.

Recommended Drying Temperature, Air Flow, Seed Depths

When heated air is used for drying, there can be large differences in degree of drying between the layer of seed near the air inlet and top layers. To minimise this difference and to avoid extensive over drying of the bottom layers before the top layers are dry, it is necessary to dry seed at shallow depths in heated air drying. Table gives the recommended maximum seed depths for batch drying in a bin. If the seed is to be stored in the bin where dried , the seed depth could be approximately double that shown in table since, in storage , drying is usually done at lower temperatures than in batch drying.

Recommended Temperatures and Depths for Heated Air Drying of Various Crop Seed in Bins:

Sr.No	Seed	Maximum Depth	Recommended Drying Temperature
1	Shelled corn	20"	110 0F
2	Wheat	20"	110 0F
3	Barley	20"	105 0F
4	Oats	36"	110 0F
5	Rice	18"	110 0F
6	Soybeans	20"	110 0F
7	Peanuts	60"	90 0F
8	Grain Sorghum	20"	110 0F

Heated Air Drying Requires Higher Rates of Air Flow for Two Reasons:

1. Water is evaporated faster and more air is needed to carry it away, and
2. The higher the rate of air flow, the more uniformly there is in the drying of upper and lower layers of seed. Moreover, drying proceeds considerably faster at recommended temperatures at higher rates of air flow. Sometimes the drying time can be halved by doubling the air flow.

Heated Air Drying

Whether in drying bins or in wagons, is usually done at air flow rates of 15 to 40 CFM/bu.For in storage heated air drying , air flow rates can be considerably lower than state above, although minimum air flow of a CFM /bu is considered tolerant with small kernel seeds and low temperatures, it is generally recommended that the minimum air flow rate be 8 to 10 CFM /bu for all seeds. There are limits to the drying temperatures to which all seeds should be subjected. Using drying temperature above this maximum can result in deterioration of seed quality.The use of lower temperature in drying reduces the danger of fire while giving all the drying capacity needed, if adequate air flow volume is used.

Procedure for Heated Air Drying in Bins:

The following is a generalised procedure for drying seeds with heated air.

1. Charge seed into bin to the recommended depth, maintaining uniform distribution of trash air broken kernels.
2. Operate dryer at recommended temperatures for that seed. This can be done manually, or by setting the control thermostat, if available to the desired temperature.
3. When drying is completed, continue blowing air through seed, without heat, to bring seed temperature down to air temperature, or to 50 0 F , if air temperature is lower. This

will require from thirty minutes to two hours, depending upon the quantity being dried and the air temperature.
High drying temperature dry the exterior of the seed kernel considerably more than the interior. Some moisture testers, which measure primarily the surface moisture of the kernel, may then indicate that the seed is dry. After a few days of storage, the moisture redistributes itself through the kernels and the same moisture tester will indicate that the grain has picked up 2 or 3 percent moisture. From this, the farmer may erroneously conclude that he cannot safely store heated air dried seed. This difficulty is largely overcome by using recommended drying temperatures.

Maximum Moisture Content for Safe Storage

Crop	Maximum Moisture Content
Wheat	12
Oats	13
Barley	13
Grain Sorghum	12
Shelled Com	13
Soybeans	11
Rice	12

Seed Drying Methods

Wagon Drying:
Wagon drying is a special type of batch drying with heated air which is finding extensive use. In this system, the seed is loaded directly from the combine on to the wagon, which is specially constructed so that it can be used for drying. The wagon is then drawn to the drier, to which it is connected with a canvas distributing duct. Three or four wagons can be dried at once. The seed is dried by hot air forced up through perforations in the wagon floor. The wagon is then disconnected from the canvas duct and drawn to one side where seed is cooled with a small fan of 1 ½ horse power, as required. After the seed is cooled, the wagon is towed to the storage bins.

Wagon drying has the following advantages:

1. Drying is essentially continuous;
2. High versatility
3. Low initial cost;
4. Saves on seed handing;
5. Easy cleaning and
6. Can be used for other purposes.

Bag Drying:

The drying of seeds could be done in bags also. This is particularly suited when many varieties are handles simultaneously, or when the seed lots are small in size and seed is received from the field in jute bags. Excellent air flow with minimum static pressure is possible because the drying bed is only one sack deep. Typical design criteria provide 25 to 40 cubic meters of air per minute, per cubic metre of seed at a static pressure of 3 cm, or even less. The construction is simple and inexpensive.

Box Drying:

The box drier is a modified bag drier. It is well- adapted for use in basic seed drying operations. With box driers, the identity of small seed lots can be maintained, despite bulk handling. The boxes, generally constructed of locally available materials, are fitted with perforated metal or woven wire bottoms. After the seed is dried, the filled boxes are removed from the drier and placed in a temporary storage area, thus making room on the drier for additionally boxes. This type of drier requires that the enough specially constructed boxes be maintained.

Principles of Cleaning Seeds

In this cleaning process, the separation of undesirable material, namely , inert matter, weed seeds, other crop seeds, light and chaffy seeds, off-size, damaged or deteriorated seed from desirable material is done on the basis of differences in physical properties of desirable seed and undesirable matter. The principal physical differences found in seeds are seed size (length, width and thickness) , density , shape , surface texture, colour , affinity for liquids, and seed conductivity. If the differences between desirable and undesirable material in regard to any of these properties exist, separation of undesirable material could be done with the help of suitable machine/ machines designed for the purpose. Seeds of different species and inert matter widely differ in regard to the physical properties. Length, width, shape , weight , and surface texture differences are quite common in crop species and forms the basis of seed cleaning operations.

Method of Cleaning Seeds

Cleaning of seed can be conveniently discussed in the following groups:

1. Preparing seeds for basic seed cleaning (pre-conditioning and pre-cleaning operations).
2. Basic seed cleaning operation.
3. Upgrading the quality of cleaned seed.

Seed Cleaning Method - Pre-Conditioning and Pre-Cleaning

Pre- conditioning refers to operations such as shelling, debearding, etc, that prepare seed lots for basic seed cleaning, and also to the removal of particles such as pieces of trash, stones, clods etc, larger in size than desirable crop seed, from threshed seed lots. Some pre-cleaners, in addition to removing larger sized particles, also remove particles that are lighter in weight and smaller in size than the crop seed. The necessity of both of these operations, other than shelling, is associated with advanced mechanised agriculture, no pre-cleaning is usually required on hand harvested and winnowed seed lots.

Pre-conditioning and Pre-cleaning Equipment and their Use:

The most common equipment used in these operations are scalers, debearders, huller-scarifier, buckhorn machine and maize Sheeler.

Scalper /Rough Cleaner:

Scalpers are simple devices intended to remove only large trash. Such units basically consist of a vibrating or rotating screen or sieve. The screen perforations are larger enough to allow the rough seed to pass through readily while the larger inert material is 'scalped off' and removed from the seed lot. The scalpers manufactured for pre- cleaning may consist of several screens or reels, with one or more controlled air separations. The single sieve pre-cleaners are called scalpers and the multiple sieve units are referred to as rough cleaners. The rough cleaners are essentially the simple air screen seed cleaners that make possible a separation of light chaff and dust with a controlled air current; a separation of large trash over a large hole screen; and a separation of small foreign material through a small hole screen. Most scalpers are arranged to make the air separation before the seeds reach the screens.

After scalping / rough cleaning many kinds of seeds can be cleaned without any further pre-processing. Seeds of some crops, however, may require hulling, scarification, etc, after scalping.

Huller- Scarier:

Huller and scarifies usually abrade the seeds between two rubber-faced surface, or impel seeds against roughened surfaces, such as sandpaper. In a huller –scarifier, the seeds fall from the feed hopper on to a rotating distributing disc, where they are thrown against the hulling and scarifying surface by centrifugal force either once or twice, depending upon the machine. At this point the seed are hulled and or scarified. After this operation the seeds are moved into a suction chamber where the suction removes the light, fine dust, and the seed discharge at the bottom of the chamber. The severity of abrasion or impact must be controlled accurately to prevent damage. Hulling (removal of an outer coat or husk) and scarification (Scratching of the seed coat) can be done separately or jointly with a huller scarifier.

Debearder:

The debearding machines have a horizontal beater with arms rotating inside a steel drum. The arms are pitched to move the seeds through the drum. Stationary posts, adjustable for clearances, with arms, protrude inward from the drum.

These machines, rub the seeds against the arms and against each other. The time, the seeds remain in the machine, is varied by regulating a discharge gate. The degree of action is determined by the processing time, beater clearance and beater speed.

Pebble Mill:

The pebble mill is used for removing cob-webby hairs from blue grass and similar seeds. It has a drum rotating about a shaft, in seeded off-centre at opposite ends. The mill is loaded with seeds and smooth half-inch pebbles and turned at a slow speed until the rubbing action of the pebbles roll the fuzz from the seeds into small round balls. The mixture of pebbles , seeds and matted fuzz is then run over a scalper to remove the pebbles.

Maize Sheller:

The maize sheller varies in size from small hand-powered Sheller to large motor- driven sheelers with capacities up to ten tonnes per hour. Small hand-power shellers consist of a crank a small feed inlet , a heavy cast iron fly whell and burns that remove the maize seed from the ear, seeds drop out to the bottom and into a container, and the cobs are discharged out from the rear of the Sheller. These types of shellers are useful for small lots of breeder's seed of inbred lines.At processing plants, power sellers are installed to give high capacity shelling. The power Sheller has four main parts, namely, inlet hopper, rotating beating cylinder, concave and fan. The inlet hopper is kept sufficient large to feed several cobs at a time. The rate of feeding could be adjusted through the sliding gate inside the inlet hopper. The rotating beating cylinder has spirally arranged sheelings lugs. On one cylinder a drive pulley is fixed. Drive pulley can be driven by an oil engine, tractor belt pulley, or an electric motor. Most indigenous power shellers require a 7.5 h.p motor. The lower concave is made of a perforated steel sheet to allow the seed to pass through , but to retain and divert cobs towards the vibrating screen so as discharge them outside. Shelled seed coming out of the lower concave is passed through an air blast to remove small cob piece and dust. For obtaining satisfactory shelling, the cylinder shaft speed should be in the ranger of 450 to 500 RPM.

Seed Cleaning Method - Basic Seed Cleaning

Basic seed cleaning refers to actual cleaning and grading of seeds. Unlike pre-cleaning/ Precleaning/ pre-conditioning, which may or may not be required, basic seed cleaning is an essential process in the seed cleaning operations. Many kinds of seeds can be completely cleaned and made into a finished product by, basic cleaning. In other instances, however, further separations to remove specific contaminants may be necessary, or desirable. Regardless of whether further specific separations are made or are not made, basic seed cleaning for every lot is invariably done.

Equipment for basic seed cleaning. Basic seed cleaning is done over an air screen machine, commonly referred to as an air screen cleaner. It is also basic equipment in seed processing plants.

Air Screen Machine:

Principles of Cleaning:

The separation of undesirable material and seeds from desirable seeds in an air screen machine is done on the basis of differences in seed size and weight. In some separations, seed shape could also be used. The air screen machine uses cleaned, but which were too large to drop through the second screen, are removed here. As the crop seed drops off the fourth screen, they fall through the lower air separation. This removes the light seed and trash which was not removed by the upper air and the screens. For efficient cleaning, the lower air blast should be strong enough to blow out a few good seed.

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Adjustment of Equipment:

1. Screen Selection:
Screens must be selected according to the shape of the crop seed being cleaned.
Round Seeds: Top screen- Round hole
Bottom screen – Slotted
Oblong Seeds: Top screen- Oblong
Bottom screens- Oblong
Lens – Shaped Seeds: Top screen- Oblong/ rectangular
Bottom screen – Round hole.

2. Rate of Feed:
The feed gate on a feed hopper is adjustable for large change of rate of feed. The basic adjustment is made by increasing, or decreasing, the speed of the feed roll.

3. Screen Knockers and Tappers:
Adjustable knockers, or tapers, to lightly tap the screens installed on the machine vibrate the screens so that the seeds will pass through close and small openings, and will jolt loose long weed seeds that wedge so tightly in the perforations that the brushes cannot remove them.

4. Upper Air Suction:

The upper air suction is regulated by an adjustable damper in the air passage, so as to remove most of the light chaff and dust before the seed reaches the top screen.

5. Variable Screens Shake:
The variable screen shake adjustment permits the operator to adjust the screen vibration speed from slow to very rapid. The rate of vibration , or shake , should be adjusted to induce a desirable action of the seed on the screen, and not to increase capacity by shaking the screen faster.

Maintenance of Air Screen Seed Cleaner

1. Check all nuts, bolts and screws daily and tighten or replace as necessary.
2. Check brushes and spring tension on the brush drive mechanism, adjust or replace when necessary.
3. Be sure that feed hopper is loaded to capacity to ensure uniform flow of seeds on to the entire width of the screens.
4. Check fan and main eccentric bearings for adjustment, wear and excessive vibration; replace when necessary.
5. Check air chest to be sure that it is not ploughed with straw and trash.
6. Check air exhaust vents to be sure that seed is not being blown by the air blast and discharged through the dust collectors.
7. Check daily to see that all screens are anchored family in the proper position in the shaker shoes.
8. Check all screens daily to see that surfaces are flat and true.
9. Clean machine after each operating shift, including the screens, and greases all bearing as instructed in the operation manual.
10. Inspect the cleaner frequently during operation to detect visually, or by ear, any malfunction.
11.At the end of the processing season, check for worn and damaged parts and replace immediately.

Seed Cleaning Methods - Upgrading the Quality of Cleaned Seed

We have mentioned earlier that in certain instances it is necessary and in others rather desirable to further upgrade the seed quality by removing either specific contaminants, or by very precise size grading. The various processing operations conducted after basic cleaning to further improve seed quality are regarded as upgrading operating. The choice of upgrading operation, however, shall depend upon the type of contaminants and crop seed. Table 17.2 describes the various types of upgrading operation equipment, their principle of operation and specific uses.

Upgrading Machines:

1. Type of Upgrading Operation and Types of Machines:

i. Sizing and Grading: (Dimensional Sizing):

a. Width and thickness sizing and grading

1. Horizontal flat screen separators, e.g. Clipper com sizer, superior rock-it-com grader.
2. Vertical ribbed screen separator, e.g. Dockings seed grader.
3. Cylindrical screen separators, e.g. Carter-day precision grader, superior high capacity sizer.

b. Length sizing and grading

1. Disc Separator

2. Principles of Operation of the Machine:

These machine make extremely sensitive and precise separations on the basis of differences in width and thickness. The seeds are sized for width by using round-hole screen openings and for thickness by using slotted screen openings. The separators employ gravity, centrifugal force, product pressure , or a combination of these forces, to make width and thickness separations on screens.

Seeds are separated on a pure length basis. In a disc separator , the discs lift uniformly shaped and sized and undersize particles, out of a mass of seed. The separation is not affected by seed coat texture, weight per bushel or moisture content.

3. Uses of Machine/ General Usage:

a) Removal of splits from soybeans, peanuts, etc.

b) The removal of chips and splits from sorghum seeds.

c) Removal of cheat from wheat.

d) Removal of cockle burns from cotton seed, wild onion from fescue , and wild oats from barley.

1. Removal of weed seeds.
2. Cross broken crop seeds.
3. To upgrade general appearance.
4. Size grade for precision plantings.

4. Specific Usage:

Sizing hybrid corn. Rice seed industry.

Small grains, corn, soybeans.

Seed Testing Laboratory

The seed testing laboratory is the hub of seed quality control. Seed testing services are required from time to time to gain information regarding planting value of seed lots. To carry out these responsibilities effectively, it is necessary that seed testing laboratories are established, manned and equipped in a manner such that whatever samples are received could be analysed in the least possible time, so that the seed quality control work and the need of seed industry are effectively met.

Kahre et al. (1975) has listed the following conditions that are essential for ensuring good seed testing work.

1. A highly responsible staff which must continue to work conscientiously when the person in charge is away.
2. Uniformity of equipment, procedures and interpretations. In other words, consistently good facilities and skilled analysts.
3. Good service, that is, prompt analysis and a cooperative spirit among employees.
4. Leaders with a scientific background to give advice to all types of customers and to furnish explanatory remarks in reports, when necessary, to those who submit samples.
5. Promotion of research, leading to improvement of the whole seed programme, especially of testing procedures, with practical questions being submitted for scientific analysis.

General Principles of Seed Testing Laboratory

1. The physical –infrastructure and facilities should be planned on the basis of average expected workload during the peak seasons, so as to permit efficient handling of seed samples without undue delays. The working space should be adequate. This is important since the time taken in reporting results is of crucial importance. There should be sufficient space left for any special tests section etc. If the need arises.
2. The kinds of tests to be carried out or likely to be carried out, for example, routine tests, seed health test, varietal purity tests etc. must be ascertained in advance for making provisions in the plan.
3. The selection and number of the equipment should be such so as to permit efficient handling of work. The equipment must meet requisite specifications.

4. The decent furnishing, light arrangement and other necessities should be provided so as to reduce the strain of otherwise strenuous work.

Building A seed testing laboratory can be housed as a separate building or it could form part of a larger building housing a department. The entire work can be organized in a hall/or in separate rooms. The size of the building or space requirement depends upon the number of samples to be handled and the kind of tests to be done. The following space requirements for testing 10,000 samples per year may serve as a guideline.

Space and Staff Requirements of Seed Testing Laboratory

Sr.No	Particulars of Room	Size of room meters	Total Area (Sq. meters)
A	Rooms		
1	Sample receipt and preparations room	3 X 3.6	10.8
2	Moisture Test room	3 X 3.6	10.8
3	Purity room	6 X 6	36
4	Germination room		
a	Walk-in-germinator	1.8 X 2.4	4.3
b	Cabinet-type germinators	3 X3.6	10.8
c	Sand Test room	3 X3.6	10.8
d	Preparation room cum germination counting room	4.5 X 6	27
5	Seed Health test room (2 nos)	4 X 6	27
6	Special Tests	6 X 6	36
7	Sample Storage	4.5 X 6	27
8	Miscellaneous room and other office space (3 nos)	3 X 3.6	32.4
		Total	243.7
B	i) Green house (Wire mesh enclosure)	4.5 X 6	27
	ii) Glass house	4.5 X 6	27
C	Grow - out test plot		o.5 ha

The purity room, in particular, should have abundant natural non-large light. It should be preferred to locate windows in this section along the north side of the building. It would also be desirable that the bottom window panes open in a horizontal manner so that the air coming through the window will be deflected upward and not blow directly across the working table of the seed analyst. Windows should be screened on the outside to keep out insects and birds.

Staff:

The number of workers in the seed testing laboratory should be related to the number of samples, crop species to be handled and kind of tests to be performed. The following criterion may serves as a guideline for a laboratory handling, 10,000 samples per year.

Sr.No	Position	No of Staff

1	Officer In charge	1
2	Senior Seed Analysis	
	i) Purity	1
	ii) Germination	1
	iii) Special Health	1
	iii) Special Test, e.g Varietal Purity	1
3	Junior Seed Analysts	
	i) Purity	2
	ii) Germination	2
	iii) Seed Health	1
	iv) Special Tests	1
4	Laboratory Asstts. (one for each of the Analysts)	10
5	Laboratory Attendants (one for each room)	4
6	Accounts Officer	1
7	Accounts clerk	2
8	Store keeper	1
9	Refrigeration Mechanic (Foreman)	1
10	Peons	2

The need for additional hands is invariably felt during the peak season. This need should be met by employing graduate students on daily wage basis.

Equipment Required for Seed Testing Laboratory

The rule for testing seeds includes the type of equipment and its specifications. The equipment for a seed testing laboratory, therefore, should be selected accordingly. Only the best available should be purchased. The following list of equipment may serve as a guideline.

List of Equipment for Seed Testing Laboratory:

Sr.No	Equipment	No of Required
A	General	
1	Seed Sampling and Dividing	
	Seed triers (assorted sizes)	1
	Gamet divider	1
	Soil type divider	1
2	Sample storage boxes and racks	As per Requirement

3	Laboratory models of following	
	Air Screen cleaner	1
	Disc separator	1
	Precision grader	1
	Spiral Separator	1
	Others (if Available)	As per Requirement
4	Balances	
	Single pan (Top loading)	2
	Analytical Balance	1
5	Purity work Boards	6
6	Germinators	
	Cabinet germinator	4
	Walk-in-room germinator	1
7	Refrigerator	1
8	Sand Sterilizer	1
9	Ovens	6
10	Grinding Mill	1
11	Stereo binocular Microscope	2
12	Incubators	2
13	Autoclave	1
14	U V Lamp	1
15	Gel Electrophoresis Unit	1
16	Miscellaneous equipment	
a	Kilogram per hectolitre apparatus	1
b	Seed Blower	1
c	Seed Scarifier	1
d	Moisture Meter (Electric)	2
e	Hand Sieves	One set
f	Seed Herbarium	1
g	Counting Boards	Assorted
h	Sand Benches	As per Requirement
i	Water Sprinklers	2
17	Miscellaneous Supplies	
a	Sample pans	10
b	Desiccators	6
c	Aluminium cans with lids	100

d	Forceps	12
e	Magnifiers	6
f	Aluminium dishes	50
g	Petri dish	As per Requirement
h	Plastic Boxes	As per Requirement
i	Other glassware and Supplies	As per Requirement

Management of Seed Testing Work

The following may be used as a guideline for managing the work in a seed testing laboratory for efficient handling of seed samples.

1. Receipt and Registration of Seed Samples:

The samples received in the laboratory should be entered in a pre-printed register or forms and assigned a test number to be used in all the analysis. The information, namely, name of the sender, type of sample, kind of tests required , crop , variety and class of seed etc. should be properly recorded. The samples especially received for moisture test in the moisture- proof containers should be passed on as such to the moisture test section after assigning the test no.

For speedy operation it would be desirable to simultaneously prepare separate seed analysis cards and envelops for working samples. The test no would invariably be written on each card and the envelop. These are passed on to the person responsible for preparation of the working samples. The entire work should be so organized that this work is completed the same day.

2. Moisture Test:

The samples intended for a moisture test requires special attention, because it may otherwise either lose or amy absorb moisture from outside. These samples after assigning the test no. should be passed on for moisture testing analysis without unnecessary delay.

3. Working Sample:

After entering the samples the next step is to prepare the working samples (s) for various tests. To save time taken in completing the seed tests the first objective should be to prepare a working sample for the germination / viability test so as to limit the seed, testing time to the minimum time required to complete seed germination / viability test, as the case may be subsequently, if the seed cleaning on laboratory model machines or test weight determination , is desired , the same may be done at this time. The working sample envelopes for the various tests along with the corresponding analysis card should be serially placed in sample trays for sending to the concerned section.

4. Routine Tests:

In a seed testing laboratory, germination test, purity test, test for other seeds and moisture test are known as routine test. For all such crops where the analysis for diseased seed or other variety seeds is also desired on the routine basis (as in the case of certified seed samples for the issuance of seed certification tags) these tests should also be included in the routine tests. Every effort should be made to analyse the samples speedily so that there are no undue delays in sending the results. These tests must be done as per rules, that is , rules mentioned in the 'Seed Testing Manual'.

5. Other Tests:

Every effort should be made to complete these tests as quickly as possible. These should be carried out as per available procedures. The name of the procedure adopted should, however be mentioned while reporting the results.

6. Reporting of Results:

After the tests have been completed, the results are reported on a printed form, known as, seed analysis certificate in the requisite manner. One of the common complaint against seed testing laboratories is "length of time", that is, the days taken in sending the report. It is therefore important to ensure that there are no undue delays. The result of seed samples received from seed inspectors under the provision of seeds Act should be communicated within 21 days from the date of receipt but not later than 30 days in any case.

7. Storage of Guard Samples:

The submitted samples received by the seed testing laboratory, on which reports are issued, should be stored after analysis for one year from the date of issue of reports, in condition calculated to minimise any change in quality.

8. Maintenance of Records:

To serve the needs of seed certification, farmers and other applicants, it is essential that records are immediately available for any sample tested during the current year, season, or at any other specified time. The records should be maintained in such a manner that any information needed can be traced immediately.

Probable Cause of Discrepancies in Seed Test Results

As a rule the seed testing, results must be accurate and reproducible within comparable limits. However, the results obtained at two different seed testing laboratories may vary, although the same rules are followed. The probable causes are:

1. Heterogeneity of Seed Lots:
This is the most important cause of variation. No two samples taken from the same container or the same lot of seeds are likely to be identical. Inadequate mixing or blending interferes with random distribution and therefore lowers the chances of getting a representative sample form a seed lot. Tendency towards stratification of particle due to varying densities during filling, stacking and transportation of seed containers can lead to sample variations.
Also, genetic heterogeneity , variability in soil and degree of pest and disease incidence during seed maturing combined with variation in operations during harvesting, drying and conditioning are some of the major causes of heterogeity in a seed lot. Utmost care in seed sampling is therefore of crucial importance.

2. Sampling and Equipment:
Defective sampling, substandard equipment and uncontrolled differences in the application of test procedures are the other important sources of variation in test results.

3. Experience:
Expertise of analysts making and or reporting the test results vary. This may also lead to variation.
It should be the endeavour of all seed analysts in the seed laboratory to stick to the procedure prescribed in the rules for seed testing. This would help in bringing uniformity, accuracy and reproducibility in test results.

Seed Treatment

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

Benefits of Seed Treatment:
1. Prevention of Spread of Plant Diseases:
The disease from treatment standpoint may be conveniently grouped under three types-

a) Systemic Disease:
That infect the seed during the harvest or storage period resulting in infection of seed , E.g Bunt or stinking smut of wheat, Helminthosporium blight of barley, loose and covered smut of oats; head and kernel smuts of rye , smuts of millet . Appropriate seed treatment is significantly effective in controlling these diseases.

b) Systemic Diseases:
That infect seed during the flowering stage to become established within the seed and from there within the resulting plant. Such diseases include loose smuts of wheat. Treatment with systemic fungicides, E.g Vitavax has been found effective.

c) Non-systemic Disease:
Diseases that infect seed during the harvest or storage period. Such diseases includes Helminthosporium blight, blotches or blight of barley, oats, rice , rye , sorghum, wheat and Fusarium. These diseases can be effectively controlled by appropriate seed treatment.

2. Seed Treatement:
Protects seed from seed rot and seedling blights. Seed treatment, by its protective coating around the seed, acts as a barrier once the seed is planted to ward off attack by both seed-borne and soil-borne organisms. These organisms affect, all crop seeds and the degree of attack depends upon a number of factors of particular importance are the organisms. Pythium spp, Rhizoctonia and Sclerotium that are present in all soils. They may rot the seed before germination gets well started, or they may kill the seedling before it emerges, or so affect it that it dies after emergence or supervives only as a weakened plant. The responses to protective treatment varies with the kind of crop seed, the vigour of the particular seed, the amount of mechanical injury to seeds, conditions of seed surface and adversity of planting conditions. The fungicide treatment compensates by protecting these cracks and abrasions from entrance of fungi.

3. Improves Germination:
Seed treatment often improves the standard of germination through the control of seed surface flora, though normally not considered pathogenic; this may infect the seed following moist harvesting and storage conditions. In the germination test it may smother the seed before it has a chance to germinate.

4. Provides Protection from Storage Insects:

The protection of seed from insect damage during storage is of increasing importance with the trend towards processing, treating and unit packaging of seeds at harvest time. For complete protection it is necessary to treat seed with insecticide also. Insecticides are more needed in warm storage than cool storage.

5. Controlling Soil Insects:
This can be done through combination treatment – the process of addition of an insecticide with fungicide for the added protection of the seed and seedling against certain soil insects, such as wire worm and the seed corn maggot. In contrast to storage insect protection, it is a means of giving limited protection to the seed and seedling until it becomes resistant to attack or can survive limited attack. It is not a means of disinfecting the soil.

Types of Seed Treatment

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

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

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

Condition under which Seed Must be Treated

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

2. Diseased Seed:

Seed may be infected by disease organisms even at the time of harvest, or may become infected during processing, if processed on contaminated machinery or if stored in contaminated containers or warehouses.

3. Undesirable Soil Conditions:
Seeds are sometimes planted under unfavourable soil conditions such as cold and damp soils, or extremely dry soils. Such unfavourable soil conditions may be favourable to the growth and development of certain fungal spores enabling them to attack and damage the seeds.

4. Disease- Free- Seed:
Seeds are invariably infected, by disease organisms ranging from no economic consequence to severe economic consequences. Seed treatment provides a good insurance against diseases, soil- borne organisms and thus affords protection to weak seeds enabling them to germinate and produce seedlings.

Seed Treating Products

1. Organo Mercurial:
Organo mercurials are recommended for the treatment of small grains, flax, cotton and safflower. Proper dosage is critical. Over-treatment, however, may result in seed injury and under-treatment may fail to adequately control disease. In general, the seed treated with the more volatile organic mercury compounds cannot be stored for more than a few days without lowering the viability of the seed, especially if the moisture content is high. The rate of application of organo mercurials should be watched closely. It should never be applied at more than the recommended rates. If the seed is to be stored for a while after treatment with a volatile fungicide, the moisture content of the seed should be below thirteen per cent.

2. Inorganic Mercurial:
The use of inorganic mercurial's for treating seeds is practically limited to mercuric chloride, mercurous chloride and mercuric oxide. These materials when used are limited primarily to seeds, roots , tubers, garden and vegetable crops. Extreme caution's is necessary in using inorganic mercurials for seed treatment. Mercuric chloride is injurious to some extent, to most seeds.

Non- mercurial:
1. Organic non-mercurial:
The use of organic non-mercurial such as Thirum and Captan has considerably increased in the recent past. Generally, they are less effective than the organic mercurial but are less

damaging to the seeds and less dangerous to persons handling the seed. Excessive dosages are not harmful to the seed which may be stored for long periods of time without suffering injury from the treatment. Organic non-mercurial are not determined to the viability of injured seed. These fungicides act as seed disinfectants and or seed protectants. That is ,they may kill fungal spores on the surface of the seed and also serve as a protectants to the seed against soil-borne organisms.

Inorganic Non-mercurial:
Copper carbonate, copper sulphate, cuprous oxides constitute the major inorganic non-mercurial compounds which are used as fungicides. Copper carbonate and copper sulphate are used as fungicides. Copper carbonate and copper sulphate are used on wheat as bunt preventives. Cuprous oxide prevents seed decay and damping-off vegetables, but is injurious to seeds of lettuce , crucifer and onions.

Insecticides:
Insecticides are finding increased use in seed treating. These may be merchandised in combination with the fungicide, or as distinct products for individual use, or combined with the fungicide in the treating process. The uses include:
1. Protection against storage insects,
2. Protection against certain soil insects that the attack the seed.

Equipment for Seed Treatment

The equipment used to apply chemicals in any form to seed are classed as seed treaters, and can be divided into two broad categories.

1. Slurry Treaters:
The slurry treatment principle involves suspension of wettable powder treatment material in water. The treatment material applied as slurry is accurately metered through a simple mechanism composed of a slurry cup and seed dump pan. The cup introduces a given amount of slurry, with each dump of seed, into a mixing chamber where they are blended. The slurry Treaters are adaptable to all types of seeds and rates of treating. The small amount of moisture that is added to the seeds (half to one percent of the weight of the seed) does not affect seed in storage, since the moisture is added to the seed surface and is soon lost.

2. Direct Treaters:
Direct Treaters are the most recent development and include the ‘pathogen’ and mist-o-matic Treaters of these two; the mist-o-matic treater is being used more widely. The mist-o-matic treater applies treatment as a mist directly to the seed. Cup sizes are

designated by the number of cc'c they actually deliver, E .g 21/2 , 5,10,15. The treater is equipped with a large treatment tank, a pump, and a return that maintains the level, in the small reservoir from which the treatment cups are fed. After metering, the treatment material flows to a rapidly revolving fluted disc mounted under a seed spreading cone. The disc breaks drops of the treatment into a fine mist. It sprays this outward to coat seed falling over the cone through the treating chamber. Just below the seed dump are two adjustable retarders designed to give a continuous flow of seed over the cones between seed dumps. This is important since there is a continuous misting of material from the revolving disc. The desired treating rate is obtained through selection of treatment cup size and proper adjustable of the seed dump weight.

Home –made Drum Mixer:
A simple mixer can be made by running a pipe through a drum at an angle. The drum is then mounted on two sawhorses. The seed and treatment are placed in the drum and it is rotated slowly until all seeds are covered.

Grain Auger:
Liquid materials can be dripped on to the seed as they enter a grain auger or screw conveyor. By the time seeds have left the augur, the liquid is spread well over most seeds. Dust and slurry materials may also be applied in this manner, but with more difficulty.

Shovel:
Seeds are spread on a clean, dry surface. Ten to fifteen centimetres in depth. The proper amount of treatment is diluted with water and sprinkled evenly over the seed. Mixing is accomplished with a shovel or scoop turning the seed at least twenty times.

Seed Treatment - Colouring of Seeds

Most seed treatment contain dyes, and some companies add their own ' colour brand' dye to seed treatments. Dyes serve two purposes.

1. As a warning that the seeds have been treated to prevent inadvertent contamination of food or feed, and
2. As a visible means of evaluating the completeness of treatment coverage.

The dyes, if used for treating formulation of dry seed, are mixed with fungicide and insecticide treatment.

Causes of Poor Seed Treatments

1. Wrong Fungicides:

Use of inappropriate fungicides, old dusts, etc, may prove relatively ineffective for protection against soil fungi.

2. Inadequate Dosages:
Failure to get sufficient fungicide on the seed results in poor seed treatment.

3. Carelessness:
The use of the best available fungicides and the latest equipment for treating seeds does not by itself guarantee proper seed treatment. Adequate care is necessary regarding machine adjustments, etc, to treat seeds effectively.

Precaution in Seed Treatment

Most products used in the treatment of seeds are harmful to humans, but they can also be harmful to seeds. Extreme care is required to ensure that treated seed is never used as human or animal food. To minimise this possibility, treated seed should be clearly labelled as being dangerous, if consumed. The temptation to use unsold treated seed for human or animal feed can be avoided if care is taken to treat only the quantity for which sales are assured. Care must also be taken to treat seed at the correct dosage rate, applying too much or too little material can be as damaging as never treating at all. Seed with a very high moisture content is very susceptible to injury when treated with some of the concentrated liquid products. If the seeds are to be treated with bacterial cultures also, the order in which seed treatments should be done shall be as follows :
i) Fungicide
ii) Bacterial Cultures.

Seed Packaging and Handling

After processing and treating are completed seeds are packaged into containers of specified new 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 practises.
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:

The Bagger Weigher:
These are small machines which, when properly mounted beneath a bin, will fill and weight a bag accurately in a single operation. Operational steps include:
a) The empty bag is suspended on the bagger weigher by a bag clamp.

b) Seed flow into the bag is begun, usually by a trip lever.
c) As seed flows into the suspended bag, a scale –type counter –balance mechanism is actuated, so that when the proper weight of seed is in the bag, the seed flow lever is tripped and seed flow is automatically stopped.
d) The bag now filled with the exact weight of seed is removed from the bagger weigher and is closed.
Bagger weigher and bagging scales, used in seed packaging may be manual, semi-automatic or automatic.

Manual Weighing:
This type of scale, usually a portable plant form is considered inefficient for volume weighing operations because of high labour requirements and relatively low capacity, in terms of bags filled per minute. With this scale, bags are filled to approximate weight, placed on the scale and then 'even weighed with a hand scoop. These scales are useful in following conditions.
a) Weighing bags of non-free flowing seeds.
b) A bagging bin is not available.
c) Labour costs are minimal.
Semi-automatic. This is the most widely used scale. The scale is attached to the bottom of a bagging bin, and the bag is clamped to the bottom of the scale. The feed gate is opened manually and may be closed either manually or automatically when the proper weight is attained. The scales have a capacity to weight four to eight bags of 50 kg per minute, depending upon the seed being packaged and the skill of the operators. When selecting a scale of this type, the circumference and composition of bags or containers must be considered. The office, or the bag clamp, must be smaller than the open end of the bag, however; too small an orifices and clamp will result in seed spilling around the edge of the bag. The bag clamps hold bag material of specific finish and thickness, therefore, the composition of the bagging material, that is, jute, cloth, plastic, paper, etc. should be stated when ordering the scale. Automatic scales: Scales of this type are used primarily for small packages, e.g vegetable and lawn seeds. In these machines the entire weighing and filling process is done automatically. Installation is similar to the semi-automatic bagger. Some completely automated systems pick up the empty bag, place if on a bagger, fill the bag and release the filled bag which then moves by conveyer to a bag closer. Regardless of the types of scales used, they should be checked regularly to determine their accuracy, particularly if they are portable. Frequent and careful cleaning of the weighing mechanism will decrease the number of inaccurate weighings and extend the life of the scale. Bag sewing machine. After an open- mouth bag is filled, the bag top must be sewed with a bag sewing machine. Bag sewing machines are precision, high speed machines and must be operated and maintained properly to prevent frequent break.

Seed Storage – Purpose and Stages

Purpose of Seed Storage:

The purpose of seed storage is to maintain the seed in good physical and physiological condition from the time they are harvested until the time they are planted.

Stages of Seed Storage:

The seeds are considered to be in storage from the moment they reach physiological maturity until they germinate, or until they are thrown away because they are dead or otherwise worthless. The entire storage period can be conveniently divided into following stages.

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

The seed quality, i.e germination and vigour, can be considerably affected at any of the stages mentioned above , unless sound principles involved in seed storage are practised and the seeds properly handled.

Storage of Seed on Plants

Seeds are considered to be physiologically and morphologically mature when they reach maximum dry weight. At this stage dry down or dehydration of the seed is well underway. Dry down continues after physiological maturity until moisture content of the seed and fruit decreases to a level which permits effective and efficient harvest and threshing. This stage can be termed as harvest maturity. There usually is an interval time between physiological maturity and harvest maturity, and this interval represents the first segment of the storage period. Any delay in harvesting the seed after they reach harvest maturity maturity prolongs the first segment of the storage period. The seed quality is greatly influence by prevailing environmental conditions; from the time seeds reach physiological maturity until harvest. Weathering damages are often a serious factor at this stage. As a result of weathering damages, seeds of many crops, E. g Soybean, lose their viability and vigour and are already low in germination even before they are harvested. Several factors such as soil conditions, mineral nutrient deficiencies, during plant growth, water stress, high or low temperatures, disease and insect damage, etc. may also deteriorate seed quality by reducing viability and vigour at physiological maturity.

Other things being equal, the seeds that have begun to deteriorate due to one or more factors mentioned above subsequently will not store as well as the relatively, undeteriorated seed. It is, therefore, of the utmost importance, to maintain initial seed quality to the near maximum attainable, by keeping weathering and other types of damages to the minimum possible. This would mean raising a good health seed crop, early harvesting and adequate arrangements for seed drying.

Storage from Harvest until Processing

The period of harvesting and cleaning is frequently one of high temperatures. During this time seeds still have high moisture content. Seed deterioration can be rather rapid during this period. Transport from field to threshing floors, threshing floors to processing plants and at the processing plants, involves periods of storage during which deterioration can be rapid and serious, if the moisture content is above thirteen percent. At moisture contents above this range, molds may grow on in the seed end heating may occur. It is therefore, necessary to take the utmost care in handling of material after harvest. If harvesting has been done above 13 percent moisture content, necessary arrangements for drying / aeration, etc, of seeds are necessary to preserve seed quality. In addition, adequate care is necessary in handling the seed materials at this stage so as to prevent mechanical mixtures and maintain lot identity.

Storage of Seed in Warehouse

It is customary for seed men and others interested in storage of seeds, to give primary attention to rooms or buildings labelled as seed storages. Seed ageing, and loss of germination during storage, cannot be stopped altogether, though it could be appreciably reduced by providing good storage conditions. Seed longevity in storage warehouses depends upon a number of factors. Important among them are:

Factors Affecting Seed Longevity in Storage

1. Kind / variety of the Seed:

The seed storability is considerably influenced by the kind / variety of seeds. Some kinds are naturally short-lived, E. g onion , soybeans, peanuts , etc. some similar kinds, E. g Tall fescue and annual rye grass, though they look very much alike, differ considerably in storability, similarly, the genetic make-up of the lines/ varieties in the same kind also influences storability.

2. Initial Seed Quality:

The seed lots having vigorous, undeteriorated seeds store longer than deteriorated lots. Depending upon the severity of damage, or degree of deterioration, E. g extent of weathering damage, mechanical injury, flat, wrinkled or otherwise damaged seed, even seed lots of good germination, at the beginning of storage, can and do decline rapidly within a few months. The important implication of this is that only high quality seed should be carried over. The mediocre quality seed may be retained only for the next plating seasons. The low quality seed should invariably be rejected.

3. Moisture Content:

The amount of moisture in the seeds is probably the most important factor influencing seed viability during storage, over most of the moisture range, the rate of deterioration increases as the moisture content on seed storability. Moisture Content and Storage Life of Cereal Seeds at Temperatures not Exceeding 90 0 F for Seeds of High Germination and High Vigour at Start of Storage (Harrington and Douglas, 1970)

Seed Moisture Content(Percent)	Storage Life
11 to 13	½ Year
10 to 12	One Year
9 to 11	Two Years
8 to 10	Four Years

Further, if seeds are kept at higher moisture contents than mentioned in table the losses could be very rapid due to mold growth on and in the seed (12 to 14 per cent moisture content), or due to heating (18 to 20 per cent moisture content). Moreover, within the normal range, biological activity of seeds, in sects and molds further increases as the temperature increases. The higher moisture content of the seeds, the more they are adversely affected by both upper and lower ranges of temperature. It is important to note that very low moisture content (below 4 per cent) may also damage seeds due to extreme desiccation. Since the life of seed and its span largely revolves around its moisture content, it is necessary to dry seeds to safe moisture contents. The safe moisture content, however, depends upon storage length, type of storage structure, kind/verity of seed, type of packaging material used. For cereals in ordinary storage conditions for twelve to eighteen months, seed drying up to ten per cent moisture content appears quite satisfactory. However, for storage in sealed containers, drying up to 5 to 8 per cent moisture content, depending upon the particular kind, may be necessary.

4. Relative Humidity and Temperature During Storage:

Relative humidity and temperature by far are the most important factors determining the storage life of seeds. Seed attain a rather specific and characteristics moisture content when subjected to given levels of atmospheric humidities. This characteristics moisture content is referred to as equilibrium moisture content, for a particular kind of speed at a given relative humidity, tends to increase as temperature decreases and as deterioration progresses. Thus the maintenance of speed moisture content during storage is a function of relative humidity and to a lesser extent of temperature, at equilibrium moisture content, there is no net gain or loss in seed moisture content. Seed placed in an environment with a relative humidity higher or lower than that with which its moisture content is in equilibrium , will gain or lose moisture until an equilibrium is established with the new environment . In sealed storage, seed moisture content determines the relative humidity of the environment in the containers. Establishment of moisture equilibrium in seeds is a time dependent process. It does not occur instantaneously. A period of time is required, the length of which varies with the seed kind, initial moisture content, the average relative humidity and the temperature. Under open storage conditions, seed moisture content, fluctuates with changes in relative humidity. However, normal diurnal fluctuation in relative humidity have little effect on moisture content. Table gives the equilibrium moisture content for important field and vegetable crops.

Absorbed Moisture Content of Cereals Seeds in Equilibrium with air (Harrington, 1959):

Sr.No	Crop	15%	45%	75%	100%
1	Shelled Maize	6.4	10.5	14.8	23.8
2	Rice, Milled	6.8	10.7	14.4	23.6
3	Sorghum	6.4	10.5	15.2	21.9
4	Wheat				
5	Hard Red Winter	6.4	10.5	14.6	25

Approximate Moisture Content of Vegetable Seeds in Equilibrium with Air

Sr.No	Crop	20%	30%	45%	75%
1	Garden Beet	4	5.8	7.6	11.2
2	Cabbage	4.6	5.4	6.4	9.6
3	Okra	7.2	8.3	10	13.1
4	Onion	6.8	8	9.5	13.4
5	Peas	7.3	7.3	10.1	15

Temperature also plays an important role in life of seed, although if does not appear to be a controlling one. Within the normal range of biological activity of seeds, insect and moulds increases as temperature increases. The higher the moisture content of the seeds, the more they are adversely affected by temperature. Decreasing temperature and seed moisture, therefore, is an effective means of maintaining seed quality in storage. Low temperatures are very effective in maintaining seed quality, even through relative humidity might be quite high. Good cold storage for seed should not exceed sixty percent in relative humidity.

5. Provenance:

It has already been stated that a number of factors, operating before and during harvest can affect seed viability. It is suprising then that samples of seed obtained from different sources may show differences in viability behaviour. It is not always easy to know and satisfactorily assess what the causes of these differences are, or even sometimes to know how important they are, because of wide variability between samples from different sources. Nevertheless, the seed begins its existence before it is harvest. And it is only to be expected that seeds harvested in different pre-harvest condition which will have caused different amounts of deterioration by the time seeds are harvested.

6. Effects of Fluctuating Environment Conditions on Viability:

There have been a few reports to the effect that fluctuating conditions are harmful, however, at present there is not a priori reason to suppose that change in temperature, or moisture content , would in itself be deterious save, possibly , for very rapid changes in seed moisture content. More critical investigations are needed on the effect of fluctuating environmental conditions.

7. Special Effect of Extreme Storage Conditions on Viability:

Researches indicate that three sets of extreme storage conditions of temperature and moisture contents, say about 30 percent, in cereals provided the temperature is suitable, germination will result in loss of viability when seeds are very moist, thirdly , if seeds are subjected to extreme desiccation , the period of viability may be less than expected.

8. Oxygen Pressure:

Recent researches on the role of a gaseous environment on seed viability indicate that increases in pressure of oxygen tend to decreases the period of viability. The little work carried out on the use of antioxidants shows that heat injury to kidney bean embryos was decreased in reduced oxygen pressures, and that the application of cysteine overcame the injury to some extent. Onion and okra seeds treated with either starch phosphate or alphatocopherol suggest that starch phosphate is very effective in prolonging the viability of both spp, and alphatocopherol had some beneficial effect on onion seeds.

Effect of Storage Condition on the Activity of Organisms Associated with Seeds in Storage:

There are six main types of organism associated with seeds in storage, namely, *Bacteria- Fungi-Mites- Insects- Rodents- and Birds*.

The activity of all these organism can lead to damage resulting in loss of vigour or viability or, particularly in the case of rodents, to complete loss of seed.

Bacteria and fungi. :The important consideration in the control of seed micro flora, is the relative humidity of the inter-seed atmosphere. Researches indicate that all storage fungi are completely inactive below 62 percent relative humidity and that there is very little activity below about 75 percent relative humidity upwards, the amount of fungi in a seed often shows an exponential relationship with relative humidity. The storage bacteria require at least 90 percent relative humidity for growth and they , therefore , only become significant under conditions in which fungi are already very active.With regard to effect of temperature on the growth of the micro-flora, certain organisms can grow at temperatures as high as 80 0 C. Consequently , since high temperatures rapidly decreases seed viability , the only practical method of controlling micro-flora activity by temperature alone is by deep freezing. At this time there are no satisfactory chemical methods of control of these organisms in storage.

Insect and Mites: There is no insect activity at seed moisture contents below 8 percent , but if grain is infected, increased activity may generally be expected upto about 15 % moisture content. The optimum temperatures for insect activity of more important storage insects ranges from 28 to 38 0 C. The temperatures below 17 to 22 0 C are considered unsafe for insect activity.

Although it is normally preferable to control insect and mite activity by the manipulation of the seed environment, it is possible to effect some control of these organism chemically, i.e through the use of fumigants and contact insecticides. One of the problems of chemical control is that the chemicals can have an adverse effect on seed viability, or vigour , and some of them are dangerous to handle. Nevertheless, fumigants which have been used successfully include methyl bromide, hydrogen cyanide, phosphine, ethylene dichloride and carbon tetrachloride in 1 3:1 mixture, carbon disulphide and naphthalene. Contact insecticides – used in seed storage include DDT, lindane and Malathion.

Rodents and Birds. Birds can be a constant source of seed loss, if even small openings exist at the lanes, or between the roof tiles. All openings should be sealed, or screened, if needed for ventilation. Rats and other rodents are more serious problems. Rodents may result into a complete loss of seed. Rodent , control measures include building the store so that the floor is 90 cm above ground level at the entrances ; having a 15 cm lip around the building at the 90 cm level of the floor; and providing a removable deck at the entrance for use only when seed is being loaded or unloaded.

9. Other Factors:

Factors besides those discussed above that affect storage life are the direct sunlight on the seed, number of times and kind of fumigation, effect of seed treatment, etc.

10. Storage in Transit, at the retailer's store and user's farm. It does little good to construct excellent warehouses if the seeds lose their viability subsequently by improper storage in transit, or at the retail store, or at the user's farm. Adequate storage precautions at all these points, therefore, are also necessary.

Factors Affecting Seed Aging

The following simple rules put forth by Harrington are a useful guide as well as measures of the effect of moisture content, temperature and relative humidity on seed ageing.

1. A one percent decreases in moisture content nearly doubles storage potential of seed.
2. A 10 0 F decreases in temperature nearly doubles storage potential of seed.
3. Good seed storage is achieved when the percentage of relative humidity in storage environment and the storage temperature in degrees Fahrenheit add up to one hundred.

These simple rules are reasonably accurate, particularly in the middle ranges of seed moisture content and temperature. For effective sealed storage two to three percent lower moisture content, as compared to open storage, is required.

General Principles of Seed Storage

In view of the various factors affecting seed viability in storage, the following principles emerge as necessary for good storage.

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

Long term storage requires more exacting conditions of seed storage than short-term storage. Similarly, the regions with favourable storage climate, i.e one where relative humidity is rather low require less sophistication than areas of high relative humidity.

It is considerable importance to decide well in advanced how long it will be necessary to maintain the germination capacity of seed lot. Two types of problems that must be dealt with in seed storage are:

1. Pest Control
2. Environment

As the requirements become more exacting, the cost of storage facility per unit of seed stored increases rapidly.

Types of storage requirements. The types of storage needed can be related to the time of storage expected and can be classified into four types:

a) Storage of commercial seeds
b) Storage of carry-over seeds
c) Storage of foundation seed stocks
d) Storage for germ plasm seeds

a) Commercial Seeds:

The largest storage need 75 to 80 % is for the storage of seed from harvest until planting time, the next year. The storage period ranges from a few days to eight or nine months. For most species, the requirements for seed storage are relatively simple. In the regions of no rainfall and low relative humidity, a smooth bare place may be reasonably satisfactory. However, loss from stealing, birds, and rodent s can be considerable and germination capacity can decline, at least in the surface seed, from heat damage and ultraviolet rays. Since it is not possible to have such a favourable climate every where, some shelter may be necessary. Such storage facilities can vary greatly. Successful storage structures and methods of storage for meeting the required needs should have following features.

i) Seeds placed in storage must be cleaned to free them of trash which may harbour insects or fungi and prevent free circulation of air.
ii) Seeds should be undamaged to minimise decline in vigour and germination.
iii) Seeds must be dried to a moisture content less than 14 percent for starchy seeds, and less than 11percent for oily seeds.
iv) Storage structure should be constructed so that the rain cannot enter, and that no serious gain in moisture will occur pests of stored seed should be effectively controlled if the following features for constructing warehouses are observed, and the other suggested measures are followed.

Construction Features for Good Seed Warehouse:

a) Warehouse should have no windows and have only one door constructed of metal which can be sealed properly and locked.
b) The material used for construction may be stone, concrete, brick, metal or wood.

Regardless of the material, the foundation should be made of stone or concrete and should extend 90 cm above the ground level.
c) A lip around the building at the 90 cm height extending out 15 cm should also be constructed. Such construction makes entrance by rodents virtually impossible, as long as the foundation remains uncracked.
d) The floor must be paved and any cracks that may develop must be repaired.
e) Construction of the floor, walls and ceiling of the storage should be such that no cracks exist which can harbour insects. All cracks around openings, E.g Electric conduits, ventilation openings, and doors should be thoroughly sealed.
f) Ventilation openings should be screened against birds and insects.

Other Measures for Pest and Disease Control:

Sanitation:
Good sanitation in the seed store is necessary for protection from insects and rodents. The tom seed bags should either be immediately repaired or replaced with new bags to avoid spillage in warehouse. All spilled seeds or floor sweepings should be immediately removed. Discarded seed and cleanings should be carried away, not just dumped outside the door and left to harbour storage insects. In addition to cleanings, the floor and walls should be sprayed with a residual insecticide as often as required. In a well – maintained store, spraying once a year may be quite satisfactory. The recommended materials and rates are DDT –(50 percent WP) ½ to 1 lb/gal 1000 ft2 (1 to 2 g/m2) , Malathion (25 percent WP) 1lb/gal 1000 ft2 (1.25 g/m2). Malathion should not be used on such surface as brick, cement and concrete.

Seed Treatement:
An insecticide combined with a fungicide may be applied as a protectant. The most commonly used insecticide is DDT. DDT also has the advantage of long duration.

Fumigation:
Once the seed storage is completely free of insects, the most serious source of reinfestation is infested seed which is brought in seed may be brought from the field already infested, or it may be transferred from an infested storage. Such infestation is controlled by fumigation. Rather than fumigating the whole storage, it is better to have a fumigation room, or to fumigate the seed on a concrete floor under a tarpaulin before it enters the main storage room. The fumigation room should have its own door to the outside, and only after fumigation, should the seed be brought in to storage area.

Fumigation:
Fumigation is effective only in gas-tight storage. Numerous effective fumigants are available. However, there is a small safety margin between the dose that is toxic to insects and a dose that will cause loss of germination or vigour of seed. Reasonably safe fumigants at temperatures below 30 0 C and seed moisture below 12 % are the following (Parking , 1963).

Dosage	Exposure Period
Methyl Bromide 16 to 32 oz per 1000 ft3 (16 to 32 mg per cubic metre)	24 hours
Hydrogen cyanide 32 to 64 oz percent 1000 ft3 (32 to 64 mg per cubic metre)	24 hours
Hydrogen Phosphide 5 to 10 tablets per metric ton of seed (Phostoxin, Phosphine)	3 to 7 Days

It must be borne in mind that fumigation, particularly repeated fumigation, amy seriously reduce the vigour and even the germination capacity of seeds. This is particularly true of seeds with high moisture content. Seeds with moisture contents greater than 14 percent should be dried to below this value before fumigation. A high temperature also increases damage to seeds by fumigants. Hence, fumigation should be used only with entering seeds, and all other measures should be used to maintain insect control in the stored seed. Prophylactic biweekly or monthly fumigation of seed storages can lead to serious germination problems. It is far better to build an insect- proof storage, and make certain that seeds, bags or anything else placed in the storage are insect –free. Ofcourse, if a storage containing much seeds does become infested, then fumigation is required.

Seed Moisture Content:
To prevent damage from storage fungi, it is best to store seeds which have been well-dried to safe moisture content limits.

Temperature Control in Seed Storage

As mentioned earlier, temperature is one of the most important environmental factors, which influence seed viability and vigour during storage, the lower the temperature, the longer the seeds maintain germination capacity, thus temperature control is an important consideration in building a seed storage.

Temperature control may be achieved in one of the following ways:

1. Ventilation
2. Insulation
3. Refrigeration

These methods are not mutually exclusive, and normally used to supplement each other.

Ventilation:

Ventilation could be used to reduce seed temperature and seed moisture content, if used judiciously. In addition, it also helps prevent hot spots from developing, the formation of convection air currents; and maintenance of uniform seed moisture content and temperature.

Time of Ventilation:

Whenever the outside temperature of air and relative humidity are low enough to benefit the seeds, either by reducing seed temperature or seed moisture content, the ventilating fans (exhaust fans) can be turned on. First determine the temperature and relative humidity of air inside and outside the storage. The temperature is measured with thermometers and the relative humidity with a psychrometer. After determining these values it could readily be determined from table when it is safe to ventilate a storage in order to cool it without increasing seed moisture.

Precautions to be Taken Ventilation:

1. The moisture content of the seed should not be allowed to increase to a value in equilibrium with air relative humidity above 65 percent and
2. The seed temperature should not increase above 33 0 C for more than few hours.

Insulation :

Insulation of seed storage is done to reduce the flow of heat from the warmer exterior , through the walls , roof, floor of the storage to the cooler air and seeds in storage. Heat flow depends upon:

1. Temperature difference between the two places in the material. Heat flow is twice as fast with a 20 0 temperature differences as with a 10 0 Difference.
2. Distance the heat must flow. Heat flows twice as fast through one inch of insulation as through two inches of the same material.It would appear that air is the best insulator. However, it has serious defect in that if the air space is more than a fraction of an inch, a convection current occurs moving the heat from one surface to another. Therefore, the air, to be of these. Moreover, they absorb moisture readily and may mold and rot. Neither are they fire-proof, nor do they have any mechanical strength. Thus, although they are cheap, they have some severe restrictions. Foam polystyrene has the advantages of being light in weight. Because the air bubbles are enclosed , no convection currents are possible. It has considerable resistance to moisture penetration. It is easy to install, has mechanical strength and dimensional stability. It can become water-logged, losing its insulation value if the storage develops leaks. Certain fumigants may affect it. It does

deteriorate slowly with age. Glass wool is rat – proof , but insects can harbour in it. It is odourless. It has a low water absorptivity. It is fire-proof. It is unaffected by fumigants. However, it allows a free flow of moisture , so an additional moisture barrier is imperative. People can be allergic to it. Convection currents are possible particularly in the lighter grades. It has less dimensional stability and mechanical strength than rigid insulation material, but is more easily worked around the curves and corners.

Refrigeration:

The basic objective of refrigeration is to keep the storage temperature below the usual ambient temperatures. An alternative to refrigeration is storing the seeds dry, either by using dehumidification or by drying and storing in sealed containers. Refrigeration often becomes necessary for carry-over seeds, special kind of seeds, foundation seed and nucleus seed/ breeder seed.

The amount of refrigeration needed depends upon the removal of heat generated from various sources. There are four important sources of heat:

1. Heat leakage *:*

This is the flow of heat through the floor, walls, and roofs into the storage when the outside temperature is higher than the temperature in the storage. This is directly proportional to the temperature difference and the distance heat must travel.

Insulation as discussed above reduces heat leakage but does not eliminate it. The better and thicker the insulation, the less refrigeration is required because leakage of heat is reduced.

2. Field Heat:

Field heat refers to the heat of seeds, packaging material, pallets, bales of bag and anything else brought into and put in the storage in excess of the heat at the storage temperature. Refrigeration capacity must be sufficient to remove field heat in a reasonably short time.

3. Heat of Respiration**:**

Heat of respiration in seed storage is not a serious heat input because dry seeds have an extremely low respiration rate. Below 11 % seed moisture, seed respiration is so low as to be almost immeasurable. Respiration , however ,is higher temperatures and decreases with decreasing temperatures in the seeds of the same moisture content. At higher seed moisture contents, the respiration jumps astronomically.

4. Incidental Heat**:**

The incidental heat includes heat from electric lights, and external heat that enters a storage when the door is opened. Care should be taken not to leave the door open.

The amount of refrigeration needed is usually arrived at by calculating heat packaging, field of respiration and then arbitrarily adding ten percent more as incidental heat.

Refrigeration seed storage should be done by a competent company. However, seed technogists have to specify the temperatures and relative humidity requirements of the seeds. Their guidance on specific technical requirements is also necessary.
Although theoretically it is possible to obtain lower relative humidity by refrigeration, the practical minimums depending on temperature are as follows:

Temperature	Minimum Relative Humidity
90 0F (32 0C)	30
81 0F (27 0 C)	35
74 0 F (23 0 C)	40
70 0 F (21 0 C)	45
67 0 F (19 0C)	50
62 0 F (16 0 C)	60
57 0 F (14 0 C)	70

Below about 15 0 C , the relative humidity possible with refrigeration alone is too high for proper seed storage. Hence refrigeration alone is not considered sufficient for storage of seed.

Seed Marketing

Seed marketing is one of the most vital components of seed technology. On it depends the size and scope of the seed industry. Broadly, it includes such activities as production, processing, storage, quality control and marketing of seeds. In the narrow sense, however, seed marketing refers to the actual actual acquisition and selling of packed seeds, intermediate storage, delivery and sales promotional activities. In the present context, our discussion is limited to seed marketing in the narrow sense.

Seed Marketing Comprises the Following:
1. Demand forecasts (assessment of effective demand),
2. Marketing structure,
3. Arrangements for storage of seeds,
4. Sales promotional activities.
5. Post- sales service; and
6. Economics of seed production and seed pricing.

Demand Forecasts:
The assessment of effective seed requirement is critical to any planned seed programme. The underlying principle in marketing demand forecasts should be that the seed supply keeps pace with seed demand (both present and future) in terms of quantity, quality ,

price, place, and time. The outcome of such an approach would be planned seed production and marketing. It would also avoid shortage and gluts and as well ensure stable prices and profits.

In making demand forecasts, the following must be considered carefully:

a) Total cultivated acreage, seed rate, quality replacement period and assessment of total potential seed requirement of each of the important crops.

b) Impact of extension efforts on the introduction of improved production techniques, and future plans for promotion.

c) Current acreage under high yielding varieties and amount of seed sold in the last year.

d) Cultivator preferences for varieties, package size, kind of packing, quality and price.

e) Number and size of competitors.

f) Kinds of publicity and sales promotion those are most effective.

g) Climate of the area where seed is being marketed.

Assessment of potential effective seed demand of the market, based on total seed requirements is of very little values, since the demand for high quality seed normally exists for the crop area which is under good fertility and irrigated conditions. The requirements for the remaining crop area are covered by uncontrolled production material obtained from the preveious crop production. Furthermore, experience shows that the varietal purity and the yield potential of high quality seed of the self pollinating varieties can be maintained by farmers during the reproduction process, without significant deterioration for three to four generations. Therefore, individual farmers only need to replace seed of self –pollinating varieties every third or fourth year. Thus, the demand for high quality seed of self –pollinated crops is normally not higher than 25 to 30 percent of the total requirement for areas under irrigated and high fertility conditions. However, there could be some exceptions, E. g , if the climate of the region is not suitable for retaining viability of seed from the preveious crop production. The farmers of such areas, if properly trained, can buy high quality seed each year, even of self-pollinated crops.

A rather different approach must be taken in the marketing of hybrid seeds, in which case new seed is needed by the farmer each season. Although, the critical period may be rather difficult, the subsequent planning is easier, particularly after sale statistics are seen to point in a certain direction. The dealers need to make periodic surveys of the market areas, to determine market potential at least one season in advance. Dealer advance orders should be treated as informational material to aid the production section in organising an effective production programme. The dealer should, however , hot to be held to the exact amounts of such advanced orders. The uses of demand forecasts are many and varied. A reliable forecast is the sheet anchor of all planning in business. Long term demand indications, in terms of quality, prices and locations, help to make an investment decision, that is how much to invest , where to locate the production facility, and how to organise marketing. Intermediate-range demand forecast help to make decisions on action necessary to optimise profits by balancing production and sales. Uses of short-term demand forecast include production planning and scheduling, distribution planning and scheduling , determination of targets and quotas for dealers and salesmen, planned buying of inputs, preparation of cash flow budgets, preparation of overall budgets and profits and loss statements , modifications of prices, policies, etc.

Marketing Structure: (Establishment of Effective Channel for Seed Distribution) :
The key to success in seed marketing is the establishment of effective channel of distribution. The various channels through which seed can be marketed vary greatly according to the needs of the seed company.

Present Status of Seed Distribution:
The types of seed distribution systems in India are:
a) Farmer to farmer distribution. This is the traditional method, whereby farmers obtain their requirements from neighbours either on cash payment or on exchange basis. No formal marketing organisation is required for this type of distribution.
b) Distribution by co-operatives. This involves procurement of seeds by cooperatives and its subsequent distribution. The distribution of seeds through cooperatives has often been encouraged by the government through subsidies and guarantees.
c) Distribution by departments of Agriculture. Seeds are purchased by the governments, out of the government funds, and are distributed district Agricultural Officers and Block Development officers.
d) Distribution of seeds by non-government or quasi-government agencies. In this system, the seeds are distributed through a network of seed distributors and seed dealers. Both the seed Review Team (1968) and the National Commission on Agriculture (1976) have recommended that the State government should withdraw from the seed procurement and distribution fields in a phased manner, so as to be able to concentrate on their principal function of providing extension education in the use of high quality seeds for improving productivity. Thus, emphasis is on the establishment of a seed marketing network to replace the role of state government, and to establish a system that will be adequate for the anticipated increase in seed demand. In this connection, it is considered necessary that a network of seed dealers should be established.

Marketing Organisation:
There are a number of possible ways a marketing network could be organised.
The simple and most efficient systems are to establish a central marketing cell and regional offices in end-use areas. The retail sale could be organised either by appointing distributors/ dealers such as private dealers, cooperatives, agro-sales service centres, etc,

or by opening seed company/ corporation –owned sales points, or both as illustrated in above:

Central Marketing Cell:
1) Regional Offices
a) Sole distributors
b) Dealers (Private)
c) Dealers (Coops)
d) Dealers (Agro-Sales Services)
e) Company sale depots
a) Sole Distributors:
i) Dealers (Private)
ii) Dealers (Coops)
iii) Dealers (Agro-Sales Service)
Under such a scheme, the central marketing cell is responsible for planning, appointment of dealers/ distributors, seed movement, marketing intelligence research , pricing , promotional activities, financing and record keeping.

Factors Affecting Seed Marketing

Seed Marketing is greatly affected by the following factors:

1. Clear –cut Policy:
A clear- cut policy for developing the seed industry, defining the tasks and responsibilities of the official, semi-official, and private economic sectors is necessary for the development of seed marketing on sound footings.

2. Availability of well – identified and Adapted Varieties.
Needless to say, a seed programme would not have any impact unless superior varieties are regularly funnelled into the seed programmes. Without these, the seed marketing programme cannot expand. Current official information on new varieties that have been recommended, and released, for crop production helps in accelerating the programme.

3. Adequate production, storage and testing facilities. These are necessary for producing and maintaining seed quantities and qualities in accordance with established standards vital for the development of sound marketing.

4. Official Programme:
When new varieties/ hybrids are first being introduced, particularly among small-scale farmers, the government generally has to take the initiative and promote the supply

arrangement. Another important role of government is to provide market information. Another important role of government is to provide market information, to set targets and to regulate and control agencies and enterprises.

5. Demand Forecast:

Realistic assessment and targets of seed demand are very necessary .Excessive quantities result in large carry-over stocks and subsequent losses, due to loss in germination and vigour of seeds, if carried over for too long. On the other hand, short supplies would deprive the seed company.

THE END