Theory Notes on

“Principles of Seed Technology”

Course No. GPG 4.4 Credit- 3 (2+1)

Compiled & Edited By

Prof. N. N. Patel
Assistant Professor (GPB)
College of Agriculture, Bharuch
Navsari Agricultural University, Gujar (India).
PBG 4.4 “Principles of Seed Technology” (2+1=3)

❖ Theory Syllabus:-

- Seed and seed technology: introduction, definition and importance;
- Deterioration causes of crop Varieties and their control;
- Maintenance of genetic purity during seed production,
- Seed quality; Definition, characters of good quality seed and different classes of seed; Foundation and certified seed production of important cereals, pulses, oilseed, fodder and vegetables;
- Seed certification, phases of certification, procedure for seed certification, field inspection;
- Seed Act and Seed Act enforcement,
- Duty and powers of seed inspector, offences and penalties,
- Seeds control order 1983;
- Varietal identification through grow out test and electrophoresis, molecular and biochemical test;
- Detection of genetically modified crops, transgene contamination in non-GM crops,
- GM crops and organic seed production;
- Seed drying, processing and their steps;
- Seed testing for quality assessment, its importance, method of application and seed packing;
- Seed storage- general principles, stages and factors affecting seed longevity during storage, measures for pest and disease control during storage;
- Seed marketing-structure and organization, sales generation activities, promotional media.
- Factors affecting seed marketing,
- Role of WTO and OECD in seed marketing

Reference books
- Bhale, M. S., Khare, D. Seed Technology 2ND REVISED & ENLARGED EDITION (2018)
PRINCIPLES OF SEED TECHNOLOGY

INTRODUCTION:

The history of agricultural progress from the early days of man has been the history of seeds new crops and crop varieties. In the early days progress, achieved through the cultivation of indigenous useful plants and introduction of new crop species. The second stage of progress was due to selection of superior types from the cultivated plants, many useful selections were made, and there was gradual but steady progress. Later on, using well-known techniques of selection and hybridization many new and better varieties were made available. However, the pace of progress remained slow. In the mid sixties, a revolution took place in Indian agriculture, with development of dwarf varieties, better responsive to high fertilizer doses in self pollinated crops rice and wheat and exploitation of heterosis in cross pollinated crops and development of hybrids of maize sorghum, Bajra, which made significant, advances in yield.

However, to the farmer, all this scientific research would be of little value unless he gets genetically pure seeds with desirable qualities high germination percentage, high purity, more vigour and better seed health. This laid down the need of seed technology. Good agriculture depends upon good seeds. The pace of progress in food production there fore depend upon the speed with which we are able to multiply and market good quality seeds of high yielding varieties.

Seed is a crucial and basic input to increase crop yield per unit area and to improve the agricultural economy of the country.

What is seed?

• Any part of plant used for propagation is called a seed.
• It may be a true seed or any vegetatively propagating material such as seedlings, cuttings, bulbs, tubers rhizomes, root etc.
• Seed have a life.
• True seed is an embryo, a living organism embedded in the supporting and food storage tissue.
• A true seed is defined as “a fertilized mature ovule consisting of embryo, storage material and protective coats.”
• It can be clearly seen from the above that seed pertaining to material meant for sowing/planting purpose; the essential function being the reproduction.
• The business of Seed Technology is to protect this biological entity and look after its ‘welfare’,
• While the focus of Food Technology is on the second component – the supporting tissue.

What is a grain?

A grain is used for consumption as a food by human beings and feed by animals. If it have a life it can also be used for sowing. Grain may or may not have life.
The major differences between scientifically produced seed and the grain (when use as seed) are as under.

<table>
<thead>
<tr>
<th>Scientifically produced seed</th>
<th>Grain (used as seed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) It is the result of well planned seed programme.</td>
<td>(1) It is the part of commercial produce, saved for sowing or planting purposes.</td>
</tr>
<tr>
<td>(2) It is the result of sound scientific knowledge organized efforts, investment on processing, storage and marketing facilities</td>
<td>(2) No such knowledge or efforts are required.</td>
</tr>
<tr>
<td>(3) The pedigree of seed is ensured. It can be related to the initial breeders seed.</td>
<td>(3) Its varietal purity is not known.</td>
</tr>
<tr>
<td>(4) During production, efforts are made to rogue out off types diseased plants, objectionable weeds and other crops plants at appropriate stages of crop growth which ensures satisfactory seed purity and health.</td>
<td>(4) No such effort is made so the purity and health status may be poor.</td>
</tr>
<tr>
<td>(5) The seed is scientifically processed treated and packed and labeled with proper lot-identity.</td>
<td>(5) It is manually cleaned. Not properly treated, labeled and packed.</td>
</tr>
<tr>
<td>(6) The seed is tested for planting quality namely germination, purity, mixtures of weed seeds and other crop seeds, seed health and seed moisture content.</td>
<td>(6) Routine seed testing is not done.</td>
</tr>
<tr>
<td>(7) The seed quality is supervised by seed Certification agency.</td>
<td>(7) There is no quality control.</td>
</tr>
<tr>
<td>(8) The seed must meet the quality standards prescribed. The quality is well known.</td>
<td>(8) No such standard is applied here hence the quality is unknown.</td>
</tr>
<tr>
<td>(9) The labels/tags on the seed containers serves as quality marks.</td>
<td>(9) There is no such label or tag which ensure quality of seed.</td>
</tr>
</tbody>
</table>

What is Seed Technology?

Seed technology can be defined as techniques comprises of seed production, seed processing, seed storage, seed testing, seed certification, seed marketing, distribution and the related research of these aspects.

Feistritzer (1975), defined seed technology as “The method through which the genetic and physical characteristics of seeds could be improved.

According to Cowan (1973), Seed Technology is “a discipline of study having to do with seed production, maintenance, quality and preservation.”

Thus, Seed Technology is essentially an interdisciplinary science, which surrounded by a broad range of subjects.

In broadest sense, “Seed Technology includes
- The development of superior crop plant varieties, their evaluation and release,
- Seed production, processing,
- Seed storage, seed testing, seed certification,
- Seed quality control, seed marketing and
- Seed distribution, and
The relationship of seed technology to other sciences

1) Genetics and Plant Breeding: The Plant Breeders and Geneticists develop new crop varieties which are high yielding and superior in resistance to diseases and pests as compared to existing ones. They are also associated with the maintenance of nucleus and breeder seeds and grow out tests etc.

2) Agronomy: The agronomist provide suitable package of practices for growing, harvesting and handling of seed crops in order to obtain maximum seed yields and best possible seed quality.

3) Horticulture: The horticulturist provide the suitable package of practices for growing, harvesting and handling vegetable, flower and other horticultural crops to ensure maximum seed yields and best possible seed quality.

4) Plant Pathology: The role of plant pathologist in seed production is to produce and distribute disease free seed and hence they provide package in regard to seed treatment and plant protection measures, to be adopted in order to produce disease free seeds. They are also involved in the development of the Seed Health Testing Techniques for detection of seed borne disease and plant quarantine.

5) Entomology: The entomologist provide the package with regard to pest control during seed production and seed storage to ensure good seed quality and minimum losses due to storage. They are also involved in the development of seed health testing techniques for the detection and determination of insect, pests infestation and plant quarantine.

6) Taxonomy: The taxonomist provide information necessary for identification of various crops and weed seeds and cataloguing of Germplasm, varieties etc.

7) Plant Physiology: The physiologist help in understating various planting seed quality problems, seed development and maturation, and seed storage problem and their possible solutions. They are associated with the development of techniques for seed germination, seed vigour, seed viability testing.

8) Agricultural Economics: They provide necessary guidance in relation to seed marketing problems and helps in devising suitable marketing and distribution system. They are also concerned with the management aspects and in the determination of cost/benefit ratio, seed price fixation etc.

9) Agricultural engineering: The agriculture engineers are associated with the development of suitable seed planting, harvesting machinery for seed crops and also the seed drying, seed processing machinery, seed handling and seed testing equipments.

10) Agricultural extension: The extension agencies are involved in popularizing the use of high quality seeds of high yielding varieties amongst the farming community and also gave feedback to the researcher for the problems of farmers.

Role of seed technology/ Importance of Seed production

Feistrizer (1975) outlined the following roles of Seed Technology

1. Improved seed – a carrier of new technology
2. Improved seed – a basic tool for secured food supply
3. Improved seed – the principal means to secure crop yield in less favourable production areas.
4. Improved seed – a medium for rapid rehabilitation of agriculture in cases of natural sudden great failure.

**Improved seed – a carrier of new technology:**

- The introduction of quality seeds of new varieties wisely combined with other inputs significantly increases yield levels e.g.
- In India, for instance the cultivation of high yielding varieties have helped to increase food production from 52 million tones to nearly 180 million tones in last four decades. Thus the introduction of new high yielding varieties boosted the food production.
- Yields increased to the extent of 112% in Cereals, 124% in Potatoes and 142% in Sugarbeet in Central Europe through the use of improved seeds and agricultural inputs.
- In the USA, the results achieved were still better.

**Improved seed – a basic tool for secured food supply:**

The successful implementation of the high yielding varieties programme in India has lead to a remarkable increase in production and to a new assessment of future development potential. As a result, food import from other countries have substantially brought down in spite of the rapid population increase.

**Improved seed – the principal means to secure crop yields in less favourable area of production:**

The supply of good quality seeds of improved varieties suitable to these areas is one of the few important continuations that Seed Technology can make to secure higher crop yields.

**Improved seed – a medium for rapid rehabilitation of agriculture in cases of natural disaster:**

Widespread floods and droughts in various parts of the country and elsewhere have focused attention to these recurrent crises. The relief operations by FAO show that it would be much more economical of the Government have National Seed Research Stocks at their disposal. The establishment of National Seed Reserve Stocks should receive high priority for meeting natural calamities.

**National Seed Stocks would have a two-fold role to play:**

1. They would provide improved seeds in emergency periods to production area for rapid production of food grains.
2. They would supply seeds to disaster regions for re-sowing; as no seed would normally be available in such regions.

**Goals of seed technology**

The major goal of seed technology is to increase agriculture production through the spread of good quality seeds of high yielding varieties. The goals of seed technology could be fulfilled in the manner as under.

(1) Rapid multiplication of seeds of improved high yielding varieties. The seed should be made available to the farmers in the quickest possible time.
(2) Timely supply of improved seeds of new varieties to the farmers well in time so that they may get timely planting and harvest the benefit of quality seeds.
(3) Assured high quality seeds: In order to obtain the expected dividends from the use of seeds of improved variety the seeds must ensure high quality.
(4) Reasonable price: The cost of high quality seed should be within the reach of the average farmers i.e. price should be so reasonable that average farmer can easily buy it.

**Characteristics of good seeds**

The features or characteristics that determine the quality of seed are as under:

1. High genetic purity
2. High germination percentage
3. Higher vigour that give effective plant stand in the field
4. High physical purity i.e. it should be free from other crop seeds and weed seeds.
5. Sound seed health: free from insect, pests and organism that causes disease, free from seed borne disease
6. Wider adaptability: It can be grown and perform better under wide environmental and soil conditions.
7. Always possess high yielding ability.
8. Quality for special characters: should maintain its superiority for the characters/traits for which bred.
9. Response to fertilizers and other inputs: should give higher response to high fertilizer dose and able to give higher yield.
10. Possess uniform seed size, weight, seed colour and specific gravity.

**Seed certification**

Seed certification is legally sanctioned system for quality control of seed multiplication and production. Its consists of following control measures

1. An administrative check on the origin of propagating material for the purpose of determining varietal purity (Genetic purity)
2. Field inspection of varietal purity, isolation to prevent cross pollination, mechanical mixtures, crop conditions as regards to disease, pest disease and weed control.
3. Supervision of agricultural and commercial operations like harvesting, threshing, storage, transport and processing to preserve the identity of seed lots.
4. Sample inspection: Drawing samples from the lot for laboratory testing like germination, moisture content, weed seed content, mixtures and purity.
5. Bulk inspection in order to check homogeneity of the lot as compared to sample drawn.
6. Control plot testing: Comparative field testing of samples drawn from the source seed or final seed production and standard sample to determine the varietal purity and seed health of the seeds produced.

**Objectives**

According to Douglas (1971) the three primary objective of seed certification are:

1. The systematic increase of superior varieties.
2. Identification of new varieties and their rapid increase under appropriate names.
3. Provision of continuous supply of comparable material by careful maintenance.

**Basic (Fundamental) concepts of seed certification**
The rapid loss of identity and genetic purity of varieties was a major problem in early years of 20th century. Hence, in 1919 the International Crop Improvement Association (ICIA) was formulated to solve the problem. In 1969 the ICIA changed its name to Association of Official Seed Certifying Agencies (AOSCA). This association laid the beginning of modern day seed certification system and explained the basic concepts of seed certification as under:

1. Pedigree of all certified crops must be based on lineage i.e. The Race.
2. The integrity (Honesty) of certified seed growers must be recognized
3. Field inspection must be made by qualified inspectors.
4. Field verification trials must be conducted to identify varieties/strains
5. Proper records must be kept to maintain pedigree of seed stocks.
6. Seed certification standards must be established for genetic purity and germination.
7. The principle of sealing of seeds must be approved to protect seed grower and the users.
8. Species of farm weeds must be identified and defined as a inert matter.

**Seed certification agency:**

Statutory regulations regarding establishment of seed certification agency have been discussed and broad principles have been framed as under.

1. A seed certification agency should not be involved in production and marketing of seeds.
2. The agency should have autonomy.
3. The seed certification standards for various crops and procedure to be adapted by seed certification agency should be uniform throughout the country.
4. The agency should be associated with technical institutes in order to have latest know how.
5. The agency should operate on basis of principle of no profit no loss.
6. The agency should have adequate trained staff updated by proper training.
7. The agency should have adequate facilities for timely and thorough inspection.
8. The agency should serve the interest of seed producer and seed users.

่าย Duties and responsibilities of seed certification officers:

1. He should arrange for suitable application, inspection and report forms.
2. He should identify the authentic source of seed for further multiplication.
3. He should ensure that certified seed should be produced form acceptable breeder or foundation seeds.
4. He should ensure through field inspections that minimum standards for isolation, planting ratio, roguing, etc are maintained as per the prescribed standards.
5. To assist the seed producer at the time of harvesting, threshing, drying and processing to prevent any type of mixture.
6. To issue appropriate seed certification tags for seed lots which fulfills all the criteria inspections.
7. To sample and inspect seed lots and submit such samples to the seed testing laboratory.
8. To carryout educational programme to promote the use of certified seeds.
9. To maintain adequate record so that the eligibility of specific lot can be determined.
10. To investigate violation of prescribed standards or complaints from users of certified seed and to take appropriate action.
Procedure for certification of seeds:

As per the provision of seeds act, 1966 and seed rules, 1968, the certification of seeds is done in the following manner:

1. **Application for seed certification**: All those interested in certified seed production are required to submit an application in prescribed performa to the concerned state seed certification agency along with an application fee Rs. 25/-. The seed certification agency upon receipt of the application will verify the following conditions:
   I. That the variety/varieties are notified and eligible for seed certification.
   II. That the source of seed is authentic and in accordance with the conditions laid down in the minimum seed certification standards.
   III. That there would be no difficulties in reaching the field for carrying out timely field inspections.
   IV. That the seed producer is able to provide requisite isolation and the seed field meets the land requirement as per minimum seed certification standards.
   V. That the seed processing facilities are available to the seed producer.
   VI. That the requisite application fee has been paid. If the applicant fulfills the above conditions than certification agency would undertake the certification.

2. **Seed certification fees**: The application on the basis of above verification is accepted by the agency then the applicant has to pay certification fees as under:

   Inspection fees includes field inspection, supervision during seed processing, seed treatment, packing, seed sampling, sealing and issue of certificate.
   a) Self pollinated crop Rs. 325/ ha.
   b) Hybrid, vegetable crops Rs. 175/ha.
   c) Seed testing : Rs. 600/sample
   d) Re processing : Rs.250/quintal
   e) Re testing : Rs. 600/sample
   f) Re validation fee : Rs.20/quintal

3. **Inspection of seed fields**: Staff of seed certification agency make field inspection at appropriate stages of growth to ensure that the minimum standards for isolation, preceding (previous) crop requirement, roguing are maintained at all the times and will maintain the records of inspections.

4. **Rejecting the field**: After completion of inspection season, the staff submits the report of field inspection and problems to the Director of Seed Certification Agency. The board of Directors review the cases and if found not in accordance with the minimum certification standards then officially reject the seed field.

5. **Inspection of seed processing**: The representative of seed certification agency makes the visit of processing unit as may be required to check the mechanical admixture, seed is cleaned and graded in satisfactory manner, seed is suitably dried, seed treatment is given and seed lot is made homogenous (uniform).

6. **Seed sampling**: The staff of the agency take samples of all the seed lots which are required to carry the tags. These seed samples are then sent to seed testing laboratory for evaluation of genetic purity, germination and moisture content. If seed lots fail to meet the requisite standard then re-sampling and re-testing is done.

7. **Tagging and sealing**: After receiving the satisfactory report from official seed testing laboratory, tagging and sealing of seed lots is done under the supervision of
the agency staff. Fixing of tags and seals on the seed container will complete the certification process.

8. Control plot testing: The seed certification agency arrange for a post season grow out test (GOT) and concern the plant breeder to check the genetic purity.

9. Extension of validity period: The extension of validity period of certified seeds shall be for a period of six months and at each subsequent validation as long as the seed confirms the prescribed standards.

10. Revocation of certification: If the certification agency is satisfied that the certificate granted by the agency has being obtained by mis-representation by the seed producer, the agency will give grower a chance to submit causes and if grower does not satisfy the situation then agency will revoke (withdraw) the certificate.

11. Appeal against certification agency: Any seed producer aggrieved by a decision of a certification agency may appeal against the certification agency to the appellate authority specified by the state government within 30 days from receiving the rejection letter from agency. The appellate authority will discuss the matter critically and pass the necessary order. The decision of the authority is final.

Seed legislation and seed law enforcement:

The basic purpose of seed legislation and its subsequent enforcement is to regulate the quality of seed sold to farmers. So long as agriculture remains traditional and static, there is little justification for regulating seed quality. However, with technological advancement and the systematic application of science to agriculture, it becomes imperative to regulate the quality of seeds through seed legislation and its subsequent enforcement to ensure that the seed buyers are not made to run undue risks.

Types of seed legislation:

Seed legislation can broadly be divided into two groups.

1. Sanctioning legislation:
   Such legislation authorizes, establishes or otherwise legally sanction the activities like formation / establishment of advisory bodies, seed certification agencies, seed testing laboratories, foundation and certified seed programmes, recognition of seed certification agencies of foreign countries, appellate authority, etc..

2. Control legislation:
   Such legislation regulates the quality of seed sold in the market and includes the establishment of suitable agencies for regulating the seed quality.

Seed legislation in India:

In India until mid-sixties (except in Jammu and Kashmir where an Act in respect of legislation of vegetable seeds was in force), there was no legislation governing the quality of seeds sold by farmers. The rapid development of agricultural production with the introduction of hybrid varieties of maize, jowar (sorghum) and pearl millet, dwarf varieties of wheat and paddy, however, necessitated the enactment of seed legislation on 29th December, 1966, the Seeds Act was passed. It came into force throughout the country on 2nd October, 1969.
The main features of the Seeds Act, 1966 are as under:

1. **Applicability**: It is applicable only to notified varieties of seed and vegetatively propagating materials used for sowing.

2. **Sanctioning legislation**: The Act provides for the formation of an apex advisory body viz., Central Seed Committee, Central Seed Certification Board, establishment of Seed Certification Agencies and State Seed Testing Laboratories etc.

3. **Regulatory legislation**: The Act provides for the provisions for notification of kinds/varieties to be brought under the purview of the Seed Act regulation regarding the sale of seed and the establishment of suitable seed enforcement machinery. Under the Act, the Central Govt. is empowered to make rules to carry out the purposes of the Act and to give necessary directions to State Govt. for execution of provisions of the Act or Rules in the state.

Statutory Bodies and Agencies established in India under the Seeds Act, 1966.

1. **Central Seed Committee**: The Central Seed Committee set up under the Act is the main source of advice to the Central Govt. on the administration of the Act and any other matter related to seeds. The committee consists of a chairman, two representatives of seed growers, eight representatives of other interests nominated by the Central Govt. and one representative of State Govt., Director (Seeds), GOI acts as secretary of the committee.

   The main function of the committee as envisaged in the Act and Rules are:

   a) To advise Central and State Govts. on all matters related to seeds.

   b) To advise Govt. regarding notification of such kinds/varieties for which it thinks it has become necessary or expedient to regulate the quality of seeds.

   c) To advise Govt. of the minimum limits for germination and purity for those kinds/varieties brought under the preview of the Seeds Act.

   d) To recommend the procedure and standards for certification, grow out tests and analysis of seeds.

   e) To recommend the suitability of any seed certification agency established in any foreign country to the Central Govt. for the purpose of this Act.

   f) To recommend the rate of fees to be charged for analysis of samples by the Central and State Seed Testing Laboratory and for certification by certification agencies.

   g) To advice the Central and State Govts. regarding suitability of seed testing laboratories.

   h) To send its recommendations and other proposals related to Act to the Central Govt.

   i) To carry out such other functions as are supplemental, incidental or consequential of any of functions conferred by the Act or Rules.

2. **Central Seed Certification Board (CCSB)**:

   The Govt. of India has also constituted the Central Seed Certification Board to deal with all problems related to Seed Certification and to co-ordinate the work of State Seed Certification Agencies. The membership consists of (i) Chairman, (ii) 3 members representing interests as the Govt. thinks fit, (iii) Directors of Research of Agril. Universities, (iv) Directors of Agriculture in State nominated by the Central Govt. besides a nominated secretary.
3. **State Seed Certification Agencies (SSCA) :**

The act provides for the establishment of state and certification agencies by notification in the official gazette of state government/central government in consultation with the state government. The governing body consists of person from state government, seed producing agency, farmers, subject specialist and seed law enforcement agencies. The governing body lays down the broad policy while the inspections, seed certification and seed analysis is the responsibility of the executive wing.

The specified functions for the seed certification agency under Seed Act are :

1) Certify seeds of any notified varieties.
2) Outline the procedure for submission of applications and for growing, harvesting, processing, storage and labeling of seeds intended for certification till the seed lots finally approved for certification meet prescribed standards for certification under the Act.
3) Maintain a list of recognized breeders of seeds.
4) Verify that the variety is eligible for certification, seed source used for planting was authentic, the record of purchase is in accordance with the rules and the fees have been paid.
5) Take sample and inspect seed lots, produced under the procedure laid down by the certification agency and such samples tested should confirm to the prescribed standards of certification.
6) Inspect seed processing plants to see that there should not be any admixture of other kinds or varieties.
7) Insure that field inspection, seed processing plant inspection, analysis of sample taken and issue of certificates including tags, marks, labels and seals is taken expeditiously.
8) Undertake educational programmes to promote the use of certified seed, publishing list of certified seed growers and source of certified seed.
9) Maintain records which may be necessary to verify that seed fields used for the production of certified seed were in accordance with the rules.
10) Inspect fields to ensure that the minimum standards for isolation, roguing, use of male sterility (wherever applicable) are maintained at all the times and that seed borne diseases are not present in the field to a greater extent than those prescribed in the certification standard.

4. **Central Seed Testing Laboratory (CSTL) :**

The seed testing laboratory located at I.A.R.I, New Delhi has been notified as central seed testing laboratory. The functions of this laboratory are as under.

I. Initiate testing programme in collaboration with state seed testing labs. to promote uniformity in test results of all seed laboratories.
II. Collect data continuously on the quality of seeds found in the market and make this data available to the committee.
III. Act as referee laboratory in testing seed samples for achieving uniformity in seed testing. The state seed testing laboratories are required to send five percent samples to the central seed testing laboratory along with their analysis results.
5. **State Seed Testing Laboratory:**
   The Act envisages the establishment of state seed testing laboratory in each state by notification in the official Gazette. The function of state seed testing laboratory is to carry out the seed analysis work of the state in a prescribed manner.

6. **Appellate authority**
   The Act envisages appointment of an appellate authority through an official notification in the Gazette, to look into the grievances of certified seed producers against a seed certification agency and that of seed traders against seed law enforcement officials.

7. **Recognition of seed certification agencies of foreign countries**
   The central government on the recommendations of the central seed committee recognizes or notifies the agency established in any foreign country for the purpose of the Indian Seeds Act, 1966

### Seed Law Enforcement

Execution of rules and regulations of Seed Act is known as Seed Law Enforcement. The responsibility of enforcing such regulations rests with seed inspectors.

#### Duties of seed inspector
1. Investigate all the places used for grading, storage or sale of any seed of any notified varieties or planting material.
2. Examine the conditions of certificates, labels, tags, etc.
3. Procure and send for analysis, the samples of any seeds found doubtful as being produced, stocked, sold or exhibited for sale.
4. Investigate any complaint made to him in writing regarding violation of seed rules.
5. May detain the containers of imported seeds which are prohibited.
6. May admit prosecution in respect of breaches of the act and rules.

- **The Seed Control Order, 1983**

### The Seed Control Order came into force on 30th Dec. 1983

#### Activities about the seed control order, 1983:-

(A) **Dealers in Seed to be licensed:**
   - (i) Dealers to obtain licence.
   - (ii) Application for licence
   - (iii) Grant and refusal of licence
   - (iv) Period of validity of licence
   - (v) Renewal of licence
   - (vi) Dealers to display stock and price list
   - (vii) Dealers to give memorandum to purchaser
   - (viii) Power to distribute seeds.
   - (ix)
(B) Seed control Order gave rules to Enforcement Authority:-

(i) Appointment of licensing authority
(ii) Appointment of inspectors
(iii) Inspection and punishment
(iv) Time limit for seed analysis
(v) Cancellation of licence
(vi) Appeal

➢ Classes of seeds :

The seed of a released and popular variety produced by scientific method is referred to as improved seed or quality seed. Variety refers to a genotype, which has been released for commercial cultivation either by state variety release committee or central variety release committee.

Improved seed results in (1) better production (2) vigorous seedling growth (3) higher crop stand (4) better quality of produce and (5) higher crop yield.

Thus production of improved seed is an important aspect of seed technology. There are four classes of improved seed viz.,

1. **Nucleus seed**: It is the initial seed of an improved variety which is always limited in quantity. It is produced by the original plant breeder of a variety. It is produced at research farm of the concerned crop under the supervision of original plant breeder. It is genetically and physically 100% pure. There is no need of seed certification for nucleus seed. Nucleus seed is used for the production of the breeder seed.

2. **Breeder seed**: It is the progeny of nucleus seed produced under the strict supervision of original plant breeder at the research farm of the concerned crop research station. It is produced in isolation from other varieties. The isolation distance differ from species to species. It is also genetically and physically 100% pure. The genetic purity is maintained by proper roguing. Seed certification is not necessary for breeder seed. However, the seed plot is inspected by monitoring team lead by original plant breeder and representative form NSC and state seed certification agency. Breeder seed is used for the production of foundation seed.

3. **Foundation seed**: It is the progeny of breeder seed. It is produced by the NSC or State Seed Corporation under the strict supervision of research scientist. Its production is taken up at the seed multiplication farms of Govt, or research farm of ICAR institute or University farm or on progressive farmer’s field. Proper isolation distance is the pre-requisite for the production of foundation seed, which varies from crop to crop. Genetically foundation seed is 100% pure while permissible physical purity is 98%. In case of foundation seed, certification is under taken by State Seed Certification Agency. Foundation seed is used for the production of certified seed.

4. **Certified seed**: It is the progeny of the foundation seed. It is produced on the field of progressive farmers under strict supervision of State Seed Certification Agency. Proper isolation is adopted for its production which varies from crop to crop. It has 100% genetic purity and 98% physical purity. The other crops seeds and weed seed should not be more than prescribed standards which vary from species to species. Seed certification from the State Seed Certification Agency is required for certified seed to meet the requirements of purity and germination of certified seed.
**Principles of Seed Production**

Production of genetically pure seed and quality seeds is an important task which requires profound technical skills. During seed production, strict attention must be given to maintain genetic purity and other qualities of seeds in order to get benefit of new improved variety. Seed production involves genetic and agronomic principles to preserve genetic purity of seeds which ultimately leads to higher seed yields.

**Deterioration causes of crop Varieties and their control:**

**Genetic principles:**

Genetic purity of a variety can deteriorate due to several factors during production cycles. Kadam (1942) listed out some important factors which deteriorate the genetic purity of seeds as under:

1. **Developmental variations**
   
   When the seed crop are grown under different soil and fertility conditions or under various agro climatic conditions or under different photoperiods or at different elevations for several consecutive generations, the developmental variations may arise due to differential growth response and there will be a genetic shift to the changed agro-climatic conditions. This change in genetic shift causes deterioration of variety. To minimize such type of variations it is advisable to grow seed crops in their areas of adaptation and growing seasons.

2. **Mechanical mixtures**
   
   This is the important source of variety deterioration during seed production. Mechanical mixture may occur at the time of sowing, if more than one variety is sown with the same seed drill, through volunteer plants of the same crop or through different varieties grown side by side in the same field get mixed at the time of harvesting or threshing. Sometimes the seed produce of all the varieties are kept in the same thresher for the processing which may result in deterioration of variety. Sometimes gunny bags, seed bins used for packing the seeds may contaminate the seeds. To avoid such type of mechanical mixtures it is necessary to rogue the seed fields. Care should be taken at every stage of seed production, harvesting, threshing, processing and packing of seeds.

3. **Mutations:**
   
   Natural mutation is the continuous process in nature and it is difficult to identify or detect minor mutations, however, such mutant plant is observed in the seed field then it should be rogued out to avoid the contamination hence, constant inspection of seed plot is to be made rigorously.

4. **Natural crossing:**
   
   Most of the field crops sexually propagate, hence natural out-crossing is another important source of contamination and varietal deterioration, due to introgression of genes from unrelated stocks through natural crossing. According to Bateman (1947), the extent of genetic contamination in seed fields due to natural crossing depends on following factors.
   
   A. The breeding system of species (nature of pollination, self or cross)
   
   B. Isolation distance: It is the minimum separation required between two or more varieties of the same crop species for the purpose of keeping seed genetically pure.

   C. Varietal mass i.e. no. of varieties grown at a time in field.

   D. Pollinating agents – Insects, predator’s, wind and wind direction.
E. Climatic factors – Humidity, temperature, wind velocity at the time of anthesis and pollination.

5. Residual or Minor genetic variability :
Sometimes, minor genetic variation may exist even in the varieties appearing uniform and homogenous at the time of release. During later cycle of seed production, these variations may affect the yield and quality of the variety and deteriorate the variety. Therefore, it is essential to take precautions during maintenance of nucleus and breeder seed.

6. Disease infestation :
Sometimes, an improved variety deteriorates because it is infested by a disease to which it was considered resistant at the time of its release. This may result either due to absence of such disease in the area where the variety was tested or due to formation of new pathogenic race of a disease.

7. Techniques of plant breeder :
Cytological irregularities may cause instability in variety, if it is not properly assessed by the breeder at the time of its release. Premature release of variety may segregate for undesirable characters, which may deteriorate the variety. Therefore, proper care is required in testing the variety before its release.

Other factors, such as breakdown of male sterility and heritable variations arise due to environmental conditions considerably deteriorates the genetic purity of variety.

**Maintenance of genetic purity during seed production**

Different workers have made suggestions to maintain the genetic purity of seeds during seed production. Notable among them are of Horne (1953) and Hartmann and Kester (1968)

**Suggestions made by Horne (1953)**

1. Seeds approved by competent authority and inspected by the competent agency before planting.
2. The seed field should be approved and inspected by the competent agency before planting.
3. Inspection of seed field and approval of growing crops at critical stage for verification of genetic purity, detection of mixtures, weeds and seed borne diseases should be made.
4. Proper care should be taken at the time of sampling and sealing of cleaned seed lots.
5. A comparison of potentially approved stock should be made with authentic stock by growing the samples.

**Suggestions made by Hartmann and Kester (1968)**

1. Adequate isolation should be provided to the seed field to prevent contamination by natural crossing or mechanical mixtures.
2. Roguing of seed field should be carried out prior to the stage at which they could contaminate the seed crop.
3. The variety should be tested periodically for its genetic purity.
4. The seed crop should be grown only in the areas of its adaptation to avoid genetic drift.
5. The seed crop should be certified by the agency to maintain genetic purity and quality of seeds.
6. The seed production should be restricted to three generation only i.e. starting from breeder seeds, it should only be multiplied up to foundation and certified class.
7. Variety grown for seed production should be tested for genetic purity by grow out test to make sure that it is being maintained in its true breeder form.

**Agronomic principles of seed production:**

In seed production programme in addition to genetic principles certain agronomic principles are to be followed to preserve good quality and abundant seed yields which are as under.

1. Selection of a suitable agro-climatic region: Regions or areas with moderate rainfall and humidity are more suitable for seed production. Most of the field crops require a dry sunny periods and moderate temperatures for flowering and pollination. The crops pollinated through wind require bright sunny weather with gentle wind velocity which results in to good seed setting. Thus, regions with extreme summer heat and very cold winter with excessive rainfall should be avoided for seed production.

2. Selection of seed plot: The plot selected for seed crop must have following characteristics
   I. Soil texture and fertility of plot should be according to the requirement of seed crop.
   II. The soil of the plot should be free from weeds, volunteer plants, insect, pests and soil borne diseases.
   III. The plot selected for seed production purpose should have not been used to grow the same crop in the previous season.
   IV. The plot should be well leveled and it should be feasible to isolate it from other side as per requirement of seed certification.

3. Isolation of seed crop: The seed crop must be isolated from other nearby fields of the same crop and other contaminating crops. Enough isolation distance should be provided as per seed certification standard. For nucleus and breeder seed production isolation may be provided by enclosing plants or group of plants in cage or by removing male flower parts and then artificial pollination.

4. Preparation of land: Good land preparation helps in improved germination, good stand establishment and eradication of weed plants, it also helps in water management and uniform irrigation. So land preparation is an important aspect.

5. Selection of variety: The variety selected should be adapted to the agro-climatic conditions. It should be higher yielder and possess desirable attributes like resistance to disease, insect, and pest, earliness and good grain quality.

6. Seed: The seed to be used for raising the seed crops should be obtained from an official authorized agency having known genetic purity and appropriate class. The tag and seal of seed bag purchased should be intact and the validity period of seed should not be expired.

7. Seed treatment: Appropriate seed treatment must be given to the seeds before sowing. For seed borne diseases and pests the seeds should be treated with fungicides, insecticides and pesticides. In case of legume crops the seeds must be inoculated by the bacterial culture for higher nodulation, water soaking treatment for softening the hard seed coat and mechanical scarification or acid treatment for breaking dormancy of hard seed.
8. Time of planting: The seed crop should be sown as per the recommended time of sowing. In hybrid seed production programme, staggered planting may be adjusted in order to have synchronized flowering (flowering of male and female plant at the same time). There should be sufficient moisture at the time of sowing to have good germination.

9. Seed rate: Recommended seed rate for different crops should be followed in order to carry out roguing and inspection of seed crop.

10. Method of sowing: In order to take effective plant protection measures, roguing operations and field inspection, line (row) sowing is appropriate method to be followed in seed production programme. In case of hybrid seed production, female and male parents should be planted in definite proportion of 4:2 or 6:2 rows.

11. Depth of sowing: The seed crop having small seeds should be planted at shallow depth while those having bigger seed size may be planted at deeper level.

12. Roguing: Roguing means removal of off type, diseased plants, weed plants, volunteer plants or plants differing in the characteristics from the seed crop variety. Timely and adequate roguing is important in order to maintain genetic purity of seed crop. Generally roguing is practiced at (1) vegetative or pre-flowering state, (2) flowering stage and (3) at maturity state. Roguing at flowering and maturity stages is more important because the undesirable plants which were not identified at vegetative stage may be removed from the seed crop to avoid the genetic contamination.

13. Supplementary pollination: If the seed crop is pollinated by insects then provision of honey bee and other beneficial insects may be made in nearby the seed crop field to ensure good pollination and setting.

14. Weed control: Efficient weed control is a basic requirement of seed crop in producing good quality seed and obtaining higher yield. Therefore, seed field should be free from weed plants or either it should be at minimum level. In no case, the weed plants should be allowed to flower or seed setting.

15. Plant protection measures: The quality of seeds may be poor if damaged by insects, pests or disease and there will be reduction in yield, so proper plant protection measures should be taken up at appropriate time as per recommendations.

16. Fertilizer application: For proper growth and development of seed crop application of fertilizers at proper time and as per recommended doses is important. Hence, it is necessary to have knowledge of nutritional requirement of seed crop.

17. Irrigation: Irrigation is important to ensure good and uniform germination at planting time so it is advisable to irrigate the seed crop as per its requirements. Irrigations should be stopped two to three weeks before seed maturity to allow the soil and plants to dry.

18. Harvesting of seed crops: Early or late harvesting will affect the yield and quality of seed hence, the seed crop should be harvested at the optimum time to allow maximum yield. Moisture content below 20 per cent is the optimum time to harvest the seed crop.

19. Drying of the seeds: In order to preserve seed viability and vigour, it is necessary to dry seeds to safe moisture content. Seeds of the field crops are dried to a room temperature.
20. Storage of raw seeds: The best method of storing seeds for a short period is gunny bags. After sun drying the seed should be filled in neat and clean bag. The stacks of bags should not be made directly on the floor but arrange them on wooden platform in dry, cool, clean and rat proof store house or godowns. The store house should be fumigated time to time to protect seed from stored grain pests.

**Maintenance of Nucleus and Breeder seed**

The nucleus or breeder seed should be produced in such a manner that it strictly satisfy the genetic purity and identify the quality of seeds and subsequently maintain the quality of foundation and certified seed produced / multiplied from it.

**Maintenance of Nucleus and Breeder in self pollinated crops**

The variety of self-pollinated crops should be completely homogenous (uniform). However, in practice some amount of variation may occur during seed production cycle due to natural crossing. Therefore, purification of such variety during maintenance of nucleus/breeder seed is necessary. The methods of maintaining nucleus/breeder seed can be divided in two groups.

1. Maintenance of newly released variety
2. Maintenance of established variety.

Harrington (1952) outlined the procedure for maintenance of nucleus seed of newly released variety as under.

(A) Sampling of the variety to obtain nucleus seed:

The selected plants or lines which are highly promising in yield trials or breeding nurseries should be sampled for seed purification. Maximum fifteen such promising line at a research station should be sampled in one year. Approximately 200 plants from the central rows should be selected. To avoid shattering of the seeds, these plants should be pulled 4 to 5 days before the grains are fully mature. To prevent breakage or loss, these plants should be tied in a bundle and wrapped in a cloth or paper. Store properly these bundles till final yield results are available. Discard any of these bundle found inferior in yield and quality based on the results.

(B) Table examination of samples:

The two hundred plants of each sample should be threshed separately, clean the seeds and examine in piles on the table. Discard the pile found off type, diseased or not uniform. The seed of these selected two hundred plants is called nucleus seed, which is to be sown in a variety purification nursery.

(C) Locating and seeding of nucleus seed:

Each nucleus seed should be grown on clean fertile land at the research farm in the region or area for which it is to be released. The land to be used for sowing the nucleus seed must not had the same crop sown in the previous year. The 200 progenies of a nucleus should be sown in 50 double rows plots in four series. To facilitate examination of rows during different growth stage the plot to plot distance should be at least 45 cm. It should be isolated properly to prevent contamination by natural crossing.

(D) Inspection of two rows plot and removal of off types:
From seedling stage up to maturity, the plot should be examined critically. Differences in early plant growth, rate of growth, time of heading, plant height, head characters and disease reaction should be observed if any plot differs from the average in such traits, it should be removed. From flowering to maturity, roguing should be done based upon ear-head characters.

(E) Harvesting and threshing of nucleus:
Each plot of the nucleus should be harvested separately, tied in bundle with proper labeling. Thresh the bundle individually, clean the seeds taking care that it should not get mixed with seeds of another plot. The seeds should be treated with fungicide and insecticide, bagged and labeled properly and stored as “Breeder’s stock seed”.

(II) Maintenance of Breeder seed of newly released variety:
1. Breeder’s stock seed obtained from nucleus should be sown on clean fertile land. The land to be used for sowing should not have a crop of the same kind grown in the previous year. The land requirement varies with the crop. e.g. In case of wheat about 1.2 ha. while, in case of transplanted paddy the land requirement is 3 hectare.
2. The seed should be properly isolated as per the seed certification standard.
3. The field should be produced at research farm of university and in the area or region for which the variety has been bred.
4. The sowing should be done in rows keeping sufficient spacing between rows so as to permit examination of plants for mixtures or off type.
5. Roguing should be critically done before flowering i.e. during growth period and after flowering i.e. during reproductive stage.
6. Harvesting, threshing, drying, cleaning, bagging and labeling should be carried out with most care to avoid contamination.
7. A portion of breeder seed should be retained by the plant breeder to multiply the stock with 100 % genetic purity.

Maintenance of Breeder seed of established variety:
The breeder seed of established variety can be maintained by two ways.
1. By raising the crop in isolation: The breeder seed of established variety can be maintained by growing it in isolated plots and by rigorous roguing during various stages of crop growth by observing plant characters.
2. By Bulk selection: In this method 2000 to 2500 plants representing typical plants characters of the variety are selected, harvested and threshed separately. The seeds from each selected plant are examined by table examination making piles of the individual plant and if seeds of any pile found off type or dissimilar than it is discarded The remaining piles are bulked to constitute the breeder seed.

How long a particular method should be used depends on the rate of deterioration in a variety either through natural crossing or mutation or mechanical mixture. If enough care is taken while production, we can maintain the genetic purity for several generations.

Carry over seed: A portion of breeder seed retained by the plant breeder for continuation of a variety is called carry over seed. The breeder must retain enough quantity of seeds to
safeguard against the loss of variety if there is complete failure during the foundation seed multiplication phase.

Methods of maintaining nucleus and breeder seed in cross pollinated crop:

The maintenance of variety of cross pollinated crops is complicated because it involves the maintenance of parental material and the method of breeding the variety.

Maintenance of nucleus and breeder seed of newly released variety:

Maintenance of nucleus seed of inbred lines:

It involves self pollination, sib pollination or combination of both the procedures. Generally, sibbing (mating between the siblings) is preferred because it does not reduce the vigour excessively. However, a change in breeding behavior is observed when selfing should be used as a means of stabilizing the inbred lines. Alternate selfing and sibbing is generally practiced to maintain the parent material. The individual ear head obtained through selfing or sibbing is carefully examined and those appearing off type or inferior in any characters like texture, color, seed size, seed shape, and shape and size of ear head are discarded. The remaining ear heads are then threshed separately and are planted in ear to row method or all ear heads of an inbred are bulked for increase in the next season.

Seed multiplication is carried out in isolation. Roguing is carried out at different growth stages. Harvesting is done at physiological maturity. Generally, ear to row line (Progeny rows) is harvested, separately. Threshing or shelling is carried out in bulk or individually and then composited by examining the seeds.

Maintenance of Breeder seed of inbred:

The breeder’s stock obtained from nucleus seed is planted in an isolated field. Attention is paid to land, isolation, roguing, harvesting, shelling and drying so as to maintain maximum possible genetic purity.

Maintenance of breeder seed of established variety:

The breeder seed of established variety can be maintained in two ways:

1. By raising the crop in isolation and roguing the off types thoroughly at various stages of crop growth right from sowing to maturity.
2. By mass selection: The crop is grown under isolation and roguing is carried out at different growth stages. At maturity 2000 to 2500 true to type plants are selected. The selected plants are harvested separately and after careful examination they are bulked to constitute the breeder seed.
Seed marketing:

Seed marketing is one of the most vital components of seed technology. In broad sense it includes such activities as production, processing, storage, quality control and marketing of seeds. In the narrow sense, seed marketing refers to the actual acquisition and selling of packed seeds, intermediate storage, delivery of seeds and sales promotional activities. Thus seed marketing comprises of the following aspects.

1. Demand forecast (Assessment of effective demand).
2. Marketing structure.
4. Sales promotional activities.
5. Post-sales service.
6. Economics of seed production and seed pricing.

1. Demand forecast: The assessment of effective seed requirements is critical to any planned seed programme. The demand forecast should be that the seed supply keeps pace with seed demand in terms of quantity, quality, price, place and time.

2. Marketing structure: The key to success in seed marketing is the establishment of effective channel of distribution. The simplest and most efficient system is to establish a central marketing cell and regional offices in end-use areas. The retail sale should be organized either by appointing distributors/dealers such as private dealers, co-operatives, agro sales service centers etc. or by opening owned sales points of seed company or seed corporation.

3. Seed storage infrastructure: Transportation of seeds from production areas to end use areas is important and time consuming task. Availability of seeds to the dealers/consumers in time is essential. Therefore, buffer godowns, with good storage conditions are to be established in end use areas.

4. Sales promotional activities: These activities reflect on the overall distribution of seeds as well as the impact on the consumer. The seed company and the dealers should jointly share in the publicity efforts. The seed company should provide basic materials such as photographs, technical reports, posters, charts, leaflets which the dealer can adopt to specify uses. A sound and effective sales programme must be based on the judicious use of three basic tools i.e. advertising, publicity and public relations.

5. Post sale services: It includes educating the farmers, technical help as and when desired by the farmers and quick follow up on the complaints about seed sold.

6. Economics of seed production and seed pricing: The seed production cost must be kept as low as possible. The farmers or seed producer will not be interested in seed production unless the prices they receive have reasonable profit.

Factors affecting seed marketing:

Seed marketing is greatly affected by the following factors:

1. Clear-cut policy: A clear cut policy regarding duties and responsibilities of the official, semi-officials and private economic sectors is necessary for the development of seed marketing on sound basis.

2. Availability of well identified and adapted varieties: A seed programme would not have any impact unless superior varieties are regularly supplied for the seed programme. Current official information on new varieties that have been recommended for crop production helps in accelerating the programme.
3. Adequate production, storage and testing facilities: These are necessary for producing and maintaining seed qualities and quantities in accordance with the established standards for the development of sound marketing.

4. Official programme: State government has to take the initiative and promote the supply arrangement of new varieties or hybrids are when first time introduced among the small scale farmers. The important role of government is to provide market information, to set targets and to regulate and control agencies and enter prices dealing with seeds.

5. Demand forecast: Real assessment and targets of seed demand are very essential. Excess quantity of seed may result in large carry over stocks and losses in storage while short supply would deprive the seed dealers of profits they could have made.

6. Market intelligence: A market intelligence systems should be so developed to provide reliable information regarding the needs of farmers, location of production areas and size of market demands as well as marketing cost to keep official and private institution up to date on production and supply patterns.

7. Transport and storage arrangement: Adequate transport arrangement for timely supply of seeds and their proper storage in end use areas/dealers or storage buffer godowns are also important in order to maintain seed germination and viability for a long period.

8. Nature of product: Seeds are perishable commodity and easily get damaged if handling is not proper at any stage of marketing so proper handling is required.

9. Quality control programme: Legally enforced effective quality control procedure should be strictly followed to ensure uniform quality levels as per the prescribed standard which may help in reducing the unhealthy competition with bonafide seed companies.

10. Publicity: A high level publicity on value, availability and returns from certified seed of the recommended varieties is important tool for increasing seed sales.

11. Financial rewards: A well-defined policy of financial rewards to those dealers who make out standing records as salesmen is of considerable importance and goes a long way in development of seed marketing.

**Seed pricing policy**

The seed pricing policy is the most effective and delicate management tool for regulating the flow of seeds in the market. The price fixed for sale should be reasonable enough, so that a large number of farmers could purchase certified seeds.

Seed production costs involves following expenses.

1. In raising a seed crop:
   a) Cost of foundation seed
   b) Cost of specialized planting (in hybrids and vegetables)
   c) Roguing costs
   d) Cost of other special operations (Detasseling etc)
   e) Cost of additional supervision required in raising a seed crop.
   f) Seed certification fee
   g) Other expenses not covered above e.g. construction of separate threshing floors, extra cleaning of equipments etc.

2. At the time of seed harvesting, drying and processing:
   a) Separate harvesting of lodged or rejected portions of field and disposing the produce as commercial.
   b) Losses incurred due to drying to 10-12 % moisture content as compared to 12-14 % for a commercial crop
c) Sorting and rejection of undesirable ears of maize, ear heads of pearl millet or sorghum, root or shoot of vegetables etc

d) Separate handling in order to maintain lot identity

e) Additional transportation costs

f) Losses in seed processing

g) Loss, that is, difference in sale price of underside, shriveled and rejected seed (roughly, 10-20 % of the seed supplied) as compared to upgraded produce.

h) Seed processing and testing charges

3. Seed marketing costs :
   a) Storage and transport expenses
   b) Interest on capital investment
   c) Distribution and sales promotion costs

**Factors (components) affecting the final marketing price**

1. Input costs
   a) Price paid to seed producers for raw seed or fully processed seed depending upon the marketing scheme
   b) Storage and transportation costs
   c) Distribution costs
   d) Wholesale margin (if applicable)
   e) Retail margin (Dealer’s commission)
   f) Sales promotion
   g) Risks costs
   h) Profit (if applicable)

2. Supply and demand : Total supply available and total demand generated also influence the seed price. If the supply is short the sale price is relatively high, if supply is abundant the price is less and profit margin is low.

3. Prices of other farm products and time trend should also be taken into consideration while fixing the price.

**Seed processing**

Seed processing is necessary in order to dry the seeds to safe moisture level, remove or reduce the various undesirable material, weed seeds, other crop seeds, deteriorated or damaged seeds, uniform size grading and seed treatment to upgrade the overall seed quality. In its common usage in India, seed processing refers to all the steps necessary for preparation of harvested seed for marketing, handling, drying, shelling, preconditioning, cleaning, size grading, treating and packaging etc. The following factors should be considered in planning and designing a seed processing plant :

1. Kinds of crop seeds to be handled, kinds of contaminating crop and weed seeds usually present in the seed lots.
2. Size of operation
3. Whether drying facilities should be required
4. Selection of suitable equipment
5. Location of plant
6. Source of power for running machinery
7. System of seed delivery to processing plant
8. Availability of labour
Analysis of operation

a) Processing sequence: After identifying the machines needed for processing, the next step is to determine proper processing sequence. The seed separators, elevators, conveyors and storage bins should be so arranged that seeds flow continuously from beginning to end.

b) Matching capacity: Equipment size of capacity must be carefully planned to prevent bottlenecks. When the overall operating capacity needs to be determined, all machines must be able to handle that capacity with some reserve capacity for problem lots. Either large models or more than one machine installed in parallel flow must be used to maintain uninterrupted flow.

c) Conveying: (Transport system): The type of conveying system is also very important factor. The conveying system must be able to handle the capacity needed in particular spot and it must be carefully adapted to the seed handled.

Seed drying

In order to maintain seed viability and vigour drying of seed lots i.e. lowering down the seed moisture content to safe moisture limits is very important, otherwise viability and vigour deteriorates fast due to mold growth, heating and increased micro-organism activity.

Methods of seed drying

The drying of seeds is done by the following methods

1. **Sun drying**: The moisture content of seeds have to be reduced in the field before harvest and later by sun drying on the threshing floor. The system involves harvesting of crops when they are fully dried in the field, leaving the harvested produce in field for a couple of days to sun dry and later spreading the threshed and winnowed produce in thin layers on threshing floors to sun dry. The main advantage of sun drying is that it required no additional expenditure. The disadvantages are delayed harvests, risks of weather damage and increased likelihood of mechanical mixtures.

   If sun drying is to be done, the following precautions should be taken:
   (a) Do not spread the produce on wet, dirty and kuchha threshing floors,
   (b) Only one crop variety and produce from one plot should be handled on threshing floor, in order to maintain lot identity and to avoid mechanical admixtures.

2. **Forced air drying**: In this system air (natural or heated) is forced into seeds. The air passing through damp seeds picks up water. The evaporation cools the air and the seed. The heat necessary for evaporating the water comes from the temperature of the air. This is the most fundamental principle of forced air seed drying.

   There are three main drying methods for drying with forced air.

   1. Natural air drying: Natural air is used in this type of drying method.
   2. Drying with supplemental heat: Heat is provided to raise the temperature about 10 to 20°C for reducing relative humidity so that drying can take place.
   3. Heated air drying: In this method the drying air is heated considerably, as much as 110°F.

   The first two methods may require 1-3 weeks or even more to reduce the seed moisture content to safe levels. They are generally used in western countries to dry
grains/seeds which will be stored on farm for some period. The third method i.e. heated air drying is universally favoured for drying the seeds. The usual practice in heated air drying is to dry the seed either in a special drying bin or in wagons. From the drying bins the seed is moved either in to processing assembly or to storage bins.

**Cleaning of seeds**

Principles of cleaning seeds: In the cleaning process, the separation of undesirable material viz., 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 main physical differences found in seeds are seed size, length, width, 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 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 form the basis of seed cleaning operations.

**Methods of cleaning seeds**

Cleaning of seeds can be done in the following groups

1. Pre-conditioning and pre-cleaning: Pre-conditioning refers to such operations as shelling etc. that prepare seed lots for basic seed cleaning, while pre-cleaning means removal of particles, larger in size than desirable crop seed from seed lots.
2. Basic seed cleaning: Basic seed cleaning refers to actual cleaning and grading of seeds. Unlike pre-cleaning/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. An air screen machine, commonly referred to as an air screen cleaner is used for basic seed cleaning. It is also the basic equipment in seed processing plant.
3. Upgrading the quality of cleaned seed: The various processing operations conducted after the basic cleaning to further improve seed quality are regarded as upgrading operations. The choice of upgrading operation, however, depends upon the type of contaminants and crop. The types of upgrading operations are as under.
   1. Sizing and grading (Dimensional sizing)
      a. Width and thickness sizing and grading
      b. Length sizing and grading
   2. Gravity or weight separations
   3. Air separations
   4. Surface texture separation
   5. Electronic separation
   6. Other separations

**Seed packaging, handling and storage**

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

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

Equipments used for packaging of seeds

The bagger and weigher: These are small machines which when properly mounted beneath a bin will fill and weigh a bag accurately in a single operation. Bagger weigher and bagging scales used in seed packaging may be manual, semi-automatic or automatic.

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 breakdowns and short operating life.

Attaching labels: At the time of placing seed into bags, a label must be placed on each bag to maintain positive identity of the seed. When bags are closed with a bag sewing machine, a label or tag can be sewn to the bag.

Maximum lot size: Each seed lot will be assigned a seed lot no. in the following manner specified in the Indian Minimum Seed Certification Standards.

First part – Month – year code
Second part – Production location code
Third part – Processing plant code
Fourth part – Seed produce code

All the four parts of the lot number shall be written in series which a dash ‘(-)’ between first, second, third and fourth parts to distinctly indicate the code number of each part. An example is show below:

Lot No. – May 88-06-01-01
May-88 : Seed harvested in May-1988
06 : Seed crop raised in Gujarat
01 : Seed processed in a processing plant identified as number 01 by the Gujarat state seed certification agency
01 : Seed produce code which will trace to the particular unit of Certification

Seed storage:

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 storage period of seeds can be divided into following six stages.

1. Storage on plants (physiological maturity to harvest)
2. Harvest, process and storing in a warehouse
3. Storages in a warehouse
4. In transit (from warehouse to retailer)
5. Retail dealers storage
6. On the user’s farm

The seed quantity i.e. germination and vigour can be considerable affected during above storage periods if the seeds are not properly handled and proper storage is not followed.

- **Factors affecting seed longevity (long life span of seed) in storage**

  Seed ageing and loss of germination during storage cannot be stopped completely but it can be minimized by providing good storage conditions. Important factors which affect the longevity of seeds are as under.

  1. **Kind / variety of the seed**: The genetic makeup of the lines / varieties influence the storage period.
  2. **Initial seed quality**: Seed damage during transit period at various stages due to mechanical injury may reduce the longevity.
  3. **Moisture content**: Moisture content of seeds to be stored determines the seed viability and germination. If the moisture content is high, the quality will deteriorate rapidly. 8-10 % moisture content is very safe to maintain good germination and vigour for longer period.
  4. **Relative humidity and temperature during storage**: Increase in relative humidity and temperature adversely affect the storage life of seeds. The relative humidity should not exceed 50 % and temperature should be around room temperature. A 10°F decrease in temperature nearly doubles the storage period. Similarly 1 % decrease in moisture content doubles the storage life. So good seed storage is achieved when the percentage of relative humidity in storage environment and the storage temperature in degree Farenhit add up to one hundred.

**General principles of seed storage**

- a) Seed storage conditions should be dry and cool.
- b) Storage must have effective pest control
- c) The seed stores must have proper sanitation
- d) The seeds should be dried to a safe moisture limit required for storage system.
- e) The seeds should be well cleaned, treated with proper insecticides, pesticides, fungicide and should have high germination percent and vigourous.

- **Seed Treatments**

  Seed treatment is the application of protective fungicides, insecticides or a combination of both to seeds prior to planting so as to disinfect and disinfest them from seed borne or soil borne pathogens and even storage insects. It also refers to the subjecting of seeds to solar energy exposure, immersion in conditioned water etc.

  After green revolution, the treatment of seeds with protective chemicals prior to planting has become a standard and widely accepted practices.

**The ideal seed treatment chemical should be**

- a) Highly effective against pathogenic organisms.
- b) Relatively non-toxic to plants
- c) Harmless to humans and livestock, even if misused
- d) Stable for relatively longer periods of time during seed storage.
- e) Easy to use
- f) Economically competitive
Benefits of seed treatments

1. Prevention of spread of plant diseases
2. Protects the seed against soil borne and seed borne organisms.
3. It improves germination
4. Provides protections against storage insects
5. It controls soil insects and pests.

➢ Types of seed treatments:

1. Seed disinfections: Seed disinfections refers to the eradication of fungal spores that have established within the seed coat or in deep-seated tissues. For effective control, the fungicidal treatment must actually penetrate the seed in order to kill the fungus present inside the seeds.
2. Seed disinfestations: refers to the destruction of surface borne organisms that have contaminated the seed surface but not infected the seed surface.
3. Seed protection: To protect the seed and young seedlings from organisms in the soil which might otherwise cause decay of the seed before germination.

Equipments for seed treatment:

The equipments used to apply chemicals in any form (slurry, a liquid form or a dust) to seed are referred to seed treaters and can be divided into two broad categories.

1. Slurry treaters: The slurry treatment principle involves suspension of wettable powder material in water. The treatment material applied as slurry is accurately prepared through a simple mechanism composed of a slurry cup into a mixing chamber where they are blended.

   The slurry treaters are adaptable to all type of seeds and rate of treating. The small amount of moisture that is added to the seeds 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 “Panogen” and “Mist-o-matic” treaters. Of these two, the Mist-o-matic” treater is being used more widely. It applies treatment as a mist directly to the seed.

Coloring of seed: Most of the treatments contain dyes and some companies add their own “color brand” dye to seed treatments.

Dyes served two purposes:

1. As a warning that the seeds have been treated to prevent contamination as 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 / insecticide treatment.
Acronyms

1. AOSA: Association of Official Seed Analysis
2. AOSCA: Association of Official Seed Certifying Agencies
3. CSCB: Central Seed Certification Board
4. IBPGR: International Board for Plant Genetic Resources
5. ISST: Indian Society of Seed Technology
6. NBPG: National Bureau of Plant Genetic Resources
7. NSDC: National Seed Development Council
8. NSSL: National Seed Storage Laboratory
9. NSC: National Seed Corporation
10. SSCA: State Seed Certification Agency
11. UPOV: Union for the Protection of New Varieties of Plants
12. ISTA: International Seed Testing Association
13. IMSCS: Indian Minimum Seed Certification Standard
14. GSSCA: Gujarat State Seed Certification Agency
15. GSSC: Gujarat State Seed Corporation

➢ Detection methods for GMOs/LMOs

➢ Definition

Any living organism that possesses a novel combination of genetic material obtained through the use of modern biotechnology

❖ Transgenic plants

• Characterized by the insertion of a new gene or sets of genes into their genome
• The new genes translate and new protein expressed
• This gives the plant new characteristic

➢ Transgenic plants – Examples

➢ Bt cotton
  Cotton plants resistant to lepidopteran insects
➢ Round-up ready soybean
  Soybean resistant to glyphosate
➢ Golden rice
  Rice grains with beta-carotene & Vitamin -A

| Bt cotton | Round-up ready soybean | Golden rice |
Detection Methods

How transgenic plants are made?

- **Promoter**
- **Gene**
- **Terminator**

Transformation:

Plant DNA before transformation

Plant DNA after transformation

**General Procedure:**

- **Detection**: to determine whether a product is GM or not. For this purpose, a general screening method can be used. The result is a positive/negative statement.
- **Identification**: to find out which GM crop or product are present and whether they are authorized or not in the country.
- **Quantification**: If a crop or its product has been shown to contain GM varieties, then it become necessary to assess compliance with the threshold Regulation by the determination of the amount of each of the GM variety present.
Detection methods

**DNA Based methods**
- Highly sensitive - can detect trace amounts GM- DNA
- Work with most product types - both processed and unprocessed products
- Can test for multiple GM varieties simultaneously
- Takes a number of days to perform - typically 3-5 days
- Requires highly skilled personnel and laboratory analysis
- More expensive than Protein Based Methods

**Protein based methods**
- Relatively cheap to perform
- Rapid turnaround - 5 to 20 mins for strips; 24 hours for ELISA
- Strips do not require trained personnel
- Limited to one or a small number of varieties per test
- Not appropriate for processed products
- Not appropriate for some GM varieties - in certain crops the GM protein is only produced in the leaves or stems and not in the actual grain. Protein tests on the grain are therefore not informative.
- Not very sensitive (~1% of GM protein)
• ELISA
• Lateral flow strip

Lateral flow stick

- Collect leaf and extract sample
- Place the strip into the extraction tube
- The sample will travel up the strip
- Allow the strip to develop for 10 minutes
- To retain the strip, cut off and
- Discard bottom section of the strip

Protein based methods
Transgenic contamination in non-GM crops:
The coexistence of genetically modified (GM) crops and non-GM crops is a myth because the movement of transgenes beyond their intended destinations is a certainty, and this leads to genetic contamination of organic farms and other systems. It is unlikely that transgenes can be retracted once they have escaped, thus the damage to the purity of non-GM seeds is permanent. The dominant GM crops have the potential to reduce biodiversity further by increasing agricultural intensification. There are also potential risks to biodiversity arising from gene flow and toxicity to nontarget organisms from herbicide-resistant (HT) and insect-resistant (Bt) crops. Unless whole regions are declared GM agriculture free, the development of distinct systems of agriculture (GM and non-GM) will be impossible as GM agriculture emerges at the expense of all other forms of production.

The movement of transgenes follows many different routes:
- By pollen
- By wind or pollinators
- By humans transport crop seeds over huge distances
- By hybridize with non-crop species
- By volunteer plants
- By isolation distance
- By accidental release of unapproved transgenes into commercial seed
- By violations of safety protocols during field trials of GM crops

GM crops and organic seed production:
- Genetically modified (GM) crops cannot be released into the environment and used as food, feed, medicines or industrial processing before they have passed through a rigorous and internationally recognized regulatory process designed to protect human and animal health, and the environment.
- The UK body that oversees standards in organic farming, the United Kingdom Register of Organic Food Standards (UKROFS), has ruled that genetically modified (GM) crops have no role to play in organic farming systems. They, therefore, have concerns about the possibility and consequences of the mixing of GM crops with organic crops.
- The two main sources of mixing are through pollen and seed. Pollen from GM crops may pollinate an organic crop. Seed from a GM crop, or plants established from them, may become mixed with organic crops or their products.
- Minimizing genetic mixing is an important feature of the production of all high quality seed samples of plant varieties supplied to farmers.
- Extensive experience has been obtained over many decades in the production of high purity seed samples. Crop isolation distances, and crop rotational and management practices are laid down to achieve this. These procedures for the production of seed of high genetic purity could be used for the production of organic crops.
• No system for the field production of seed can guarantee absolute genetic purity of seed samples. Very rarely long distance pollination or seed transfer is possible, so any criteria for organic crop production will need to recognise this.
• There has always been the possibility of hybridization and seed mixing between organic crops and non-organic crops.
• Organic farming systems acknowledge the possibility of spray or fertilizer drift from non-organic farming systems, and procedures are established to minimize this.
• In practice, detecting the presence of certain types of GM material in organic crops, especially quantification, is likely to be difficult.
• Some seed used by organic farmers are currently obtained from abroad.
• Organic farmers and/or GM crop producers will need to ensure that their crops are isolated from one another by an appropriate distance or barrier to reduce pollen transfer if the crop flowers. To reduce seed mixing, shared equipment will need to be cleaned and an appropriate period of time allowed before organic crops are grown on land previously used for GM crops. Responsibility for isolation will need to be decided before appropriate measures can be implemented. The report highlights the need for acceptable levels of the presence of GM material in organic crops and measures identified to achieve this.

Seed production technologies in different field crops

Wheat

(1) Selection of seed plot: The plot to be used for seed production of wheat shall be free from weeds and volunteer plants. The plot should be well drained. Prepare the land with deep ploughing, followed by harrowing and leveling. Pre-sowing irrigation should be given for uniform germination.

(2) Isolation distance: Wheat is normally a self-pollinated crop, however, natural cross-pollination to the extent of 1 to 4 percent occurs. So an isolation distance of 3 meter should be kept in all the side of seed plot to avoid natural crossing. If a variety of the seed plot is likely to get infected by loose smut then isolation distance of 180 meters between seed field and other field of wheat is recommended.

(3) Planting time and seed rate:
1) Long duration (late maturing) varieties may be sown during the first fortnight of November.
2) Short (early) and medium duration varieties may be sown during second fortnight of November.
3) The seed crop should be sown in rows at spacing of 20 to 22.5 cm to a depth of 5 cm.
4) The recommended seed rate for seed crop is 85 to 100 kg /ha.

(4) Cultural practices:
1) Fertilizer: The recommended doses of fertilizer is 80 kg nitrogen, 60 kg phosphorous and 40 kg potash per hectare. Apply all the quantity of phosphorous and potash fertilizers at the time of sowing while 50 % quantity of nitrogen at time of sowing and remaining 50 % nitrogen at the crown root initiation stage i.e. 30 to 35 days after sowing.

2) Irrigation: Depending upon the soil texture and structure about 4 to 6 irrigations are sufficient. 1st irrigation at 30 to 35 days after sowing and other irrigations at late tillering, panicle emergence, flowering, milk and dough stages should be given.

3) Inter-culturing and weeding: Periodically inter culturing and weeding should be carried out to keep the crop free from weeds. Chemical weedicides like 2,4-D @ 0.5 kg a.i. per hectare and pendimethalin @ 1 kg a.i. per hectare in 750 litres of water should also be used for effective control of weeds.

4) Plant protection:
   I. For the control of termites, use chlorpyriphos 20 EC @ 2.3 litres/ha with irrigation water.
   II. For control of stem borer apply carbofuran 3 G @ 25 kg/ha two weeks after germination or spray the crop with endosulfan 35 EC @ 1.5 litres per hectare.
   III. Seed treatment with systemic fungicide should be given for control of loose smut.

5) Roguing : Two to three roguing are sufficient
   1) 1st roguing may be done at the time of heading to remove off types and plants infected with loose smut.
   2) 2nd roguing should be done just after flowering to remove off types plants with late flowering based upon ear head (panicle) characters.
   3) 3rd roguing should be done at the time of maturity based upon variation in ear head color. Color of awns and ear head types as well as volunteer plants and weed plants should be removed.

6) Harvesting and threshing : Harvesting may be done by sickle and threshing with thresher. Care should be taken to avoid mechanical mixture.

7) Processing : Wheat seeds should have 9 to 10 percent moisture content for storing purpose. To maintain good quality of seeds, it should be cleaned, treated with fungicide and should be properly bagged. The seed should be stored in a dry, clean and rodent proof warehouse.

8) Yield : The average seed yield should be between 30 to 40 qtls per hectare.

### Minimum seed certification standard

<table>
<thead>
<tr>
<th></th>
<th>Foundation seed</th>
<th>Certified seed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germination (%)</td>
<td>85</td>
<td>85</td>
</tr>
<tr>
<td>Genetic purity (%)</td>
<td>98</td>
<td>98</td>
</tr>
<tr>
<td>Inert matter (%)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Other crop seeds (No./kg)</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Weed seeds (No./kg)</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Diseased seeds (%)</td>
<td>0.05</td>
<td>0.25</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>
Rice (Paddy)

1. Selection of seed plot: The plot should be free from weeds and volunteer plants and should not have been used for growing the same crop in previous year or season. Prepare the land with deep ploughing followed by harrowing so that the transplanted seedlings establish quickly. A plot should be kept flooded for a week or ten days before transplanting.

2. Isolation chamber: The extent of cross pollination in rice varies from 0 to 6.8% hence it is necessary to keep the plot isolated at least by 3 meters from other rice plot for pure seed production.

3. Cultural practices: The paddy crop must be grown by direct sowing or by transplanting. For seed production transplanting method is desirable.

I. Raising nursery: Land selected for paddy nursery should not have paddy as previous crop to avoid varietal mixture due to volunteer plant. The appropriate time of sowing nursery for early duration varieties is from 10th to 25th June and for late duration varieties, it is 25th May to 10th June. Long and narrow nursery beds (1 m x 10 m) are more ideal. Prepare raise bed to facilitate drainage of excess water and also to irrigate the nursery uniformly. About 80 to 90 beds of the size 10 m x 3 m are sufficient for raising seedlings to transplant one hectare of land.

II. Seed rate: 20 -25 kg for fine grain varieties, 30-35 kg for coarse grain varieties. Seed should be obtained from the source approved by the seed certification agency. The sowing of seeds in nursery may be carried out in row (line) sowing or broadcasting may be done. Irrigate the nursery after sowing the seeds. Recommended plant protection measures and fertilizer application may be made to raise the seedlings successfully. Keep the nursery free of weeds.

III. Uprooting of seedlings and transplanting: Seedling are ready for transplanting after 3 to 4 weeks of sowing. Uproot the seedling gently, discard weak, diseased or those seedlings differing in any way from the original variety. The land should be puddled either by tractor or by bullock pair and flood it with appropriate water level to transplant the seedlings. Fertilizer may be applied based on soil test, however, the fertilizer recommendation is 120-60-00 kg N:P:K for later varieties and 100-50-00 kg N:P:K for early and mid-late varieties. Apply whole amount of phosphorus and potash as basal dose at the time of puddling. 50% nitrogen may be applied as basal dose while 25% of nitrogen at tillering stage and 25% at panicle initiation stage. If the land is deficient in zinc, apply 15 kg zinc sulphate per hectare at puddling stage. Spacing should be kept at 20 cm x 15 cm. Maintain a water level of 2.5 to 5 cm of water till milking stage. Drain excess water when the crop does reach to physiological maturity.

IV. Weed control: Keep the crop free from weeds by hand weeding or using chemical herbicides. Butachlor or benthiocarb @ 1.5 kg a.i./ha 5 to 7 days after transplanting.

V. Plant protection: Stem borer, brown plant hopper, leaf roller and Gundhi bug are the major pests of paddy.

a) For the control of stem borer use carbofuran 3% granules @ 20 kg/ha or phorate 10% granules @ 10 kg/ha.

b) For the control of brown plant hopper and leaf roller spray endosulphan 35 EC @ 1 litre per hectare.

c) Disease: Blast, bacterial leaf blight, bacterial leaf streak and brown spot are the important disease of paddy.
i. For control of blast Hinosan 625 ml per hectare in 625 litres of water one or two times before panicle emergence and once after panicle emergence.

ii. For the control of bacterial leaf blight spray 75 g agrymycine + 500 g copper oxychloride in 500 litres of water per hectare 3 to 4 times at an interval of 10 to 15 days.

iii. For control of bacteria leaf streak spray 12 g of streptocycline or 75 g agromycin in 50 litres of water per hectare at an interval of 10 to 15 days.

iv. For the control of brown spot spray 0.25 percent dithane M-45 or Zineb after 6 weeks of transplanting at an interval of 10 to 12 days.

4. Roguing : Roguing of off types and volunteer plants should be done once before flowering and then at flowering and maturity stage. Roguing of wild rice or plants infested by pests and diseases may be done from time to time as required

5. Harvesting and threshing : It is important to harvest the crop when the seed is ripe. The moisture content at this stage varies between 17 to 23 percent. Harvest the crop by sickle or combined harvester. Allow the crop to dry for two to three days till the moisture content reduce to 12 to 13 percent. Clean the seeds to remove chaff, durt, empty husks and light seeds by winnowing. Store in a gunny bags in a cool and dry place on wooden racks.

6. The average paddy seed yield should be from 50 to 60 quintals per hectare depending upon the varieties.

Minimum Seed Certification Standard

<table>
<thead>
<tr>
<th></th>
<th>Foundation seed</th>
<th>Certified seed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germination (%)</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>Genetic purity (%)</td>
<td>98</td>
<td>98</td>
</tr>
<tr>
<td>Inert matter (%)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Other crop seeds (No./kg)</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Weed seeds (No./kg)</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Diseased seeds (%)</td>
<td>0.01</td>
<td>0.05</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>13</td>
<td>13</td>
</tr>
</tbody>
</table>

**Seed production of hybrid rice**

The successful development and use of hybrid rice technology in china during 1970s led the way for development and release of rice hybrid. In India 14 rice hybrids have been bred and released for commercial cultivation by some the state agricultural universities and private seed companies. Hybrid rice can be produced in the following ways.

1. Three line system : This involves multiplication of cytoplasmic genetic male sterile line (A line), maintainer line (B line) and a restorer line (R line). Finally production F₁ hybrid seed (A × R)

2. Two line approach : This involves the use of photoperiod sensitive genetic male sterile (PSMS) and any normal line can serve as a restorer.

3. By using chemical emasculators : Chemicals which act as male gametocytes have been developed which can sterilize the stamen without affecting the normal functioning of pistil. These chemicals are used to emasculate female parent for hybrid rice production. In this method, two varieties are planted in alternate strips and one is chemically sterilized and pollinated by the other.
Steps involved in seed production:

1. Selection of seed field: The field should be free of volunteer plant, well leveled, should have fertile soil with good physical properties and well drainage facilities.
2. Isolation: The hybrid rice field should be isolated from other paddy fields by 200 meters for foundation seed and 200 meters for hybrid seed production (A x R).
3. Synchronization of flowering: Synchronizing of flowering of both parents is the key factor to increase the yield. Technical measure such as staggered planting of female and male parents may be adjusted to ensure synchronizing the flowering time. In addition, one or two extra planting of male parents may be done to extend the time of availability of pollens. Flowering time can be manipulated by additional fertilizer application and regulation of water in the field.
4. Methods of improving seed setting:
   a) Supplementary pollination: This can be done by pulling the nylon rope back and forth on the restorer line and panicles of restorer lines are shaken which helps in transfer of pollen grains.
   b) Leaf clipping: Clipping of leaves prior 1-2 days of panicle emergence will increase the probability of pollination and out crossing so blade of the flag leaf may be clipped.
   c) GA3 application: Spraying of 60 ppm (60 mg/l) solution of GA3 on the female parent two to three times at the time of panicle emergence will increase quick exertion of panicle and helps in seed setting.
5. Roguing: The seed field should be free of rogues (off type plants). Remove off type plants in the male and female parents. First before panicle initiation and then soon after emergence of panicles. Rogue out the plants of maintainer lines or semi-sterile plants from the female parent plot as and when required.
6. Harvesting and processing: Harvest male rows first to avoid chances of mechanical mixture. Moisture percentage in the grain at the time of harvesting should be less than 18 percent for combine harvester or harvested by hand and must be sun dried to 12 percent for storing purpose. Cleaning of seeds should be done taking enough care to avoid mixture. Store the seed in cool and dry place.

Minimum seed certification standard

<table>
<thead>
<tr>
<th></th>
<th>Foundation seed</th>
<th>Certified seed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolation distance (m)</td>
<td>200</td>
<td>100</td>
</tr>
<tr>
<td>Germination (%)</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Genetic purity (%)</td>
<td>98</td>
<td>98</td>
</tr>
<tr>
<td>Other crop seeds (No./kg)</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Weed seeds (No./kg)</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Diseased seeds (%)</td>
<td>0.01</td>
<td>0.02</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>13</td>
<td>13</td>
</tr>
</tbody>
</table>

Seed production of composite and synthetic varieties in Pearl millet (Bajara)

1. Land preparation: One ploughing followed by two harrowing and leveling. Land should have well drainage capacity. It should be free from volunteer plants and weeds.
2. Time of sowing:
Kharif : 2\textsuperscript{nd} fortnight of July
Rabi : Mid October to mid December

3. Isolation : Foundation seed – 400 m
   Certified seed – 200 m

4. Source of seed : Obtain foundation seeds from the source approved by the certification agency.

5. Seed rate, method of sowing and spacing :
   a) Direct sowing : 3.5 kg to 5.0 kg, keeping 50 cm spacing between rows.
      Thinning should be done at a distance of 10 to 15 cm.
   b) Transplanting : 1.5 kg/ha, Spacing : 45 cm between the rows

6. Fertilizer : 50 kg NPK as basal, 25 kg N after 25-30 days of sowing and 25 kg N after 40-45 days of sowing.

7. Irrigation : Irrigate the crop as and when required. If rain is inadequate, 1-2 irrigation may be given.

8. Weed control : Pre-emergence application of Propazine or Atrazine @ 1 kg/ha and one hand weeding would be effective to control weeds. One or two inter-culturing would be sufficient to keep the crop weed-free.

9. Plant protection :
   a) White grub and shoot fly : Apply 10 % phorate granules 10-15 kg/ha as soil application at the time of sowing. Spraying of carbaryl @ 2 kg in 500 litres of water per hectare would be effective.
   b) Red hairy caterpillar, leaf roller, hopper and army worms : Thiodan 35 EC, 1.25 litre/ha in 600 to 800 litres of water.
   c) Sucking pests like aphids, jassids can be controlled by Dimethoate 30 percent @ 250 ml in 500 litres of water per hectare.
   d) Earhead midge and blister beetles : Carbaryl 50 % @ 3 kg/ha or Malathion 2 % dust @ 15 kg/ha.
   e) Smut : Seed treatment with Agrosan 3 gm/one kg seed.
   f) Rust : Spray zineb 50 % w.p. 1 kg/ha in 600 litre of water.
   g) Ergot : Spray the ears with Ziram (Cuman) 0.15 % or mixture of copper oxichloride (Fytolan) and zineb (Dithane-Z-78) in 1:2 ratio

10. Roguing : Remove off types and volunteer plants identified on the basis of plant characteristics like stem color, hairiness, plant height, peduncle shape, colour etc.

11. Harvesting : Seed crop should be harvested when it is fully matured. Remove diseased or damaged ear-head at the time of harvest. Threshing can be done by thresher. Dry the seed to 10 % moisture before storage.

**Production of hybrid seed in Pearlmillet** :

The hybrid seed is produced by using cms line and restorer (CGMS concept) as similar to other cereals.

Important steps are :
   a) Maintenance of parental lines, i.e. male sterile line, B line and restorer line.
   b) Production of hybrid seed i.e. (A x R)

Planting ratio : Female : male , 4 : 2 rows. Eight border rows of parent should be provided on all sides of the field or sufficient availability of pollen grains.
Spacing : 75 cms between rows adjust planting by sowing early or late.
Seed rate :
   Direct sowing - Female : 1.5 kg/ha and male : 0.75 kg/ha
   Transplanting : female : 400 g/ha, male : 200 g/ha

Isolation : 200 meters from other field
Roguing:
   a) Start roguing before flowering
   b) All off type plants and volunteers must be cut from the ground level or pulled out to prevent re-growth.
   c) Remove off types both from the seed parent and pollinator parents.
   d) Remove pollen shedding plants at the time of flowering from the rows of female (seed parent).
   e) Seed (female) parent should be rogued at least once a day.
   f) Remove diseased plants at the time of harvest.

Harvesting: Harvest male rows first. Keep it separately. Female rows should be harvested after completion of male rows. The seed should be dried, threshed and cleaned before storage.

Seed yield: 3 to 4 qtls/ha

Minimum seed certification standard:

<table>
<thead>
<tr>
<th></th>
<th>Foundation seed</th>
<th>Certified seed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolation distance (m)</td>
<td>75</td>
<td>75</td>
</tr>
<tr>
<td>Inert matter (%)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Genetic purity (%)</td>
<td>98</td>
<td>98</td>
</tr>
<tr>
<td>Other crop seeds (No./kg)</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Weed seeds (No./kg)</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Diseased seeds (%)</td>
<td>0.02</td>
<td>0.04</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>12</td>
<td>12</td>
</tr>
</tbody>
</table>

Hybrid seed production in maize

Production of hybrid maize seed involves three steps
1. Maintenance of parental lines (Inbreds)
2. Production of single cross
3. Production of commercial hybrids
   a) Production of three way cross: (A X B) X C
   b) Production of double cross: (A X B) X (C X D)

Maintenance of parental lines and production of single cross are called as foundation seed production while production of three way cross or double cross is known as certified seed.

Maintenance of inbred lines:
1. Land requirement (Selection of seed plot): The soil should be well aerated and suitable for maize growing. Selected field should be free from volunteer plants and weed plants. It should have good drainage capacity as maize is sensitive to excess water as well as drought conditions.
2. Isolation distance: The seed field of an inbred line must be isolated by not less than 400 m. from any maize field with the same kernel colour and texture and 600 m. from maize field with different colour and texture.
3. Seed rate: Female parent: 10 kg/ha, male parent: 5 kg/ha
4. Planting time: 2nd week of June to Mid July.
   a) Ratio - Female: male row ratio should be 4 : 2
4. Roguing: Start roguing the distantly tall and vigorous plant when the crop is at knee light stage. At pre-flowering stage, rogue off plants which are easily identified on the basis of plant characteristics such as leaf shape, size, plant height etc.
roguing during flowering stage to remove plants differing in tassel or silk character. Final roguing should be done to remove stalk-rot affected plants.  

(5) Harvesting: Maze ears can be harvested when the seed moisture content is around 15 per cent. The male rows are harvested first so as to avoid mixing of male ears with female ears. After compilation of harvesting of male rows, harvesting of female rows is carried out. After harvest, sort out all off type maize ears, particularly those showing different colours and torture and infested by disease.  

(6) Processing: Before shelling of maize ears they are once again examined and any off-type or diseased ear is found, it is removed immediately. Processing for kernel is carried out at processing plant under the supervision of staff of seed certification agency.

Minimum seed certification standard

<table>
<thead>
<tr>
<th></th>
<th>Foundation seed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germination (%)</td>
<td>90</td>
</tr>
<tr>
<td>Genetic purity (%)</td>
<td>98</td>
</tr>
<tr>
<td>Inert matter (%)</td>
<td>2</td>
</tr>
<tr>
<td>Other crop seeds (No./kg)</td>
<td>5</td>
</tr>
<tr>
<td>Weed seeds (No./kg)</td>
<td>none</td>
</tr>
<tr>
<td>Diseased seeds</td>
<td>none</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>12</td>
</tr>
</tbody>
</table>

**Hybrid seed production in sorghum**

The hybrid sorghum seed is produced by utilizing cytoplasmic genetic male sterility. The steps involved in hybrid seed production are as under.

1. Maintenance of parental lines i.e. line A carrying cytoplasmic genetic male sterility. Line B male fertile (maintainer lines of A) and R line i.e. restorer line used as male parent for the purpose of producing hybrid seed male fertile, pollen restoring line.

2. Production of hybrid seed: This involves crossing of male sterile line A with restorer line (R line) to produce hybrid seeds. The maintenance of parental lines is known as foundation seed production and the production of hybrid seed is known as certified seed production.

**Maintenance of male sterile lines (Line A)**

I. The male sterile line (line A) carried male sterility due to cytoplasmic genetic factors. It is maintained by crossing with male fertile non-pollen restoring line (non-restorer line) in an isolated plot. The isolation distance kept is 400 meters. In a crossing field the planting ratio of line A and B is 4 : 2. Four to six border rows of line B are planted all around the seed plot. The seed harvested from line A is male sterile and is used for hybrid seed production as a female parent and for further maintenance of line A. The seed harvested from line B is pollen fertile and may be used in further maintenance of line A.

II. Seed rate, spacing and planting ratio:

Seed rate : Female line (Line A) 8 kg/ha  
            Male line (Line B) 4 kg/ha  
Spacing   : 75 x 10 cm  
Ratio     : Female line to male line ratio is 4 : 2.
III. Roguing: It is very important for quality seed production. Before flowering remove all off type plants from both seed parent and pollinator parent. Roguing may be started before off type, volunteers and pollen shedders in female rows start shedding pollens. At flowering roguing should be done every day to remove pollen shedding plants in the female rows. Pre-harvest roguing i.e. the field should be thoroughly rogued before harvesting and after the seed has matured to the stage when we can identify the true plant and seed characters easily. The roguing of diseased heads should also be done critically.

IV. Harvesting: Harvest male rows (B lines) first and keep their ear heads separate. The female rows (A line) should be harvested after completion of harvesting of B lines.

Production of hybrid seed:

Hybrid seed is produced by crossing male sterile line (line A) with specified restorer line (line R) in an isolated field. This is hybrid seed that is to be sold to farmers.

i. Selection of seed plot: The land should be free from volunteer plants and weed plants. There should be no Johnson grass in the seed field or within the isolation distance. The field should be well drained.

ii. Isolation distance:

<table>
<thead>
<tr>
<th></th>
<th>Foundation seed</th>
<th>Certified seed</th>
</tr>
</thead>
<tbody>
<tr>
<td>From field of other sorghum varieties</td>
<td>200 m</td>
<td>100 m</td>
</tr>
<tr>
<td>Johnson grass</td>
<td>400 m</td>
<td>400 m</td>
</tr>
<tr>
<td>Forage sorghum</td>
<td>400 m</td>
<td>400 m</td>
</tr>
</tbody>
</table>

iii. Spacing, planting ratio, seed rate:

Spacing: 75 to 90 x 10 cm
Planting ratio: Female to male rows ratio 4 : 2, and four border rows of male parent in all the sides of the field
Seed rate:
- female parent 8 kg/ha
- Male parent 4 kg/ha

iv. Synchronization flowering time in male and female parent: Perfect synchronization of flowering time between male and female parent is most important. Differential flowering time may result in non-synchronization of the parents which may result into poor seed set, hence knowledge regarding flowering habit of the parent is very useful for planning of suitable staggering to ensure nicking and thereby maximum seed set.

v. Roguing: During vegetative growth stage, before flowering remove all off type plants from the rows of both female and male parents. Start roguing before off type plants, volunteer plants and pollen shedders in female rows start shedding pollens. At flowering and during flowering period roguing should be done every day to remove pollen shedding plants from the female rows. Pre-harvest roguing before harvesting and after maturity roguing should be done thoroughly and ear heads infested with the disease should be removed.

vi. Harvesting and threshing: Harvest male rows any time after the maturity prior to harvest the female rows. Remove the produce of the male parent from the seed field before harvesting the female rows to avoid the mixture. The threshing machine may be thoroughly cleaned before threshing the female ear heads to avoid mechanical mixture.

vii. Seed yield: Average seed yield of 4 to 6 quintals per hectare.
Minimum Seed Certification Standard

<table>
<thead>
<tr>
<th></th>
<th>Foundation seed</th>
<th>Certified Seed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germination (%)</td>
<td>75</td>
<td>75</td>
</tr>
<tr>
<td>Genetic purity (%)</td>
<td>98</td>
<td>98</td>
</tr>
<tr>
<td>Inert matter (%)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Other crop seeds (No./kg)</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Weed seeds (No./kg)</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Diseased seeds</td>
<td>0.02 %</td>
<td>0.04 %</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>12</td>
<td>12</td>
</tr>
</tbody>
</table>

Seed Production In pulses crops:

➢ Pigeon pea:

(1) **Selection of seed plot** : The plot to be used for seed production of pigeon pea shall be free from weeds and volunteer plants. The plot should be well drained. Prepare the land with deep ploughing, followed by harrowing and leveling.

(2) **Isolation distance** : Pigeon pea is normally a Often cross-pollinated crop, however, natural cross-pollination to the extent of 65 percent occurs. So an isolation distance of 200 meter should be kept for foundation seed class and 100 meter for certified class side of seed plot to avoid natural crossing.

(1) **Planting time and seed rate** :

   Sowing of seed crop in first week of June is recommended for obtaining higher yields.

   Seed crop should be sown in rows at spacing of Row to Row- 60 to 75 cm

   Plant to plant- 25 to 30 cm

   a depth of 5 cm.

   The recommended seed rate for seed crop is 12 to 15 kg /ha.

(2) **Cultural practices** :

   (a) **Fertilizer**: The recommended doses of fertilizer is 25 kg nitrogen, 50 kg phosphorous per hectare. All the quantity of nitrogen and phosphorous should apply in drilled at time of sowing of seed.

   (b) **Irrigation**: one to two light irrigation prior to onset of monsoons may be necessary. if rain distirbution is irregular and weather remains dry for prolonged periods, one irrigation at flowering time and subsequent irrigation after flowering are necessary.

   (c) **Inter-culturing and weeding**: Periodically inter culturing and weeding should be carried out to keep the crop free from weeds. Chemical weedicides like 2,4-D @ 0.5 kg a.i. per hectare and pendimethalin @ 1 kg a.i. per hectare in 750 litres of water should also be used for effective control of weeds.

   (d) **Plant protection** :

      For the control of pod fly spray endosulphan 1.25 liters per hectare or monocrotrophos at 750 ml per hectare in 250 liters of water.

      For the control of pod bug or plume moth and gram catter piller, spray, 750 ml of monocrotrophos or dust 25 kg malathion 5% dust per hectare.

(3) **Roguing** : rogue the off-type plants and diseased plants affected by wilt, leaf spot and stem canker, YVMV and sterility virus from seed field from time to time as required.
(4) **Harvesting and threshing**: Harvesting may be done by sickle and threshing with sticks. Care should be taken to avoid mechanical mixture.

(5) **Processing**: Pigeon pea seeds should have 8 to 10 percent moisture content for storing purpose. To maintain good quality of seeds, it should be cleaned, treated with fungicide and should be properly bagged. The seed should be stored in a dry, clean and rodent proof warehouse.

(6) **Yield**: The average seed yield should be between 20 to 25 qtls per hectare.

### Minimum seed certification standard

<table>
<thead>
<tr>
<th></th>
<th>Foundation seed</th>
<th>Certified seed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germination (%)</td>
<td>85</td>
<td>85</td>
</tr>
<tr>
<td>Genetic purity (%)</td>
<td>98</td>
<td>98</td>
</tr>
<tr>
<td>Inert matter (%)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Other crop seeds (No./kg)</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Weed seeds (No./kg)</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Diseased seeds (%)</td>
<td>0.05</td>
<td>0.25</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>9</td>
<td>9</td>
</tr>
</tbody>
</table>

**Chickpea**

(1) **Selection of seed plot**: The plot to be used for seed production of chickpea shall be free from weeds and volunteer plants. The plot should be well drained. Prepare the land with deep ploughing, followed by harrowing and leveling.

(2) **Isolation distance**: chickpea is normally a Self-pollinated crop, however, natural cross-pollination to the extent of 1 percent occurs. So an isolation distance of 10 meter should be kept for foundation seed class and 5 meter for certified class side of seed plot to avoid natural crossing.

(3) **Planting time and seed rate**:
   Sowing of seed crop in third and fourth week of October is recommended for obtaining higher yields.
   Seed crop should be sown in rows at spacing of Row to Row- 45 to 60 cm
   Plant to plant- 10 to 15 cm
   a depth of 7-10 cm.

   The recommended **seed rate** for seed crop is 55 to 100 kg /ha.

(4) **Cultural practices**:
   (a) **Fertilizer**: The recommended doses of fertilizer is 15-20 kg nitrogen, 50 kg phosphorous per hectare. All the quantity of nitrogen and phosphorous should apply in drilled at time of sowing of seed.
   (b) **Irrigation**: one to two light irrigation prior to onset of monsoons may be necessary. If rain distribution is irregular and weather remains dry for prolonged periods, one irrigation at flowering time and subsequent irrigation after flowering are necessary.
   (c) **Inter-culturing and weeding**: Periodically inter culturing and weeding should be carried out to keep the crop free from weeds. Chemical weedicides like 2,4-D @ 0.5 kg a.i. per hectare and pendimethalin @ 1 kg a.i. per hectare in 750 litres of water should also be used for effective control of weeds.
   (d) **Plant protection**:
      For the control of pod fly spray endosulphan 1.25 liters per hectare or
monocrotophos at 750 ml per hectare in 250 liters of water.
For the control of pod bug or plume moth and gram caterpillar,
spray, 750 ml of monocrotophos or dust 25 kg malathion 5 % dust per
hectare.

(5) Roguing : Rogue the off-type plants and diseased plants affected by wilt and
blight, from seed field from time to time as required.

(6) Harvesting and threshing : Harvesting may be done when the seeds are fully
matured. At the leaves are reddish brown by sickle and threshing with
sticks. Care should be taken to avoid mechanical mixture.

(7) Processing : Chick pea seeds should have 8 to 10 percent moisture content for
storing purpose. To maintain good quality of seeds, it should be cleaned,
treated with fungicide and should be properly bagged. The seed should be
stored in a dry, clean and rodent proof warehouse.

(8) Yield : The average seed yield should be between 15 to 20 qtls per hectare.

Seed Production in Major Oil seed Crops

➢ Castor

Foundation seed production

Seed production male and female parents and their maintenance is known as foundation
seed production.

1. Land requirement & preparation : Castor seed production can be successfully taken
up on any type of soil provided they are fairly deep, fertile and well drained.
Medium to deep sandy loam and heavy loam soils are ideally suited for seed
production. Since, castor is a deep rooted crop, deep ploughing has been very useful.
One deep ploughing followed by two to three harrowing is sufficient to bring the
field to the desired tilth.

2. Isolation : Castor is monoecious and highly cross pollinated crop. The cross
pollination by wind varies from 5 to 40 % depending upon the climatic condition.
The seed field must be isolated from other variety field at least
300 m from foundation seed class and 150 meters for certified seed class.

3. Source of seed : Obtain nucleus/breeder/ foundation seed from authentic source
approved by seed certification agency.

4. Time of sowing : For kharif season first fortnight of July, for rabi mid of September
to mid of October.

5. Method of sowing : The crop is planted in rows either by drill or in furrows opened
by plough or by transplanting the seedlings

6. Spacing : 120 to 90 x 90 to 45 cm

7. Seed rate : 15 5o 20 kg/ha. Seed rate varies according to seed size spacing and
method of sowing.

8. Fertilizer : 80 : 40 : 00, NPK kg/ha. Of these, 50 % nitrogen plus all the amount of
phosphorus and potash is given as basal dose at the time sowing. Remaining 50 %
nitrogen is given in two equal split, first at 40 to 60 days after sowing and second
after first picking.

9. Irrigation : The number of irrigations required varies with the rainfall received.
However, usually 2 to 3 irrigations during the entire crop season may be sufficient to
avoid moisture stress. Adequate moisture in soil at time of flowering is necessary otherwise moisture stress at this stage may lead to high proportion of male flowers in monoecious varieties.

10. Weed control: The castor field must be kept weed free up to 60 days after planting. 2 to 3 hand weeding / hoeing are sufficient to keep the field clean.

11. Plant protection:
   a) Phytophthora blight and Cercospora leaf spot are the major diseases. Spraying of Bordeaux mixture at 15 days interval or 2 to 3 spray of 0.25 % dithan M-45 may be effective.
   b) 1) Semilooper: 0.35 % thiodan, 0.03 % dimecron
      2) Pod borer: 0.35 % thiodan

12. Roguing: Remove all off type plants before flowering. Rogue out diseased plants as soon as they are noticed in the field and take plant protection measures to check the spread of disease. For male parent two rounds of roguing are required, first about 10 days prior to flowering and the second at flowering. As soon as flower initiation is noticed in primary raceme, reduce the population to 50 % of initial plant stand by roguing of variants in respect to number and the spread of male flowers beyond lower two whorls. After second round of roguing maintain the node number up to primary raceme.

   For female parent there will be four field inspections viz., before flower initiation (35-45 DAS), full flowering in primary raceme (60-65 DAS). Besides the routine two rounds of roguing for removal of off-types based on stem colour, internodes type, leaf shape, nodes up to primary raceme, sex expression, branching etc. inspect every female plant regularly for any possible reversion to monoecism at secondary, tertiary and quarternary orders. These plants should be removed and destroyed.

13. Harvesting and threshing: Start harvesting when all the capsules in primary spikes and 1 to 2 secondary spikes start turning light yellow. The picking continues till 2 to 3 months, because the capsules mature unevenly due to sequential development of racemes. Keep picking-wise seed lot separately, sun dry them, thresh them separately for drawing representative seed samples. Before storage, the seed must be dried to 8 % moisture content.

14. Seed yield: 8-10 qtl under rainfed condition, 15-20 qtl under irrigated condition.

Minimum seed certification standard:

<table>
<thead>
<tr>
<th></th>
<th>Foundation seed</th>
<th>Certified seed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolation distance for hybrid seed production (m)</td>
<td>1500</td>
<td>1000</td>
</tr>
<tr>
<td>Germination (%)</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Genetic purity (%)</td>
<td>98</td>
<td>98</td>
</tr>
<tr>
<td>Inert matter (%)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Other crop seeds (No./kg)</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Weed seeds (No./kg)</td>
<td>none</td>
<td>None</td>
</tr>
<tr>
<td>Objectionable weed seeds (No./kg)</td>
<td>none</td>
<td>None</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>8</td>
<td>8</td>
</tr>
</tbody>
</table>
SUNFLOWER

- Sunflower is second most important oilseed crop after soybean because of its non-cholesterol and anticholesterol properties. The sunflower head is made up of 1,000 to 2,000 individual flowers joined at a common receptacle. The flowers around the circumference are ligulate ray flowers without stamens or pistils; the remaining flowers are perfect flowers. Anthesis (pollen shedding) begins at the periphery and proceeds to the center of the head. It is highly cross pollinated. It is protandrous (androecium matures before gynoecium), since many sunflower varieties -self-incompatibility, insects and bee colonies have generally increased yields. Pollens are sticky, heavy, only transferred by insect (Honey bees). Hybrid seed produced A, B and R line utilizing CGMS concept.

1. Isolation distance: Foundation seed – 1.5 km, Certified seed – 1.0 km
2. Sowing time: November to October
3. Spacing: 60 x 30 cm
4. Seed rate: A line – 4 kg/ha and R line – 1.25 kg/ha
5. Planting ratio: Female : Male ratio should be 3 : 1, staggered planting can be adopted for synchronization of flowering.
7. Roguing: Pollen shedders in cms lines (A lines) should be rogued out. Other traits like plant type, stem, leaf, height, hairiness, leaf size etc. should be considered for roguing purpose.
8. Pollination: This crop has heavy pollens. Artificial pollination by muslin cloth or by collected the pollens in mugs and spreading on female plant using brush will be helpful to increase the seed set and overall production.
11. Yield: 7 to 8 qtls/ha

Minimum Seed Certification Standard

<table>
<thead>
<tr>
<th></th>
<th>Foundation seed</th>
<th>Certified Seed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolation distance (m)</td>
<td>1500</td>
<td>1000</td>
</tr>
<tr>
<td>Germination (%)</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>Genetic purity (%)</td>
<td>98</td>
<td>98</td>
</tr>
<tr>
<td>Inert matter (%)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Other crop seeds (No./kg)</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Weed seeds (No./kg)</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Objectionable weed seeds (No./kg)</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>9</td>
<td>9</td>
</tr>
</tbody>
</table>
Seed production in cotton
Selection of seed plot: The land to be used for seed production must be free of volunteer plants and weeds. The soil should be deep, well drained and should be retentive of moisture and fertile. Plough the land with deep ploughing and harrow two to three times followed by leveling to make it well pulverized.

1. Isolation distance: Cotton is mainly a self pollinated crop but natural cross pollination to the extent of 1 to 10% in *G. arboretum* and *G. barbadense* while 10 to 50% in *G. hirsutum* has been recorded, so a minimum isolation distance of 50 meters for foundation class and 30 meters for certified class is recommended.

2. Planting time:
   - Seed rate:
     - American cotton: 20-25 kg/ha
     - Deshi Cotton: 12-15 kg/ha
   - Spacing:
     - American Cotton: 90 x 30 cm
     - Deshi Cotton: 75 x 30 cm

3. Stage wise roguing: Roguing for off type and diseased plants should start at vegetative growth stage, subsequent roguing should be done at square initiation and flowering time.

4. Picking: The time of picking is important for maintaining seed quality. The picking should start when the cotton is fully mature. Since maturing (ripening) of balls is continuous process several picking may be done. Seeds obtained from initial two to three picking give better germination but planting seeds will be best when collected at the peak of the harvest. The seed cotton picked from last picking should not be kept for seeds or dew. Balls damaged due to insect pest may be discarded for seed purpose.

5. Ginning and delinting: Ginning of cotton seed should be done on the gins approved by certification agency. The machinery must be thoroughly cleaned before the ginning. Gin only those cotton seed with a moisture content of 6 to 8 percent and the ginning rate should not exceed 4.5 to 5.5 kg of lint cotton per hour. Removal of seed coat hairs and short fiber that remains after ginning is called delinting. This may be done with the help of either machine, acid or flame.

6. Seed cotton yield: Average seed cotton yield varies from 6 to 10 quintals per hectare depending upon the yield potential of the variety.

7. Minimum seed certification standard

<table>
<thead>
<tr>
<th></th>
<th>Foundation seed</th>
<th>Certified Seed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germination (%)</td>
<td>65</td>
<td>65</td>
</tr>
<tr>
<td>Genetic purity (%)</td>
<td>98</td>
<td>98</td>
</tr>
<tr>
<td>Inert matter (%)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Other crop seeds (No./kg)</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Weed seeds (No./kg)</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Diseased seeds</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>8-10</td>
<td>8-10</td>
</tr>
<tr>
<td>Minimum purity in GOT (%)</td>
<td>90</td>
<td>90</td>
</tr>
</tbody>
</table>
Hybrid seed production in cotton

The hybrid cotton seed is produced by hand emasculation. The individual bud emasculation of the female parent is done in the evening of the previous day and the same is pollinated in the morning of next day with the pollens of male parent. The emasculated bud is covered either with butter paper bag or a soda straw tube after emasculation and pollination.

1. Selection of seed plot: The land selected for seed production must be free from volunteer plants and weeds. The plot should not have cotton crop in the previous year or season. It should be well drained, moisture retentive and well fertile. Prepare the land with deep ploughing followed by 2 to 3 harrowing and leveling.

2. Isolation distance: 50 meters from other cotton crop variety.

3. Planting ratio, time, seed rate and spacing
   - Female to male ratio is 4 : 1.
   - The flowering period in cotton is spread over a long time. So sowing of male parent should be done in 2 to 3 installments at an interval of eight to ten days in order to get sufficient pollens for pollination of female flower.

<table>
<thead>
<tr>
<th>Time</th>
<th>Seed rate</th>
<th>Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>on set of monsoon or one week earlier than usual date of onset of monsoon</td>
<td>Female parent : 3.75 kg/ha., male parent : 2.5 kg/ha.</td>
<td>Female parent : 150 cm between rows, 100 cm within row. Male parent : 150 cm between row and 50 cm within row.</td>
</tr>
</tbody>
</table>

Precautions to be taken during crossing programme:

1. Rogue out all off type plants before starting of the crossing programme.
2. Emasculate and pollinate, all buds appearing during the first seven weeks of the reproductive phase duration to ensure good seed setting and better development of balls.
3. Emasculate the flower bud in the evening time i.e. 2 to 6 pm only and pollinate them in the next morning between 9 to 13 pm.
4. Emasculate the flower bud i.e. remove all the anthers carefully.
5. Remove un-emasculated flower if any found open.
6. Do not choose very young or old buds for emasculation.
7. Cover the buds of male parent with paper bags in the previous evening for their use in the next day.
8. Emasculated bud may be covered with coloured butter paper bag or soda straw tube to identify for pollination in the next morning.
9. Tie a thread to the pedicel of the bud after pollination. Cover crossed buds with soda straw tube.
10. Close the crossing programme after 11th week and remove all buds and flowers appearing subsequently to facilitate better development of crossed balls. Nip the top end shoots to stop further vertical or horizontal growth.
11. Give light irrigation as and when required during the crossing programme.

4. Stage wise roguing: Roguing for off type and diseased plants should start at vegetative growth stage. Subsequent roguing should be done at square initiation and flowering time.
5. Picking of hybrid seeds: Pickup the ripe and completely opened balls along with threads on and collect in basket for a second sorting. Collected crossed balls should be sorted to verify that they are actually crossed seeds. Sundry for one to two days and store in gunny bags till supplied to processing unit. Care should be taken to avoid mechanical mixture during and after picking.
6. Ginning and delinting: Ginning cotton seed should be done on the gins approved by certification agency. The machinery must be thoroughly cleaned before ginning. Gin only those seed cotton with a moisture content of 6 to 8% and the ginning rate should not exceed 4.5 to 5.5 kg lint cotton per hour. Delinting may be done using machine, acid or flame.

7. Seed cotton yield: Average seed cotton yield varied from 8 to 10 quintals per hecature. Minimum seed certification standard (MSCS)

<table>
<thead>
<tr>
<th></th>
<th>Foundation seed</th>
<th>Certified seed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germination (%)</td>
<td>65</td>
<td>65</td>
</tr>
<tr>
<td>Genetic purity (%)</td>
<td>98</td>
<td>98</td>
</tr>
<tr>
<td>Inert matter (%)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Other crop seeds (No./kg)</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Weed seeds (No./kg)</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Diseased seeds (%)</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>8</td>
<td>8</td>
</tr>
</tbody>
</table>

- Seed Production in Vegetable Crops

- Brinjal, Chilli and Tomato
  - Nucleus, breeder and foundation seeds are produced by selfing in brinjal, chilli and tomato. Hybrids seed is produced by hand emasculation and hand pollination. Anthers form cone around bilobed stigma. In chilli, CGMS system is utilized to produce hybrid where, as usual, A line is maintained by B line (maintainer, non-restorer line), B line and R line (restorer) by selfing and hybrid seed is produced by crossing A line with R line.
  - During the certified seed production, isolation distance remains 200 m for foundation seeds and 100-200 m for certified seeds. Though these are self pollinated crops, some amount of cross pollination occurs by insects. Inspections are made during vegetative, flowering and maturity stages.

<table>
<thead>
<tr>
<th></th>
<th>Tomato</th>
<th>Brinjal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Foundation</td>
<td>Certified</td>
</tr>
<tr>
<td>Isolation distance (m)</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Germination (%)</td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>Genetic purity (%)</td>
<td>98</td>
<td>98</td>
</tr>
<tr>
<td>Inert matter (%)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Other crop seeds (No./kg)</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Weed seeds (No./kg)</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>8</td>
<td>8</td>
</tr>
</tbody>
</table>

- Cucurbits (bottle gourd and ridge gourd)
  Bottle gourd and ridge gourd are monoecious crops (separate male flower and female flowers on same plant) and so high amount of cross pollination occurs. Female flowers can be visualized on plant as ovary with rudimentary anthers (pistillate) and in male flowers ovary is absent (staminate) but 3 anthers are present. To prevent selfing male flowers are plucked off at bud stage and hand pollination is done for crossing. Isolation distance is
1500m for foundation seeds and 1000m for certified seeds. Four inspections are made, 1\textsuperscript{st} during vegetative stage, 2\textsuperscript{nd} and 3\textsuperscript{rd} during flowering stage and 4\textsuperscript{th} during maturity stage.

<table>
<thead>
<tr>
<th></th>
<th>Foundation seed</th>
<th>Certified Seed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolation distance (m)</td>
<td>1500</td>
<td>1000</td>
</tr>
<tr>
<td>Germination (%)</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Genetic purity (%)</td>
<td>98</td>
<td>98</td>
</tr>
<tr>
<td>Other crop seeds (No./kg)</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Weed seeds (No./kg)</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Objectionable weed seeds (No./kg)</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Moisture (%)</td>
<td>7</td>
<td>7</td>
</tr>
</tbody>
</table>

➢ **Onion**

In onion seed is not economic unit, bulbs are consumed which are vegetative tissue of the plant.

**Method of reproduction :**

1. Bulb to seed : It requires two season. In first seasons bulbs are obtained from seeds and in the next season these bulbs are planted and seed are harvested at the end of the second season.
2. Seed to seed (Bolting) : In this method only one season is required to produce seed. Seeds are planted in nursery and seedlings are transplanted. In onion occasional bolting (appearance of flowering) occurs and if allowed to mature, these flowers will bear seeds taking food material from developing bulb under the soil surface.

Onion is highly cross pollinated crop having protandrous nature and pollinated by bees, flies and other insects. Cms lines (cytoplasmic male sterility) available for hybrid seed production. Cytoplasmic male sterility is utilized to produce hybrids viz Arka Lalima and Arka Kirtiman. Inbreds are produced by selfing or sibmating covered with net. In onion restorer line is not required because seed is not economic material. Restorer lines are required to restore the fertility in other crops like rice, bajara, sorghum, sunflower etc. where seed is the economic material. Onion hybrid seed production includes maintenance of A line and crossing of this A line with any other parent. Recall that in other crops R line (restorer lines) are utilized as male parent to restore the fertility in F\textsubscript{1} hybrid.

**Isolation distance :**

<table>
<thead>
<tr>
<th></th>
<th>Foundation seed</th>
<th>Certified seed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulb</td>
<td>5 m</td>
<td>5 m</td>
</tr>
<tr>
<td>Seed</td>
<td>1000 m</td>
<td>500 m</td>
</tr>
</tbody>
</table>

Male and female ratio is 2:8 for hybrid seed production. The planting ratio depends upon the pollen production ability of male and pollinating agents especially *Apis melifera*. Staggered planting can be done for synchronization. The seed harvested from female rows is used as hybrid seed. Harvest the crop when 5-10 % capsule shows black seeds. Umbel (type of inflorescence in onion flower) is harvested keeping 10-15 cm seed stalk along with it. Mature heads are harvested 2-3 times after proper drying of umbel. Onion seeds are stored at < 8 % moisture.
WORLD TRADE ORGANISATION AND ITS ROLE IN
INTERNATIONAL TRADE:

Introduction:

This paper calls for the meaning of international trade, a look at the international organisation known as World Trade Organisation and its role as far as international trade is concerned.

International Trade.

International trade may be defined as a contract of buying and selling goods and services entered into between parties whose places of business are in different countries or trade in goods and services that cut across international borders or boundaries or between nationals of different countries. This involves imports from one country to another and or exports to one country from another country or trans boundary trade. An international sale or export trade contract can also be described as an agreement for the sale and delivery of goods across international borders or boundaries and for all other things incidental to it.

➤ Five essentials of such international trade are:
  • A contract of sale of goods.
  • A contract of carriage of goods.
  • The contract of insurance for the goods.
  • The compliance with formalities and documentation requirements stipulated by the exports and imports’ authorities.
  • The mechanism for payment set up by the buyer.

Since no nation can produce all it needs by itself alone, international trade has become not only a means by which nations source those goods and services they lack or do not have in sufficient quantities but also a subject of international politics either for achieving, promoting or maintaining peace between international trading partners or countries and a source of national insecurity as a result of external developments in countries with which it inter-depends or depends on for essential products and sometimes wars are fought to preserve that national security. For instance it has been argued that one of the reasons for US’ going into the Gulf Wars on the side of Kuwait against Iraq was US’ intention to preserve the vulnerability (weakness) of its economy to oil crisis if it is cut off from oil purchases from the Gulf by the hostile Iraq that had annexed the oil-rich portions of Kuwait.
The Role of WTO:

The role of WTO in international trade is as stipulated in the Agreement establishing it and includes:

1. facilitating the implementation, administration and operation and furthering the objectives of the agreement establishing it and other Multilateral Trade Agreements and providing the framework for the implementation, administration and operation of the Plurality Trade Agreements,

2. Providing the forum for negotiations among its Members concerning their multilateral trade relations in matters dealt with under the agreements in the Annexes to the Agreement setting it up and for the results of such negotiations as may be decided by the Ministerial Conference,

3. Administering the Understanding on Rules and Procedures Governing the Settlement of Disputes or the Dispute Settlement Understanding which is Annex 2 to the agreement setting it up,

4. Administering the Trade Policy Review Mechanism in Annex 3 of the agreement setting it up, and

5. Cooperating as appropriate with the International Monetary Fund and the International Bank for Reconstruction and Development [the World Bank] with a view to achieving greater coherence in global economic policy making.

LIST OF ABBREVIATIONS

AOSA  Association of Official Seed Analysts
AOSCA  Association of Official Seed Certifying Agencies
ECOWAS  Economic Community of West African States
EU  European Union
FAO  Food and Agriculture Organization of the United Nations
GPA  Global Plan of Action
IP  Identity Preserved
IPPC  International Plant Protection Convention
ISF  International Seed Federation
ISTA  International Seed Testing Association
MLS  Multilateral System of Access and Benefit-Sharing
NDA  National Designated Authority
OAPI  Organisation africaine de la propriété intellectuelle
OECD  Organisation for Economic Co-operation and Development
OIC  Orange International Seed Lot Certificate
PGRFA  Plant Genetic Resources for Food and Agriculture
QA  Quality Assurance
QDS  Quality Declared Seed
RPPO  Regional Plant Protection Organization
SADC  Southern African Development Community
SMTA  Standard Material Transfer Agreement
SPS  Sanitary and Phytosanitary
TRIPS  Trade-Related Aspects of Intellectual Property Rights
UPOV  International Union for the Protection of New Varieties of Plants
WTO  World Trade Organization
OECD- Organisation for Economic Co-operation and Development (OECD)

The OECD Schemes for the Varietal Certification or Controlling of Seed traded internationally was established in 1958. Membership is open to OECD, UN and WTO countries, and there are currently 61 member countries. The principal aim of all eight Seed Schemes in place is to encourage the production and use of high quality seed. Each Scheme is defined according to a group of species of cultivated plants; at present, 200 agricultural and vegetable species are covered.

The OECD Schemes for the Varietal Certification or the Control of Seed Moving in International Trade include Rules and Regulations applicable to eight groups of species constituting the following Schemes:

- Grasses and Legumes
- Crucifers and other Oil or Fibre species
- Cereals
- Maize
- Sorghum
- Sugar and Fodder Beet
- Subterranean clover and similar species
- Vegetables.

The OECD is known for its evidence-based advice and standards, as well as for being a forum where national experts from different areas can meet and jointly develop common standards and procedures. This and the involvement of highly qualified seed experts in the standard setting process ensure the wide acceptance of the OECD seed varietal certification system, and its value to the global seed and agricultural sectors.

I. INTRODUCTION

- World population will increase from 6.9 billion in 2010 to 9.3 billion people in 2050; and agriculture will play a fundamental role in meeting the world’s growing demand for food, feed and fibre. In order to feed the world population in 2050, agricultural production will have to almost double, and most of the incremental output will have to come from increases in yields (FAO, 2009).¹

- High-quality seed is a pre-requisite to achieve maximum outputs and good returns for farmers.

- To strengthen the seed sector, it is crucial that seed growers and companies adhere to policies that guarantee quality standards and appropriate regulatory features. Many countries have adopted seed laws.

- A number of international organisations, conventions and treaties deal with the regulation of seed trade, ranging from access to delivery of quality seeds to growers. Together they provide an international regulatory framework by overseeing the interests of breeders, producers and consumers. Among these organisations are the Organisation for Economic Co-operation and Development (OECD), whose Seed Schemes are globally recognized for the certification of seed moving in international trade.

- International regulatory framework for related aspects of seed trade, including plant health and phytosanitary measures, access and benefit-sharing for plant germplasm and use of pesticides.
An appropriate regulatory framework helps to promote competitive seed markets and lowers barriers to trade. Special attention is paid to the OECD Seed Schemes and their contribution to the development of an international seed certification framework as well as their links to other international organizations.

The plan aims to further strengthen the work of the Schemes and its value to Member countries.

This document is intended as an information document for policy-makers in Member countries of the OECD Seed Schemes and in countries interested in joining the Schemes.

The OECD Seed Schemes: A globally recognized seed certification system

1. The OECD Seed Schemes provide an international framework for the certification of seed. They aim to facilitate seed trade by reducing technical barriers, improving transparency and lowering transactions costs.

2. The Seed Schemes authorise the use of labels and certificates for seed produced and processed for international trade according to agreed principles. One of the main principles is that OECD certification is applied only to those varieties that are officially recognised as distinct and having an acceptable value in at least one participating country.

3. An OECD list of varieties eligible for seed certification is regularly published and available online and in hard copy. For a country to use the OECD labels, it is required to register the species and varieties in the OECD list of varieties. The list contains most internationally traded varieties, and it has grown progressively over the last 30 years. There are currently 49,899 varieties and 200 species listed.

4. The rules of the Seed Schemes cover seven groups of species, constituting seven distinct and independent Schemes. In response to the needs of Member countries, the rules are regularly amended.

5. In order for a country to participate in the OECD Seed Schemes, several criteria must be met: The country must provide a description of the national seed certification scheme and a copy of the national rules and procedures governing variety registration and seed certification.