

**Study material of**  
**Principles of Seed science &**  
**technology**  
**(Course No: ASPG2202)**



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# 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.**

<b>Scientifically produced seed</b>	<b>Grain (used as seed)</b>
(1) It is the result of well planned seed programme.	(1) It is the part of commercial produce, saved for sowing or planting purposes.
(2) It is the result of sound scientific knowledge organized efforts, investment on processing, storage and marketing facilities	(2) No such knowledge or efforts are required.
(3) The pedigree of seed is ensured. It can be related to the initial breeders seed.	(3) Its varietal purity is not known.
(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.	(4) No such effort is made so the purity and health status may be poor.
(5) The seed is scientifically processed treated and packed and labeled with proper lot-identity.	(5) It is manually cleaned. Not properly treated, labeled and packed.
(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.	(6) Routine seed testing is not done.
(7) The seed quality is supervised by seed Certification agency.	(7) There is no quality control.
(8) The seed must meet the quality standards prescribed. The quality is well known.	(8) No such standard is applied here hence the quality is unknown.
(9) The labels/tags on the seed containers serves as quality marks.	(9) There is no such label or tag which ensure quality of seed.

### **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

- Research on seed physiology, seed production and seed handling based on modern botanical and agricultural sciences.”

### **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 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.

In the sexually reproducing crop plants definite male and female sexual organs namely androecium and gynoecium produce male gametes and female gametes respectively. The male gametes are formed from a haploid cell called microspore and the female gametes are formed from a haploid cell, megaspore.

## **MODE OF REPRODUCTION**

Knowledge of the mode of reproduction and pollination is essential for a plant breeder, because these aspects help in deciding the breeding procedures to be used for the genetic improvement of a crop species. Choice of breeding procedure depends on the mode of reproduction and pollination of a crop species.

Reproduction refers to the process by which living organisms give rise to the offspring of similar kind (species). In crop plants, the mode of reproduction is of two types: viz. 1) sexual reproduction and 2) asexual reproduction

### **I. Sexual reproduction**

Multiplication of plants through embryos which have developed by fusion of male and female gametes is known as sexual reproduction. All the seed propagating species belong to this group.

#### **Sporogenesis**

Production of microspores and megaspores is known as sporogenesis. In anthers, microspores are formed through microsporogenesis and in ovules, the megaspores are formed through megasporogenesis.

#### **Microsporogenesis**

The sporophytic cells in the pollen sacs of anther which undergo meiotic division to form haploid i.e., microspores are called microspore (MMC) or pollen mother cell (PMC) and the process is called microsporogenesis. Each PMC produce four microspores and each microspore after thickening of the wall transforms into pollen grain.

#### **Megasporogenesis**

A single sporophytic cell inside the ovule, which undergo meiotic division to form haploid megaspore, is called megaspore mother cell (MMC) and the process is called megasporogenesis. Each MMC produces four megaspores out of which three degenerate resulting in a single functional megaspore.

#### **Gametogenesis**

The production of male and female gametes in the microspores and megaspores is known as gametogenesis.

#### **Microgametogenesis**

This is nothing but the production of male gametes or sperm. On maturation of the pollen, the microspore nucleus divides mitotically to produce a generative and a vegetative or tube nucleus. The pollen is generally released in this binucleate stage. The reach of pollen over the stigma is called pollination. After the pollination, the pollen germinates. The pollen tube enters the stigma and travels down the style. The generative nucleus at this phase undergoes another mitotic division to produce two male gametes or sperm nuclei. The pollen along with the pollen tube possessing a pair of sperm nuclei is called microgametophyte. The pollen tube enters the embryo sac through micropyle and discharges the two sperm nuclei.

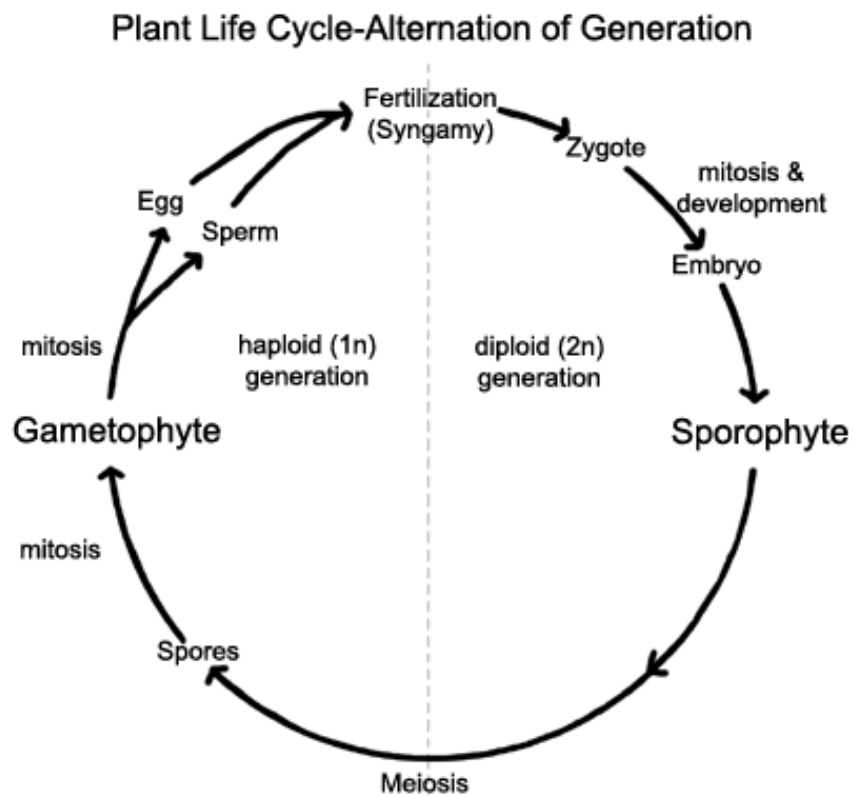
## Megagametogenesis

The nucleus of the functional megaspore undergoes three mitotic divisions to produce eight or more nuclei. The exact number of nuclei and their arrangement varies from one species to another. The megaspore nucleus divides thrice to produce eight nuclei. Three of these nuclei move to one pole and produce a central egg cell and two synergid cells on either side. Another three nuclei migrate to the opposite pole to develop into three antipodal cells.

The two nuclei remaining in the center, the polar nuclei, fuse to form the secondary nucleus. The megaspore thus develops into a mature female gametophyte called megagametophyte or embryo sac. The development of embryo sac from a megaspore is known as megagametogenesis. The embryo sac generally contains one egg cell, two synergids with the apparent function of guiding the sperm nucleus towards the egg cell and three antipodals which forms the prothalamus cells and one diploid secondary nucleus.

## Fertilization:

The fusion of one of the two sperms with the egg cell producing a diploid zygote is known as fertilization. The fusion of the remaining sperm with the secondary nucleus leading to the formation of a triploid primary endosperm nucleus is termed as **triple fusion**. The primary endosperm nucleus after several mitotic divisions develops into mature **endosperm**, which nourishes the developing embryo.



## II. Asexual reproduction

Multiplication of plants without the fusion of male and female gametes is known as asexual reproduction. Asexual reproduction can occur either by vegetative plant parts or by vegetative embryos which develop without sexual fusion (apomixis). Thus asexual reproduction is of two types: viz. a) vegetative reproduction and b) apomixis.



Vegetative reproduction refers to multiplication of plants by means of various vegetative plant parts. Vegetative reproduction is again of two types: viz. i) natural vegetative reproduction and ii) artificial vegetative reproduction.

## Natural vegetative reproduction

In nature, multiplication of certain plants occurs by underground stems, sub aerial stems, roots and bulbils. In some crop species, underground stems (a modified group of stems) give rise to new plants. Underground stems are of four types: viz. rhizome, tuber, corm and bulb. The examples of plants which reproduce by means of underground stems are given below:

**Rhizome:** Turmeric (*Curcuma domestica*), Ginger (*Zingiber officinale*)

**Tuber:** Potato (*Solanum tuberosum*)

**Corm:** Arvi (*Colocasia esculenta*), Bunda (*C. antiquorum*)

**Bulb:** Garlic (*Allium sativum*), onion (*A. cepa*)



**Rhizome: Turmeric**



**Tuber: Potato**



**Bulb: Onion**

Sub aerial stems include runner, sucker, stolon, etc. These stems lead to vegetative reproduction in mint (*Mentha* sp) rose, strawberry, banana, etc. **Bulbils** are modified forms of flower. They develop into plants when fall on the ground. Bulbils are found in garlic.

## Artificial vegetative reproduction

Multiplication of plants by vegetative parts through artificial method is known as artificial vegetative reproduction. Such reproduction occurs by cuttings of stem and roots, and by layering and grafting. Examples of such reproduction are given below:

**Stem cuttings:** Sugarcane (*Saccharum* sp.) grapes (*Vitis vinifera*), roses, etc.

**Root cuttings:** Sweet potato, citrus, lemon, etc.

Layering and grafting are used in fruit and ornamental crops.

## Apomixis

Apomixis refers to the development of seed without sexual fusion (fertilization). In apomixis embryo develops without fertilization. Thus apomixis is an asexual means of reproduction. Apomixis is found in many crop species. Reproduction in some species occurs only by apomixis. This apomixis is termed as **obligate apomixis**. But in some species sexual reproduction also occurs in addition to apomixis. Such apomixis is known as **facultative apomixis**.

There are four types of apomixis: viz.

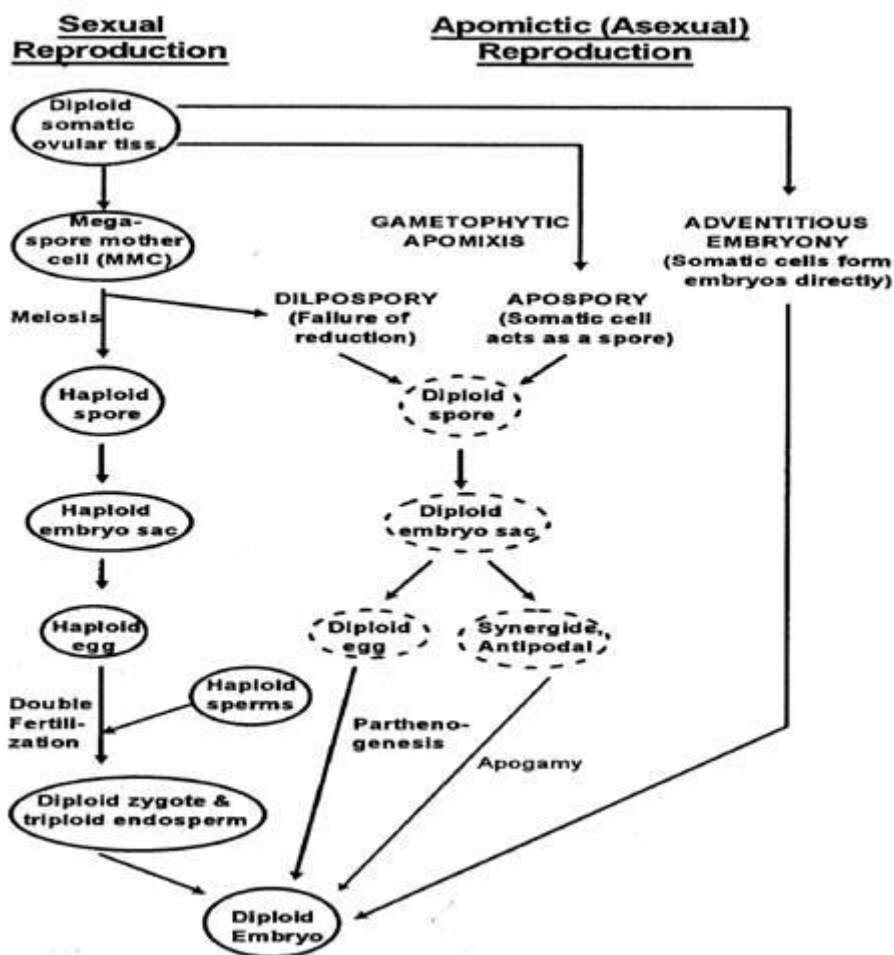
1) parthenogenesis, 2) apogamy, 3) apospory and 4) adventive embryony.

**1. Parthenogenesis.** Parthenogenesis refers to development of embryo from the egg cell without fertilization.

**2. Apogamy.** The origin of embryo from either synergids or antipodal cells of the embryosac is called as apogamy.

**3. Apospory.** In apospory, first diploid cell of ovule lying outside the embryosac develops into another embryosac without reduction. The embryo then develops directly from the diploid egg cell without fertilization.

**4. Adventive embryony.** The development of embryo directly from the diploid cells of ovule lying outside the embryosac belonging to either nucellus or integuments is referred to as adventive embryony.



## Seed Quality

Seed is a basic input in agriculture. Strictly speaking seed is an embryo, a living organism embedded in the supporting or the food storage tissue. In seed, the importance is given to the biological existence whereas; in grain the importance is given to the supporting tissue the economic produce.

### Seed is defined as

- ✓ A ripened ovule or a fertilized matured ovule containing embryo which has developed after fertilisation.
- ✓ The dry dispersal unit or matured ovule developed after fertilization
- ✓ Any part (or) organ of plant which has the capability to regenerate into a new plant
- ✓ A propagule responsible for maintaining the intrinsic (or) genetic qualities of the variety / hybrid.
- ✓ An 'embryo', a living organism embedded in the supporting (or) the food storage tissue and a protective coat.
- ✓ Any propagative material.
- ✓ Miniature plant.
- ✓ Dormant plant
- ✓ Link between two generations
- ✓ Carrier of service material.
- ✓ Generative part of a plant that develop into a new plant.

However, the widely accepted definition for a seed is matured ovule that consisting of an embryonic plant together with a store of food, all surrounded by a protective coat.

### As per Seed Act (1966) seed includes

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

### Differences between seed and grain

SEED	GRAIN
It should be a viable one	Need not be a viable one
It should have maximum genetic & physical purity	Not so
Should satisfy minimum seed certification standards	No such requirements
It should be completely treated with pesticide /fungicide to protect seed against storage pests and fungi	It should never be treated with any chemicals, since used for consumption
Respiration rate and other physiological and biological processes should be kept at low level during storage	No such specifications
Should be compulsorily certified / truthful labelled	No such condition in grain production

Should never be converted into grain unless warranted	Can be converted as seed provided the situation warrants
It should satisfy all the quality norms	Not considered

### **Importance of seed**

Seed is the vital input in crop production because through seed only the investment made on other inputs like pesticide, fertilizer, irrigation and crop maintenance can be realized. The seed required for raising the crop is quite small and its cost is also less compare to other inputs, but the greater income farmer gets depends upon the quality of the small quantity of seed he uses.

In addition to above seed is the basic for the following event of agriculture.

### **A carrier of new technologies**

In India for instance, the cultivation of high yielding varieties have helped to increase food production form 52 million tonnes to more than 200 million tones over a period of 50 years.

### **A basic tool for secured food supply**

The successful implementation of the High Yielding Varieties Programme (HYVP) in India has led to a remarkable increase in production and to a new assessment of future development potential. As a result, food imports from other countries have been substantially brought down inspite of the rapid population increase.

### **The principal means to secure crop yields in less favourable production areas**

The supply of good quality seeds of improved varieties suitable to these areas is one of the few important immediate contribution to secure higher crop yields.

## **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 on these recurrent crises and the accompanying threats of famine and starvation. The establishment of National Seed Reserve Stocks should receive high priority for meeting such natural calamities.

- ⊙ This would provide improved seeds in emergency periods to production areas for rapid production of food grains.
- ⊙ This would supply seeds to disaster regions for resowing, as no seed would normally be available in such regions.

### **SEED QUALITY**

Seed quality is the possession of seed with required genetic and physical purity that is accompanied with physiological soundness and health status.

The major seed quality characters are summarized as below.

#### **1. Physical Quality:**

It is the cleanliness of seed from other seeds, debris, inert matter, diseased seed and insect damaged seed. The seed with physical quality should have uniform size, weight, and colour and should be free from stones, debris, and dust, leaves, twigs, stems, flowers, fruit well without other crop seeds and inert material. It also should be devoid of shriveled, diseased mottled, moulded, discoloured, damaged and empty seeds. The seed should be easily identifiable as a species of specific category of specific species. Lack of this quality character will indirectly influence the field establishment and planting value of seed.

This quality character could be obtained with seed lots by proper cleaning and grading of seed (processing) after collection and before sowing / storage.



## **2. Genetic purity:**

It is the true to type nature of the seed. i.e., the seedling / plant / tree from the seed should resemble its mother in all aspects. This quality character is important for achieving the desired goal of raising the crop either yield or for resistance or for desired quality factors.

## **3. Physiological Quality:**

It is the actual expression of seed in further generation / multiplication. Physiological quality characters of seed comprises of seed germination and seed vigour.

The liveliness of a seed is known as viability. The extent of liveliness for production of good seedling or the ability of seed for production of seedling with normal root and shoot under favorable condition is known as germinability. Seed vigour is the energy or stamina of the seed in producing elite seedling. It is the sum total of all seed attributes that enables its regeneration of under any given conditions. Seed vigour determines the level of performance of seed or seed lot during germination and seedling emergence.

Seed which perform well at sowing are termed as quality seed and based on the degree of performance in production of elite seedling it is classified as high, medium and low vigour seed. The difference in seed vigour is the differential manifestation of the deteriorative process occurring in the seed before the ultimate loss of ability to germinate. Difference in seed vigour will be expressed in rate of emergence, uniformity of emergence and loss of seed germination.

Hence it is understood that all viable seeds need not be germinable but all germinable seed will be viable. Similarly all vigorous seeds will be germinable but all germinable seed need not be vigorous. Physiological quality of seed could be achieved through proper selection of seed (matured seed) used for sowing and by caring for quality characters during extraction, drying and storage.

Seed with good vigour is preferable for raising a good plantation as the fruits, the economic come out are to be realized after several years. Hence selection of seed based on seed vigour is important for raising perfect finalize plantation.

#### **4. Seed Health**

Health status of seed is nothing but the absence of insect infestation and fungal infection, in or on the seed. Seed should not be infected with fungi or infested with insect pests as these will reduce the physiological quality of the seed and also the physical quality of the seed in long term storage. The health status of seed also includes the deterioration status of seed which also expressed through low vigour status of seed. The health status of seed influences the seed quality characters directly and warrants their soundness in seed for the production of elite seedlings at nursery / field.

#### **Hence the quality seed should have**

- ✓ High genetic purity
- ✓ High pure seed percentage ( physical purity)
- ✓ High germinability
- ✓ High vigour
- ✓ Higher field establishment
- ✓ Free from pest and disease
- ✓ Good shape, size, colour etc., according to the specification of variety
- ✓ High longevity / shelf life.
- ✓ Optimum moisture content for storage
- ✓ High market value

#### **Characteristics of good quality seed**

##### **➤ Higher genetically purity:**

Breeder /Nucleus	- 100%
Foundation seed	- 99.5%
Certified seed	- 99.0%

➤ **Higher physical purity for certification**

Maize , Bhendi	99%
All crops ( most)	98%
Carrot	95%
Sesame, soybean &jute	97 %
Ground nut	96 %

- Possession of good shape, size, colour, etc., according to specifications of variety
- Higher physical soundness and weight
- Higher germination ( 90 to 35 % depending on the crop)
- Higher physiological vigour and stamina
- Higher storage capacity
- **Free from other crop seeds ( Expressed in number /kg)**

<b>Crop</b>	<b>Designated inseparable other crop seeds</b>
Barley	Wheat ,oats & gram
Oats	Wheat ,gram & barley
Wheat	Oats, gram & barley

Other crop seeds are the plants of cultivated crops found in the seed field and whose seed are so similar to crop seed that is difficult to separate them economically by mechanical means. Cause physical admixture with the crop seed only when these crop mature approximately at the same time when seed crop matures.

➤ **It should be free from objectionable weed seeds**

These are plants of weed species which are harmful in one or more of the following ways.

- ✓ The size and shape of their seeds are so similar to that of the crop seed that is difficult to remove their seed economically by mechanical means.
- ✓ Their growth habit is detrimental to the growing seed crop due to competing effect.
- ✓ Their plant parts are poisonous or injurious to human and animal beings
- ✓ They serve as alternate hosts for crop pests and diseases.

**Objectionable Weeds of Seed Crop Plants**

<b>Crop</b>	<b>Objectionable weeds</b>
Berseem	Chicory( <i>Chicorium intybus</i> )
Cucurbits	Wild Cucurbita sp.
Kasuri methi	Melilous sp.
Lettuce	Wild lettuce( <i>Lactuca sativa</i> )
Bhendi	Wild Abelmoschus sp
Rape & Mustard	<i>Argemone mexicana</i>
Wheat	<i>Convolvulus arvensis</i> (Hiran kuri)
Paddy	Wild paddy ( <i>Oryza sativa</i> var. Fatua)

➤ **It should be free from designated diseases**

It refers to the diseases specified for the certification of seeds and for which certification standards are to be met with. These diseases would cause contamination, when they are present in the seed field or within the specified isolation distance ( eg. loose smut of wheat). For this the certification distance has been prescribed as 180 meters.

<b>Crop</b>	<b>Designated disease</b>	<b>Causal organism</b>
Wheat	Loose smut	<i>Ustilago tritici</i>
Sorghum	Grain smut Kernel smut	<i>Sphacelotheca sorghii</i>
Mustard	Alternaria blight	<i>Alternaria sp</i>
Pearl millet	Grain smut Green ear Ergot	<i>Tolyposporium penicillariae</i> <i>Sclerospora graminicola</i> <i>Claviceps microcephala</i>
Sesame	Leaf spot	<i>Alternaria sp</i>
Brinjal	Little leaf	Datura virus 2
Chillies	Anthraco nose leaf blight Leaf blight	<i>Gloesporium piperatum</i> <i>Alternaria solani</i>
Cucurbits	Mosaic	<i>Cucumis virus</i>
Cowpea	Anthraco nose	<i>Colletotricum sp</i>
Bhendi	Yellow vein mosaic	Hibiscus virus 1
Potato	Brown rot Root knot nematode	<i>Pseudomonas solanacearum</i> <i>Meloidogyne incognita</i>
Tomato	Early blight Leaf spot	<i>Alternaria solani</i> <i>Xanthomonas vesicatoria</i>

➤ **It should have optimum moisture content for storage**

Long term storage - 6 - 8 %

Short term storage - 10-13%

➤ **It should have high market value**

**Role of good quality seed**

Therefore at most care must be given upon the use of quality seed and thus certification guarantees quality and ensures high and assured yield under environmental stress conditions. This emphasizes the need for increasing the area under quality seed production. So one has to take efforts to produce quality seed and boost the yield by seed to seed seedling concept.

**Significance of quality seed**

- Ensures genetic and physical purity of the crops
- Gives desired plant population
- Capacity to withstand the adverse conditions
- Seedlings produced will be more vigorous, fast growing and can resist pest and disease incidence to certain extent
- Ensures uniform growth and maturity
- Development of root system will be more efficient that aids absorption of nutrients efficiently and result in higher yield.
- It will respond well to added fertilizer and other inputs.
- Good quality seeds of improved varieties ensures higher yield atleast 10 – 12 %

**SEED AND ITS MULTIPLICATION**

**Seed multiplication ratio**

It is the ratio of seed yield per seed generation i.e. many seeds are produced from a single seed.



### **Seed renewal period**

Seeds undergo genetic deterioration on continuous usage for reproduction, due to the developmental variation, mechanical mixture mutation, natural crossing, minor genetic variation, selective influence of pest and disease and techniques of plant breeder. Hence some seed should be used for multiplication continuously. Hence selectively multiplied seed should be used after certain generation, i.e. seed should be renewed after certain generations adopting generation systems.

### **Seed replacement rate**

Seed replacement rate is the quantity of quality seed that have replaced the actual seed requirement of the location that are normally produced by the farmer using their own seed.

$$\text{SRR} = \frac{x}{y} \times 100$$

Where x = Quantity of actual quality seed sown / used in an area / location

Y = Quantity of quality seed (certified) required for the entire production area / location

This replacement rate can give an idea on how much certified (quality) seed is being used. The seed replacement rate in India is around 15 – 20% which may vary with crop varieties. However it will be 100% for hybrid seeds. This SRR give an idea on how much certified seed is being used as a base seed for production of crops by farmers which will indirectly stresses or expose the requirement of quality seed for further production.

### **Generation system**

In seed production as per Seed Act and Rules seeds are multiplied in definite system which is known as generation system of seed production. It involves three stages of multiplication known as Breeder seed, Foundation seed and certified seed. This generation system can be altered depending on pollination behaviour and demand if warranted.

## Multiplication ratios and seed multiplication stages

S.No	Seed crop	Multiplication ratio	Seed renewal period (times)	Seed multiplication stages		
				BS	FS	CS
1.	Paddy	152	4	1	1	2
2.	Wheat	49	4	1	1	2
3.	Barley	26	4	1	1	2
4.	Maize hybrid	248	1	1	1	1
5.	Maize variety	115	3	1	1	1
6.	Jowar hybrid	179	1	1	1	1
7.	Jowar variety	94	3	1	1	1
8.	Bajra hybrid	380	1	1	1	1
9.	Bajra variety	175	3	1	1	1
10.	Ragi	420	4	1	1	2
11.	Gram & Peas	24	3	1	1	2
12.	Pigeon peas	150	3	1	1	1
13.	Other pulses	125	3	1	1	1
14.	Groundnut	18	5	1	2	2
15.	Brassicas	200	3	1	1	1
16.	Sesamum	200	3	1	1	1
17.	Linseed	42	4	1	1	2
18.	Other oil crops	(73-100)	3	1	1	1
19.	Cotton	46	3	1	1	1
20.	Jute	120	3	1	1	1
21.	Fodder	75	3	1	1	1

## **CLASSES OF SEED**

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### **Breeder seed**

The seed or vegetatively propagated material directly controlled by the originating or the sponsoring breeder or institution which is the basic seed for recurring increase of foundation seed.

### **Foundation seed**

It is the progeny of breeder seed. The seed stock handled to maintain specific identity and genetic purity, which may be designated or distributed and produced under careful supervision of an agricultural experiment station. This seed is the source of all other certified seed classes either directly or through registered seed.

### **Registered seed**

The progeny of the foundation seed so handled as to maintain its genetic identity and purity and approved and certified by a certifying agency. It should be of quality suitable to produce certified seed.

### **Certified seed**

It is the progeny of the foundation seed. Its production is so handled to maintain genetical identity and physical purity according to standards specified for the crop being certified. It should have the minimum genetical purity of 99%. Certified seed may be the progeny of certified seed, provided this reproduction does not exceed two generations beyond foundation seed and provided that if certification agency determines the genetic and physical purity, it not be significantly altered. In case of highly self pollinated crops certification of one further generation may be permitted. Certified seed produced from certified seed shall be eligible for further seed increase under certification, except in case of highly self-pollinated crops, where certification of one further generation may be permitted. Certification tags

issued once for certified seed not eligible for further seed increase under certification.

- For paddy and wheat , certified seed produced from certified seed is eligible for certification by NSC up to two generations from foundation seed

Foundation seed - Certified seed (I) - Certified seed (II)

- For barley, garden pea ,ground nut, soyabean, certified seed produced from certified seed is eligible for certification up to 3 generations from foundation seed

Foundation seed - Certified seed (I) - Certified seed (II) - Certified seed (III)

Certification of certified seed produced from certified seed is not permitted for crops other than those listed above.

### **Differences between certified seed and truthful labelled seed**

<b>Certified seed</b>	<b>Truthful labelled seed</b>
Certification is voluntary	Truthful labelling is compulsory for notified kind of varieties
Applicable to notified kinds only	Applicable to both notified and released varieties
It should satisfy both minimum field and seed standards	Tested for physical purity and germination
Seed certification officer ,seed inspectors can take samples for inspection	Seed inspectors alone can take samples for checking the seed quality.

## GENERATION SYSTEM OF SEED MULTIPLICATION

### Generation system of seed multiplication

Generation system of seed multiplication is nothing but the production of a particular class of seed from specific class of seed up to certified seed stage. The choice of a proper seed multiplication model is the key to further success of a seed programme. This basically depends upon

- The rate of genetic deterioration
- Seed multiplication ratio and
- Total seed demand

Based on these factors different seed multiplication models may be derived for each crop and the seed multiplication agency should decide how quickly the farmers can be supplied with the seed of newly released varieties, after the nucleus seed stock has been handed over to the concerned agency, so that it may replace the old varieties. In view of the basic factors, the chain of seed multiplication models could be.,

#### a. Three - Generation model

Breeder seed - Foundation seed - Certified seed

#### b. Four - Generation model

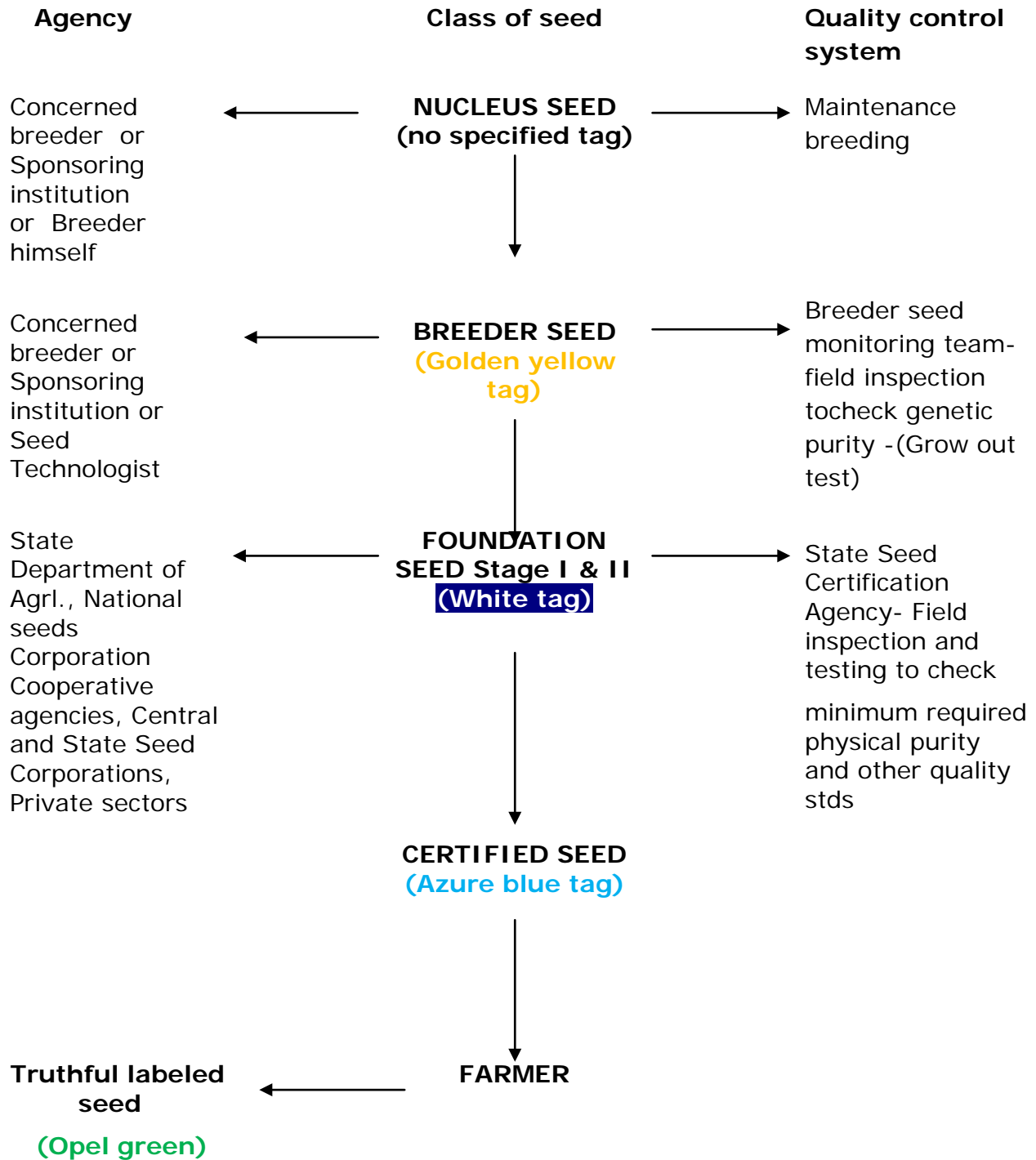
Breeder seed - Foundation seed (I) Foundation seed (II) - Certified seed

#### c. Five - Generation model

Breeder seed - Foundation seed (I)- Foundation seed (II) -Certified seed (I) - Certified seed (II)

For most of the often cross pollinated and cross pollinated crops 3 & 4 generation models is usually suggested for seed multiplication. **Ex:** Castor, Redgram, Jute, Greengram, Rape, Mustard, Sesame, Sunflower and most of the vegetable crops.

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





## **Nucleus and Breeders seed production**

The initial handful of seeds obtained from selected individual plants of a particular variety, for the purposes purifying and maintaining that variety by the originating plant breeder and its further multiplication under his own supervision, or the supervision of a qualified plant breeder, to provide Breeder's Seed constitutes the basis for all further seed production. The varietal purity of subsequently multiplied foundation, registered and certified seed largely depend upon the quality of the nucleus/breeder's seed. Unless the nucleus/ breeder's seed is of highest purity and quality the seed multiplied from it cannot be regarded as of satisfactory genetic purity. Unsatisfactory genetic purity, especially in cross pollinated crops, could ultimately severely affect the performance of a variety. It is therefore, of utmost importance that the nucleus/breeder's seed is produced in such a manner that satisfactory genetic purity, identity and the other good qualities of seed are maintained.

### **Methods of maintenance of nucleus and breeder's seed in self fertilized crops**

Methods of maintaining nucleus seed/breeder's can be conveniently divided into the following two groups:

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

### **Maintenance of Nucleus Seed of Pre-released or Newly Released Varieties**

The procedure outlined by Harrington (1952) for the maintenance of nucleus seed of pre-released or newly released varieties is described below:

- a. Sampling of the variety to obtain nucleus seed. New numbers, lines or selection which are highly promising, on the basis of performance in breeding nurseries and yield trials, should be sampled for seed purification. These samples provide a beginning for purifying new varieties and for possible

increase and distribution to farmers. Not more than fifteen new varieties in any one crop at a station should be sampled in one year.

- b. Table examination of samples: The two hundred plants of each sample should be threshed separately and the seed should be examined in piles on the table. Discard any pile appearing obviously off type, diseased or otherwise unacceptable. The seeds of each two hundred plant samples or less is now ready to be sown in a variety purification nursery called as nucleus.
- c. Locating and seeding of nucleus: Each nucleus seed should be grown on clean fertile land at an experiment station in the region or in area in which this new variety could be grown, in the event of its release. The land must not have had a crop of the same kind in the previous year.
- d. Inspection of nucleus two-row plots and removal of off types: Throughout the season of growth, from the seedling stage until maturity, the nucleus plot should be examined critically. Differences in the habit of early plant growth, leaf colour, rate of growth, time of heading, height head characteristics and diseases reactions should be looked for. If a plot differs distinctly from the average in the preheading stages of growth, it should be removed before heading.
- e. Harvesting and threshing of nucleus; each remaining plot, of which there should be at least 180 out of the original 200. Should be harvested individually with a sickle and tied in a bundle. The total bundles of each nucleus should be labelled and stored until the current years yield rests for trials are obtained. The nucleus bundles of any new variety should be discarded, if it is found unworthy of being continued.

Later the seed should be cleaned in a fanning mill or by hand methods, the grain from each nucleus plot being placed in a pile on the seed table. The 180 or more piles of seed of one nucleus must be examined for approximate uniformity of seed appearance, and any pile, which appears to be off type discarded. All the remaining piles of the seed should be masked together in one lot. This should be treated with fungicide and insecticide, bagged, labelled and stored as "Breeder's

Stock Seed" for use in the next year. Breeder's stock seed is the original purified seed stock of a new variety in the hands of the plant breeders.

### **Maintenance of Breeder's Seed of Pre-released or Newly Released Varieties**

The following steps are involved in the maintenance of breeder's seed.

- a. Breeder's stock seed from the nucleus should be sown on the clean, fertile land, which did not grow a crop of the same kind in the previous year. The space required for the seeding the breeder's stock is about 1.2 ha in the case of wheat and as much as 3 ha in the case of transplanted rice.
- b. The field should properly isolated.
- c. The best farm procedures should be used in the sowing, raising and harvesting of breeder's stock.
- d. It should be produced at the experiment station in the area in which the new variety has been bred.
- e. The seeding should be done in such a way as to make the best use of the limited amount of seed available and to facilitate roguing. The row spacing should be sufficient to permit examination of plants in rows for possible mixture or off types.
- f. Roguing: All plants not typical of the variety should be pulled and removed. There should be very few plants to rogue out if the previous years nucleus breeder's stock seed was well protected from natural crossing and careful roguing was done and there were no impurities during cleaning etc. The roguing should be done before flowering, as was done for the nucleus/breeder's stock seed.
- g. Harvesting the breeder's stock: In the breeder's stock is harvested and threshed, the equipment used must be scrupulously clean and free from seeds of any other varieties. This cleanliness should be extended to cards and bags as well as threshing machine it self. The seed should now be about 99.9 per cent pure as to variety. These breeder's seed is ready now for increase of foundation seed. A portion of this breeder's seed should be retained by the breeders to sown a continuation breeders seed of the variety.

## **Maintenance of breeder's seed of established varieties**

The breeder's seed of established varieties could be maintained satisfactorily by any one of the following methods

**a) By raising the crop in isolation:** The breeder's seed of local varieties could be maintained by growing them in isolated plots and by very rigorous roguing during various stages of crop growth, where the various plant characters are observable. The method of handling the breeder seed crop is the same as described earlier for breeder's seed of newly released varieties.

**b) By bulk selection:** The genetic purity of established varieties could be satisfactorily improved by bulk selection. In this method 2,000 to 2,500 plants typical of the variety are selected, harvested, and threshed separately. The seeds from each plant are examined and any pile which shows any obvious off-types, or otherwise appears dissimilar, are discarded. The remaining piles of seed are bulked to constitute the breeder's seed. The other practices of handling remains the same.

## **Carry-over Seed**

The breeder must carry-over at least enough seed to safeguard against, the loss of variety if there is a complete failure during the foundation seed multiplication phase. In addition, the breeder should further safeguard variety by arranging to have a portion of the seed originally released stored under the ideal conditions.

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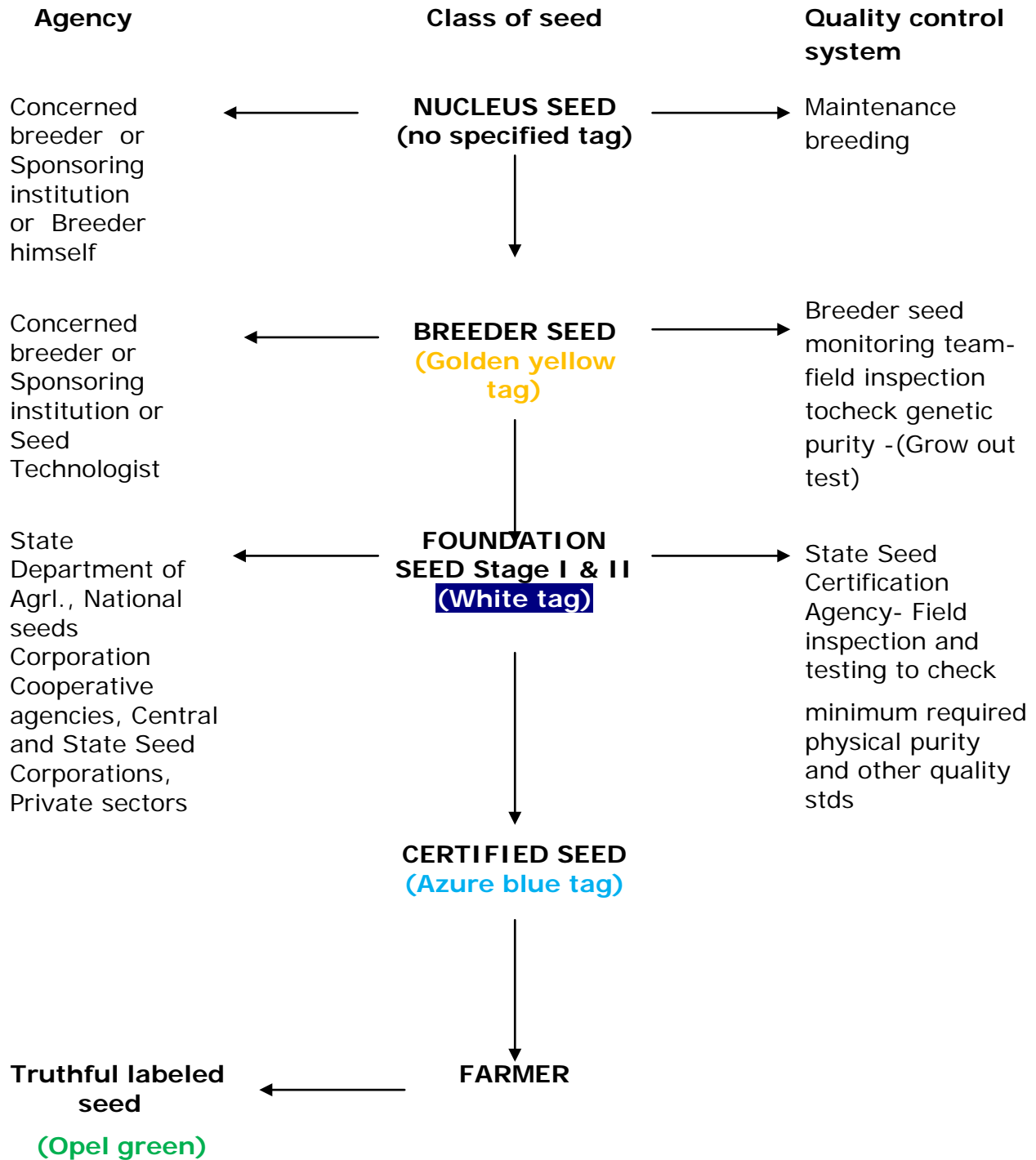
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## **SEED POLICY**

### **National Seed Policy, 2002**

[The Seed Act, 1966](#), seed control order 1983 and New Policy on Seeds Development, 1988, from the basis of promotion and regulation of the Indian Seed Industry.

[The "New Seed Policy" of 1988](#) ushered in a new area of growth and phenomenal development. Because, it allowed limited import of commercial seed, remove curbs on imports of seeds of vegetables, flowers and ornamental plants and even allowed import of seed of coarse cereals, pulses and oilseeds for a period of two years.

The important constraints were

- Non existence of National Seed Policy
- IPR laws
- Restrictions and licenses on seed exports and imports
- Lack of incentives for the public and private seed sectors of the country

India later developed the National Seed Policy in 2002. The main objectives are the provision of an appropriate climate for the seed industry to utilize available and prospective opportunities, safe guarding of the interests of Indian farmers and the conservation of agro-biodiversity.

### **Thrust Areas**

1. Varietal Development and PVP
2. Seed Production
3. Quality Assurance
4. Seed Distribution and Marketing.
5. Infrastructure facilities
6. Transgenic Plant Varieties
7. Import of seeds and planting material
8. Export of seeds

9. Promotion of Domestic Seed
10. Strengthening of monitoring system

## **1. Varietal Development and PVP**

To stimulate investment in research and development (R&D) new varieties an effective *sui generis* system for IPR will be implemented.

- Establishment of PVPFRA (Plant Varieties Protection and Farmers Rights Authority, to implement [PVPFR Act, 2001](#).
- Under this Act, Plant Varieties will be registered based on Novelty, Distinctness, Uniformity and Stability (DUS) characters.
- Farmers Rights: Farmers can save, use, exchange, share or sell seeds of protected variety but not under the brand name.
- Researchers Rights: Seed / planting material of protected varieties can be used for research and breeding new varieties.
- Breeders Rights: Benefit arising out of use of varieties upon commercialization of seeds of new variety, will be shared with the respective breeder.
- Community Rights: Benefit sharing with Farmers / Village communities will be ensured for contributing in evaluation of plant variety upon registration.

## **2. Seed Production**

India seed programme will adhere to generation system of multiplication namely nucleus, breeder, foundation and certified seed.

Public seed sector will be restructured and will continue to have free access to breeder seed, while Private Seed Sector will have conditional access. Seed village scheme will be facilitated to upgrade the quality of farmers saved seeds.

Seed Replacement will be raised progressively, National Seed Map will be prepared to identify potential areas of seed production, seed banks will be established with cold storage facilities, seed minikits will be supplied for popularizing new varieties and will Seed Crop Insurance will be encouraged.

### **3. Quality Assurance**

1. New Seed Act will be enacted.
2. National Seed Board will be established as apex body in place of existing Central Seed Committee to implement New Seed Act.
3. National Seeds Register will be maintained varieties will be registered based on "Value for Cultivation and Usage". (VCU).
4. Farmers will retain rights to save, use, exchange, share or sell seeds of any variety but not under the brand name.

### **4. Seed Distribution and Marketing.**

1. Seed Distribution and Marketing of any variety will be subject to registry in NSB.
2. National Seed Grid will be established as a data base on seed requirement, production, distribution and farmers preference.
3. Access to finance from commercial banks will be facilitated.
4. Availability of high quality seed will be ensured through improved distribution system and efficient marketing set up.

### **5. Infrastructure facilities**

1. National Seed Research and Training center (NSRTC) will be set up.
2. Seed processing and storage faculties will be augmented.
3. Computerized National Seed Grid will be established to provide information on seeds marketing.

### **6. Transgenic Plant Varieties**

1. All GM crops will be tested for environment and bio safety before commercial release as per EPA (1986).
2. Seeds of GM crops will be imported only through NBPGR as per the EPA (1986).
3. Required infrastructure will be developed for testing, identification and evaluation of transgenic planting material.

## **7. Import of seeds and planting material**

Provision will be made to make available best planting material from anywhere in the world to Indian farmers without any compromise on quarantine requirements.

## **8. Export of seeds**

1. Long term policy will be evolved to exploit varied agro climatic condition of India and strong seed production system, to raise seed export from present level of less than 1% to 10% by 2020.
2. Seed export promotion zones will be established and strengthened.
3. Data Bank on International Market will be created.

## **9. Promotion of Domestic Seed Industry**

It will be facilitated by providing incentives to domestic seed industry, financial support through NABARD, commercial and co-operative banks, considering tax rebate / concessions for R&D, reduction of import duty on machines and equipment used for seed production and encouragement of membership in National and International organization related to seed.

## **10. Strengthening of monitoring system**

Strengthening of Department of Agriculture and Co-operation (DAC) will supervise the implementation of National Seed Policy.



National Seed Policy will be vital in doubling food production of India

## **SEED DEMAND FORECASTING AND PLANNING FOR CERTIFIED, FOUNDATION AND BREEDER SEED PRODUCTION**

### **Demand Forecasting of seed**

In adequate estimation of demand and the consequences of over production or under production can cause serious financial consequences for a seed company. Too many carryovers and stock write-offs will prove to be expensive, while lack of seed means a loss of revenue and a source of frustration for the sales force and the dealer network. This combination of special features in the seed industry makes the accurate assessment of demand even more critical. Some of these features are

- Longer period of time for the development new products from breeding programmes
- Seasonality of production
- Production subject to variables like agro climatic conditions outside the control of management
- Statutory controls and quality standards
- Existence of a generation system – where by the production in one year is the progenitor the next
- Limited shelf life and loss of germination
- Seed replacement rate: Seed Replacement Rate is the rate at which the farmers replace the seeds instead of using their own seeds

### **Seed Replacement Rate of Select Crops : 2005-06**

<b>Crop</b>	<b>SRR (%)</b>
Paddy	17
Milletss	7
Pulses	12.5
Cottton - Rainfed /Irrigated	10/15
Groundnut	5
Gingelly	15

Sunflower	50
Castor	30
Soyabean	20

*Source: Narrative notes on Plan Programme-2005-06, S.P.C, ,Chennai.*

In demand forecasting the first step is to calculate the existing requirement multiplied by percent bought seed, which is the amount of commercial seed purchased by farmers. In calculating seed requirement, seed multiplication rates must be taken into account. Seed Multiplication Ratio is the ratio at which the seed multiplies.

In the present Indian scenario, seed production can be taken up as a small-scale industry or it can be taken up as under contract for the other seed companies. In either way, seed production has huge potential to ensure better returns.

### **Factors which affect demand**

It is important to distinguish between actual demand, perceived demand and what the government expects the farmers to buy. The total amount of certified or labelled seed sold may be quite a small proportion of the total requirement.

Many factors have to be considered while assessing and forecasting demand. Some of these are:

- Cropping pattern and intensity
- Type of seed used
- Climate
- Demand for crop products
- Market scenario
- Disposable farm income
- Rate or level of adoption of new technology
- Government policy
- Crop cycles
- Habits and tradition
- Product performance

- Competitiveness
- Price
- Promotion

The most important factors that need to be taken into account when an individual company or organization is estimating the market share that may be gained by its own products are product performance, competitive positioning, price and promotion. This will form the basis of sales forecasting and production planning.

### **Demand forecasting techniques**

Forecasting is the process of making projections of demand for products by examining past and present performance levels, combined with an assessment of available products and markets. This may be carried out within the government service or by individual companies in a purely commercial context. The following approaches can be used:

**Target setting:** This method is commonly used in developing countries where government is directly involved in planning and seed supply. In a centrally managed economy, targets are likely to be set at a national level and production plans fixed for each region.

India is an example of a more open economy where both the public and private sectors coexist in a well-developed seed industry, but where the government retains a coordinating function and has the ultimate responsibility for the security of seed supply. The Ministry of Agriculture sets the targets and organizes meetings to establish the supply situation and production plans of the various organizations involved.

Companies may opt to set a target for an ideal sales level while, at the same time, recognizing that this is unlikely to be achieved and budgeting for a more achievable situation.

**Growth trends:** This approach is based on the assumption that the rate of growth of seed demand as seen in past years will continue. This may give unrealistically high forecasts and will depend on the stage of market development for improved seeds. Small increases in volume in the early stages of improved seed use will represent a large increase in percentage terms, which may not be possible to sustain.

**Growth rates adjusted for new technology adoption:** Using this approach a given region is considered on the basis of degrees of new technology uptake and the likely speed of change. Each part of the region can then be categorized as 'low' to 'medium' or 'high' growth, better reflecting the overall situation.

**Sampling:** The accuracy of the above approaches can be improved if sample groups of farmers are questioned to gauge their anticipated demand for seed. This exercise is more reliable where there is a reasonable awareness of the benefits of using improved seeds.

## **SEED PRODUCTION**

To meet the Nation's food security needs, it is important to make available to Indian farmers a wide range of seeds of superior quality, in adequate quantity on a timely basis. Public Sector Seed Institutions will be encouraged to enhance production of seed towards meeting the objective of food and nutritional security. The Indian seed programme adheres to the limited three generation system of seed multiplication, namely, breeder, foundation and certified seed. Breeder seed is the progeny of nucleus seed.

- Nucleus seed is the seed produced by the breeder to develop the particular variety and is directly used for multiplication as breeder seed.
- Breeder seed is the seed material directly controlled by the originating or the sponsoring breeder or Institution for the initial and recurring production of foundation seed.

- Foundation seed is the progeny of breeder seed. Foundation seed may also be produced from foundation seed. Production of foundation seed stage-I and stage-II may thus be permitted, if supervised and approved by the Certification Agency and if the production process is so handled as to maintain specific genetic purity and identity.
- Certified seed is the progeny of foundation seed or the progeny of certified seed. If the certified seed is the progeny of certified seed, then this reproduction will not exceed three generations beyond foundation stage-I and it will be ascertained by the Certification Agency that genetic identity and genetic purity has not been significantly altered.

Public Sector Seed Production Agencies will continue to have free access to breeder seed under the National Agriculture Research System. The State Farms Corporation of India and National Seeds Corporation will be restructured to make productive use of these organisations in the planned growth of the Seed Sector.

Private Seed Production Agencies will also have access to breeder seed subject to terms and conditions to be decided by Government of India.

State Agriculture Universities/ICAR Institutes will have the primary responsibility for production of breeder seed as per the requirements of the respective States.

Special attention will be given to the need to upgrade the quality of farmers' saved seeds through interventions such as the Seed Village Scheme.

Seed replacement rates will be raised progressively with the objective of expanding the use of quality seeds.

DAC, in consultation with ICAR and States, will prepare a National Seed Map to identify potential, alternative and non-traditional areas for seed production of specific crops.

To put in place an effective seed production programme, each State will undertake advance planning and prepare a perspective plan for seed production and distribution over a rolling (five to six year) period. Seed Banks will be set up in nontraditional areas to meet demands for seeds during natural calamities.

The 'Seed Village Scheme' will be promoted to facilitate production and timely availability of seed of desired crops/varieties at the local level. Special emphasis will be given to seed multiplication for building adequate stocks of certified/quality seeds by providing foundation seed to farmers.

For popularising newly developed varieties and promoting seed production of these varieties, seed minikits of pioneering seed varieties will be supplied to farmers. Seed exchange among farmers and seed producers will be encouraged to popularize new/non-traditional varieties.

Seeds of newly developed varieties must be made available to farmers with minimum time gap. Seed producing agencies will be encouraged to tie up with Research Institutions for popularization and commercialization of these varieties.

As hybrids have the potential to improve plant vigour and increase yield, support for production of hybrid seed will be provided.

Seed production will be extended to agro-climatic zones which are outside the traditional seed growing areas, in order to avoid unremunerative seed farming in unsuitable areas.

Seed Banks will be established for stocking specified quantities of seed of required crops/varieties for ensuring timely and adequate supply of seeds to farmers during adverse situations such as natural calamities, shortfalls in production, etc. Seed Banks will be suitably strengthened with cold storage and pest control facilities.

The storage of seed at the village level will be encouraged to facilitate immediate availability of seeds in the event of natural calamities and unforeseen situations. For the storage of seeds at farm level, scientific storage structures will be popularized and techniques of scientific storage of seeds will be promoted among farmers as an extension practice.

Seed growers will be encouraged to avail of Seed Crop Insurance to cover risk factors involved in production of seeds. The Seed Crop Insurance Scheme will be reviewed so as to provide effective risk cover to seed producers and will be extended to all traditional and non-traditional areas covered under the seed production programme.

### **Recommended System of Breeder Seed Indent and Supply**

1. Every State shall provide the agro-climatic zone-wise, district-wise and variety-wise quantity of certified/quality seeds sold and area covered in the previous Kharif/Rabi season along with SRR, productivity data to ICAR, DAC and SAUs by ***1st December for Kharif crops and 1st May for Rabi crops.***

2. ICAR shall prepare and circulate a list of State/area/agro-climatic zone-specific recommended varieties/hybrids of seeds particularly the newly released varieties/hybrids for cultivation along with relevant data regarding their yield potential, duration etc. to every State on or before ***1st January for Kharif crops and 1st June for Rabi Crops*** with copy to Seed Division, DAC.

3. SAUs shall do a similar exercise in respect of State varieties.

4. Each State in consultation with ICAR Institutes, SAUs and Seed producing Agencies shall formulate seed plan (for Breeder, Foundation and Certified Seed) for the cropping seasons on the basis of an assessment of existing and new varieties in terms of actual or potential yield in each district/agro-climatic zone.



5. State Governments shall submit the seed plan and the Breeder Seeds indent to DAC, ICAR, SAUs. The Breeder Seed Indent shall be submitted to the SAUs directly for State varieties and submitted to Seeds Division DAC/ICAR for national varieties by **15th January for Kharif crops and 15th June for Rabi crops.**

6. Private seed companies will also place the breeder seed indent by **15th January for Kharif crops and 15th June for Rabi** crops through National Seeds Association of India (NSAI) to Seeds Division, DAC.

7. DAC shall compile all the Breeder Seed Indents of States and private seed companies and furnish them to ICAR/ concerned PDs/PCs for production of the breeder seeds.

8. The breeder seed will be allotted to all States and private seed companies for lifting from institutes of ICAR, SAUs to produce foundation and certified seed.

9. The Lifting of Breeder Seed is to be monitored every 15 days jointly by DAC and ICAR.

10. To popularise new varieties and to induce confidence among the farmers apart from Front Line Demonstrations (FLDs), each ICAR centre, SAU and KVK shall adopt 1-2 villages in a block in an agroclimatic zone of the State for demonstration in participatory mode in the farmers fields to demonstrate the productivity/potential of the new variety with an appropriate mix of inputs and practices. State Government extension staff willfully participates in the finalisation plan of FLDs-list of farmers training etc.

11. In case of hybrids of important food crops such as paddy hybrids the State Agriculture Universities shall take the responsibility in large scale production of Pure high quality parental lines (A Lines, R Lines) (Breeder and foundation seed). It would be ensured that NSC, SFCI, State Seeds Corporations will procure the foundation seeds on priority.

12. SAUs shall provide foundation seed to all State Seed Corporations, State Seed Farms, NSC, SFCI and Private Seed Companies for taking up large scale hybrid seed production and make it available to farmers at affordable prices. SAUs may also take up large-scale hybrid seed production in their Farms.

## **Deterioration of Crop Varieties – Causes and Maintenance**

### **Deterioration of Genetic Purity**

The genetic purity of a variety or trueness to its type deteriorates due to several factors during the production cycles. Kadam (1942) listed the following important factors responsible for deterioration of varieties.

1. Developmental variations
2. Mechanical mixtures
3. Mutations
4. Natural crossing
5. Minor genetic variations
6. Selected influence of pest and diseases
7. The techniques of the plant breeder

#### **1. Developmental Variations**

When seed crops are grown under environments with differing soil fertility, climate, photoperiods, or at different elevations for several consecutive generation's developmental variations may set in as differential growth responses.

It is therefore, preferred to grow the varieties of crops in the areas of their natural adaptation to minimize developmental shifts.

#### **2. Mechanical Mixtures**

Mechanical mixtures, the most important reason for varietal deterioration, often take place at the time of sowing if more than one variety is sown with the same seed drill, through volunteer plants of the same crop in the seed field, or through different varieties grown in adjacent fields. Two varieties growing next to each other field is usually mixed during harvesting and threshing operations. The threshing equipment is often contaminated with seeds of other varieties. Similarly, the gunny bags, seed bins and elevators are also often contaminate, adding to the mechanical mixtures of varieties.

Roguing the seed fields critically and using utmost care during seed production and processing are necessary to avoid such mechanical contamination.

### **3. Mutations**

Mutations do not seriously deteriorate varieties. It is often difficult to identify or detect minor mutations occurring naturally. Mutants such as, 'fatuoids' in oats or 'rabbit ear' in peas may be removed by roguing from seed plots to purify the seeds.

### **4. Natural Crossing**

Natural crossing can be an important source of varietal deterioration in sexually propagated crops. The extent of contamination depends upon the magnitude of natural cross-fertilization. The deterioration sets in due to natural crossing with undesirable types, diseased plants or off types. In self-fertilized crops, natural crossing is not a serious source of contamination unless variety is male sterile and is grown in close proximity with other varieties. The natural crossing, however, can be major source of contamination due to natural crossing are the breeding system of the species, isolation distance, varietal mass and pollinating agent. The direction of prevailing winds, the numbers of insects present and their activity and mass of varieties are also important considerations in contamination by natural crossing.

The isolation of seed crops is the most important factor in avoiding contamination of the cross-fertilized crops.

### **5. Minor Genetic Variations**

Minor genetic variations can occur even in varieties appearing phenotypically uniform and homogenous when released. The variations may lost during later production cycles owing to selective elimination by the nature. The yield trials of lines propagated from plants of breeder's seed to maintain the purity of self-pollinated crop varieties can overcome these minor variations. Due care during the maintenance of nucleus and breeder's seed of cross-fertilized varieties of crop is necessary.

## **6. Selected Influence of Pest and Diseases**

New crop varieties often are susceptible to newer races of pests and diseases caused by obligate parasites and thus selectively influence deterioration. The vegetatively propagated stock also can deteriorate quickly if infected by virus, fungi or bacteria. Seed production under strict disease free conditions is therefore essential.

## **7. The Techniques of the Plant Breeder:**

Serious instabilities may occur in varieties owing to cytogenetic irregularities in the form of improper assessments in the release of new varieties. Premature release of varieties, still segregating for resistance and susceptibility to diseases or other factors can cause significant deterioration of varieties. This failure can be attributed to the variety testing programme.

In addition to these factors, other heritable variations due to recombination's and polyploidisation may also take place in varieties during seed production, which can be avoided by periodical selection during maintenance of the seed stock.

### **Maintenance of Genetic Purity during seed Production**

The various steps suggested, to **maintain varietal purity**, are as follows.

- a. Use of approved seed only in seed multiplication.
- b. Inspection and approval of fields prior to planting.
- c. Field inspection and approval of growing crops at critical stages for verification of genetic purity, detection of mixtures, weeds, and for freedom from noxious weeds and seed borne diseases etc.
- d. Sampling and sealing of cleaned lots
- e. Growing of samples of potentially approved stocks for comparison with authentic stocks.

The various steps suggested for **maintaining genetic purity** are as follows:

- a. Providing adequate isolation to prevent contamination by natural crossing or mechanical mixtures
- b. Rouging of seed fields prior to the stage at which they could contaminate the seed crop.
- c. Periodic testing of varieties for genetic purity.
- d. Avoiding genetic shifts by growing crops in areas in their adaptation only.
- e. Certification of seed crops to maintain genetic purity and quality of seed.
- f. Adopting the generation system.
- g. Grow out tests.

### **Genetic Purity Maintenance in [Hybrid Seeds](#)**

Maintenance of the genetic purity of hybrid seeds is a complicated one requiring elaborate procedures.

### **Nucleus Seed of [Inbred Lines](#)**

- The nucleus seed of inbred lines can be maintained by self pollination, sib-pollination, or a combination of the two procedures (hand pollination).
- Some breeders prefer 'sibbing" because it maintains vigour. "[Selfing](#)" is used to stabilize inbred lines if a change in breeding behavior is noticed.
- Some parental material is preferably maintained by alternate selfing and sibbing from one generation to other.
- Individually selfed or sibbed ears should be examined critically, discarding off types or inferior characteristics (texture, colour, seed size, chaff color and shape of earhead).
- The uniform ears are then threshed separately and planted in ear to row method to easily detect and discard off types from individual ears if any.
- Alternatively all of the ears from an individual inbred line may be composited for bulk planting in the next season.
- The hand pollination seed is sown on clean, fertile soil having no previous crop of the same kind or variety during the previous year (bearing maize).

- It is rather important to ensure that the crop is well isolated, with the requirement varying from crop to crop and depending upon the nature of the material to be protected by isolation, the nature of the contaminant, and the direction of the prevailing wind.
- The isolation can be achieved either by distance or by time (maize). The inbred line may be composited for bulk planting in the next season.
- Maintenance of genetic purity in inbred lines through hand pollination and adequate isolation alone is not enough to achieve perfection.
- The isolated fields must be critically rogued for off types and other impure types prior to the shedding of pollen.
- The nucleus seed crop is harvested after physiological maturity if artificial drying facilities exist.
- Ear to harvest lines are harvested separately and piled; These are again critically examined for ear characteristics, sorting out of all off-coloured, diseased, or otherwise undesirable ears.
- If the overall percentage of off types exceeds 0.1%, hand pollination should be repeated to produce the second year's breeders seed.
- The uniform ears are bulked, dried in a clean dry bin at temperatures not exceeding 43°C, shelled, cleaned, treated with pesticides, and stored under ideal storage conditions as breeder stock seed. This seed may be increased during the following season by paying adequate attention to isolation, roguing, etc., to maintain high genetic purity of the seed.

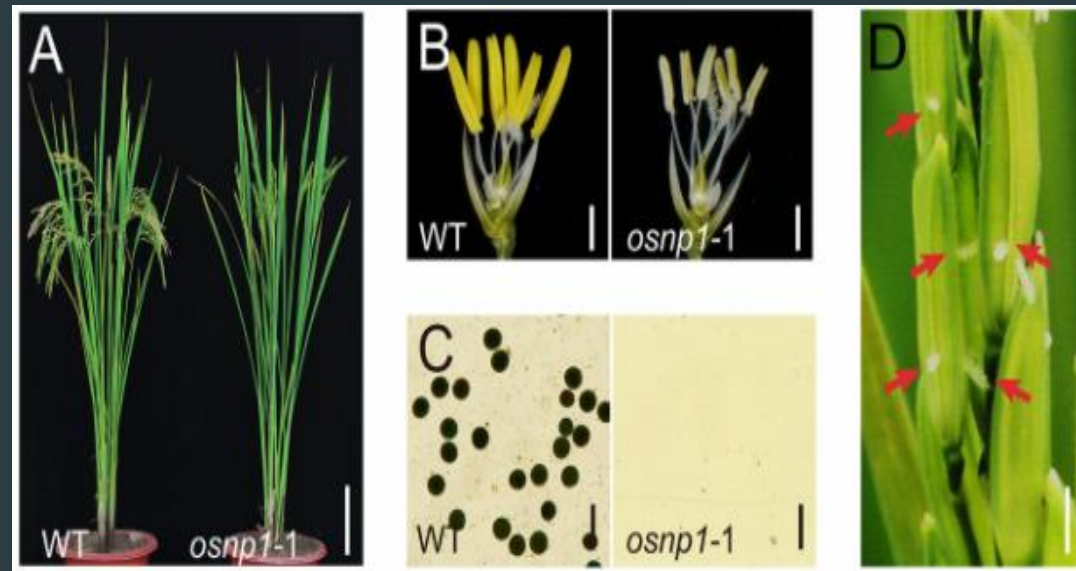
### **Nucleus Seed of Non-Inbred Lines**

- To maintain in the genetic purity of the nucleus seed of non-inbred lines, the number of plants for hand pollination should be large enough to preserve genetic make up of the variety, narrowing the genetic base by sibbing only a few plants (about 5000 plants or more).
- The sibbed ears are examined critically, discarding of colour, texture, or diseased ones.
- Uniform ears are bulked, dried, shelled, cleaned, treated and stored as usual.

- Other practices of seeding sibbed nucleus seeds are similar to those described earlier for inbred lines.
- Roguing however, needs to be observed more critically by individuals with good knowledge of the material.
- The breeder's stock seed thus produced from the nucleus seed can be utilized to increase the breeder's stock of non-inbred lines, paying adequate attention to land requirements, isolation, roguing, harvesting and handling of seed to achieve maximum genetic purity.
- The breeder's seed of the established varieties of cross-pollinated crops can be maintained by raising breeder's seed crop in isolation and roguing the crop thoroughly at various stages.
- It is often purified by mass selection.
- The crop is grown in isolation and rogued carefully as described earlier.
- At maturity about 20,000 - 25000 true to type plants are selected, harvested separately, and bulked after careful examination.
- This constitutes the breeder's stock seed. The seed may be carried over to ensure against possible failures or unforeseen shortages



# Male sterility in plant breeding



By

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**Male sterility in plants** implies an inability to produce or to release functional pollen, and is the result of failure of formation or development of functional stamens, microspores or gametes.

Male sterility is usually classified into the following four groups:

- ▶ (1) Genetic Male sterility (GMS),
- ▶ (1a) Temperature-sensitive genetic Male sterility (TGMS),
- ▶ (1b) Photoperiod-sensitive genetic Male sterility (PGMS),
- ▶ (1c) Transgenic genetic Male sterility (TrGMS),
- ▶ (2) Cytoplasmic Male sterility (CMS),
- ▶ (3) Cytoplasmic-genetic Male sterility (CGMS),
- ▶ (4) Chemically-induced male sterility.



# Phenotypic classes of male sterility

- ▶ **Structural male sterility** (stamens absent, malformed or modified into other floral parts: a lack or malformation of microsporogenous tissue or absence of microsporogenesis).
- ▶ **Sporogenous male sterility** (apparently normal stamens, but abnormal microsporogenous tissue or PMC/microspore formation or anomalous meiosis).
- ▶ **Functional male sterility** (pollen development normal, but pollen function is impaired). It may, however, be reiterated that in these cases of male sterility, the development and function of the male reproductive organs is almost normal, and only pollen function is impaired.

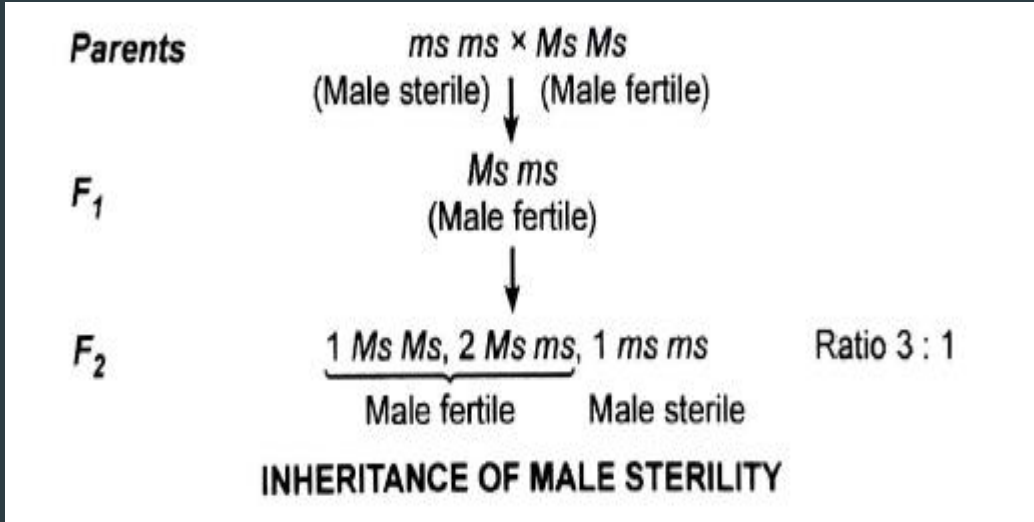
# Genetic Male Sterility (GMS)

- **MALE STERILITY** Caused by nuclear genes is called genetic male sterility. Reported in several plants like wheat, barley, cotton, pigeonpea, tomato, chilies etc.
- **Feature of GMS:-**
- GMS is mainly governed by a monogenic, recessive gene but rarely oligogenic, dominant. This system consists of two type line, viz. A line & B line.
- ✓ A line:- It is male sterile line which is used as female parent in hybrid seed production.
- ✓ B line:- It is a male fertile line which is used to maintain male sterility in A line. Also called maintainer line.
- ✓ Both A & B lines are isogenic lines with a differences only on fertility/sterility locus.

## Origin of ms Allele:

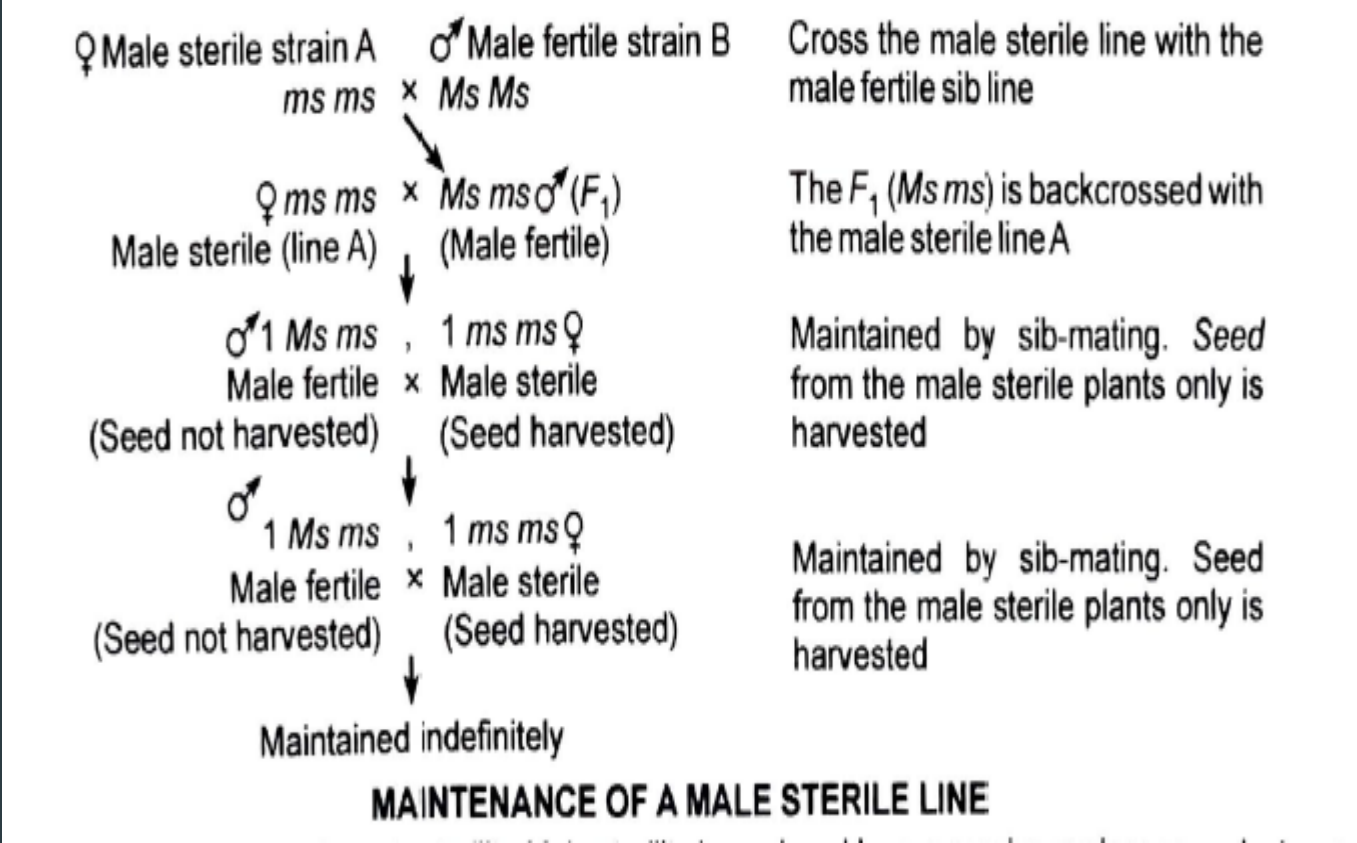
- ✓ The male sterility alleles may rise spontaneously or it can be induced artificially viz. Pigeon pea, castor, tomato, limabean, barley, cotton, etc.
- ✓ The most commonly used mutagens were gamma rays and EMS, but even colchicine (in jowar or sorghum), ethidium bromide (in groundnut, wheat and maize) and acetone (in barley) are reported to have induced mutation for male sterility.

# Inheritance of Male Sterility



**Site of Action of ms Alleles:**  
 A majority of ms genes act either immediately prior to meiosis, during meiosis or at the end of meiosis.

# Maintenance of a Male Sterile Line

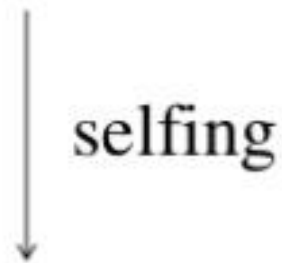


# Temperature-Sensitive Genetic Male Sterility (TGMS)

TGMS line	Temperature	Expression
5460S	< 28 °C	Complete male fertility
	> 30°C	Complete male sterility

LOCATION A  
(< 28 °C Temperature)

**TGMS line (5460S.)**



TGMS line  
(Complete fertile)

LOCATION B  
(> 30°C Temperature)

**TGMS line (5460S.)** x **Male fertile line**

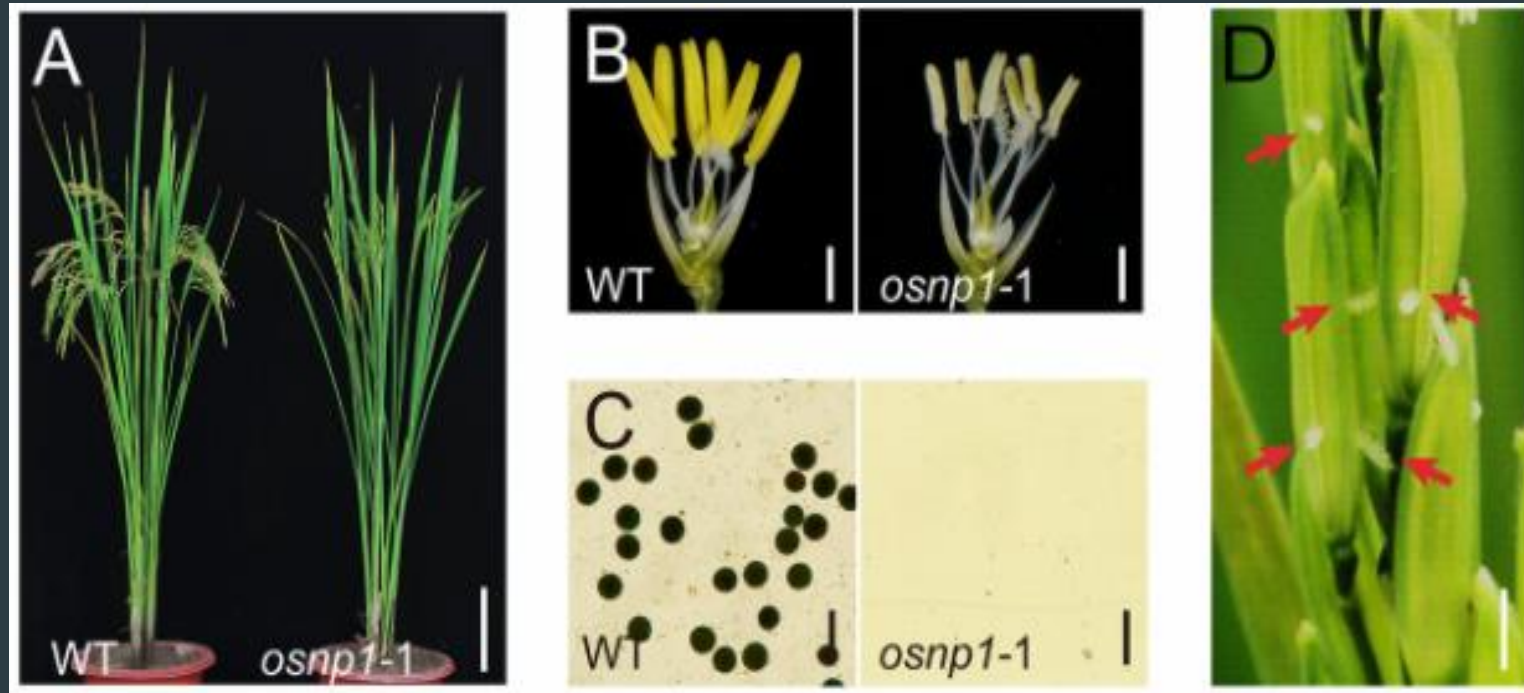


**Hybrid Seed**  
(Produced on TGMS line )



# Photoperiod-Sensitive Genetic Male Sterility (PGMS)

- ▶ In case of PGMS, Expression of ms gene is drastically affected by the prevailing photoperiod, provided the temperature is within a critical range (e.g., 23-29°C for rice PGMS) within this temperature range complete sterility obtained in rice plant grown under long day condition (Day length more than 13 hr 45 min).
- ▶ Generally short-day condition obtain normal fertility.



Phenotypes of *osnp1-1* mutant plant (A) A WT plant and *osnp1-1* mutant plant after bolting. (Scale bar, 10 cm.) (B) Spikelets of WT and *osnp1-1* with the palea and lemma removed. (Scale bar, 1 mm.) (C) I<sub>2</sub>-KI staining of the WT and *osnp1-1* pollen grains. (Scale bar, 100  $\mu$ m.) (D) Inflorescence of *osnp1-1*, showing stigma extrusion. (Scale bar, 2 mm.) Chang *et.al.*, 2016.



# Transgenic Genetic Male Sterility (TrGMS).

▶ Barnase (110 amino acids) is a secreted ribonuclease from *Bacillus amyloliquefaciens*.

▶ Barstar (89 amino acids) is a cytoplasmic barnase inhibitor.

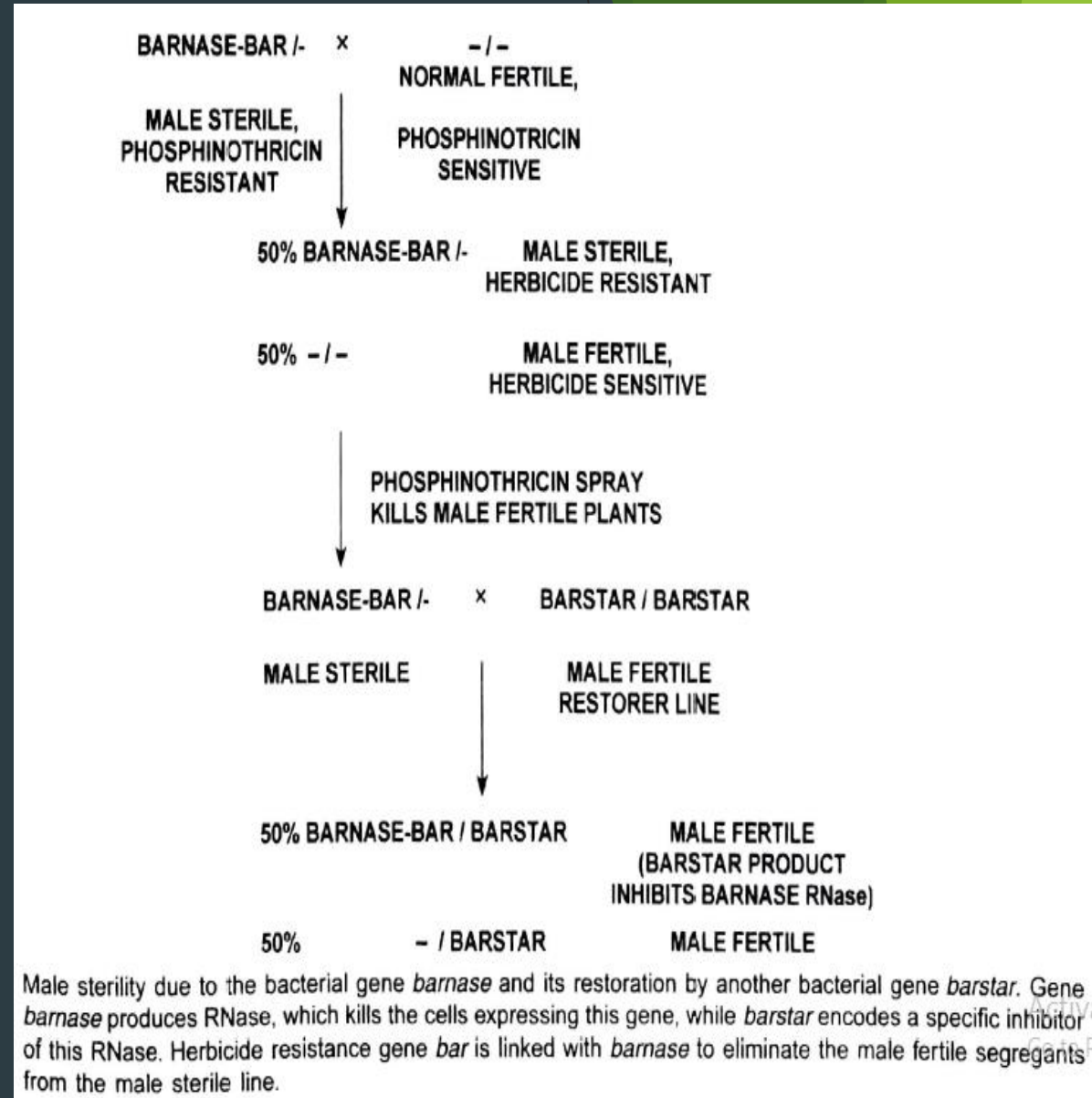
▶ Fuse the Barnase and Barstar genes to TA29 promoter (TA29 is a plant gene that has tapetum specific expression

▶ Plants containing the TA29-Barnase construct are male sterile. RNase is linked with bar gene (glufosinate tolerant), so glufosinate tolerant plant will be male sterile.

▶ Those with TA29-Barstar are not affected by the transgene barnase.

▶ Barstar is dominant over the Barnase

▶ GM canola containing barstar/ barnase system composes about 10% of commercially cultivated crops in Canada and is one of the few GMO cleared for agricultural use in Europe.



**Wild Type**



**Male Sterile Plants**



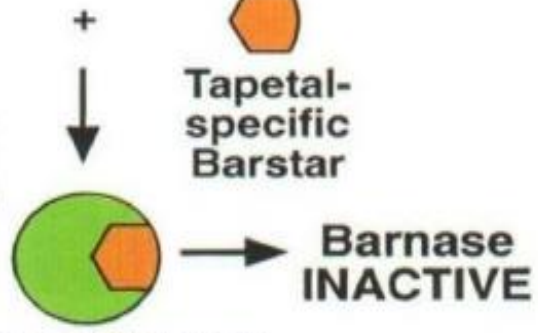
**Restored Male Fertile Plants**



**Normal Tapetum Development**



**Tapetum Destroyed**



**Normal Tapetum Development**

Active  
Go to P

## Advantages :-

- ▶ Fertility restoration in the hybrid and crossing plants are relatively easy.
- ▶ Use in both seed propagated and vegetatively propagated crops.
- ▶ Less area and labour because maintain only two lines.

## Disadvantage :-

- ▶ Less stable due to GMS affected by environmental factors like temperature and day length condition.
- ▶ Increases cost of production of hybrid seed because 50% fertile plants are removed every year.

## Utilization In Plant Breeding:-

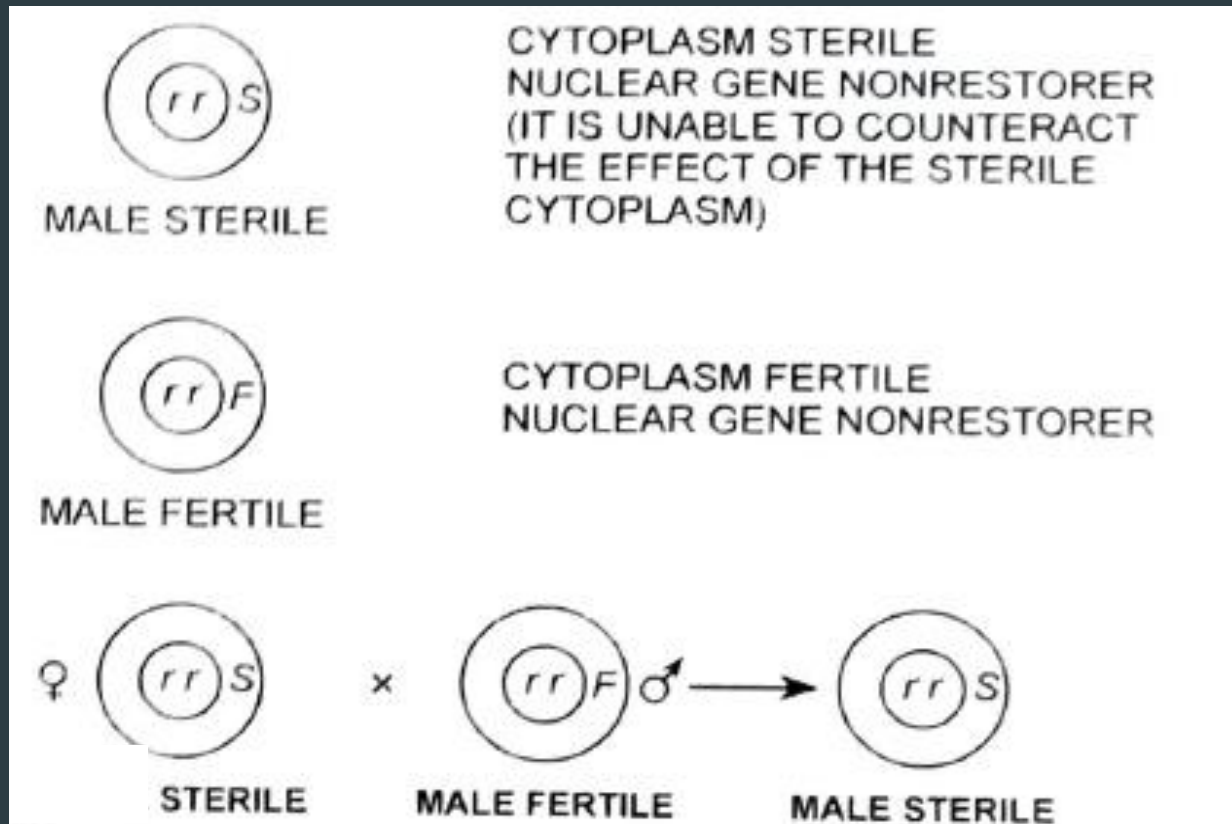
- ▶ GMS has been exploited commercially in few country, in U.S.A. successfully used in castor. In India, it was used for pigeon pea hybrid ICPH8 by ICRISAT, Hyderabad during 1991, and other public sector hybrids (ICPH4, CoH1, CoH2, AKPH4104, AKPH2022).
- ▶ It is used for seed and vegetatively propagated crops.

# Cytoplasmic Male Sterility(CMS)

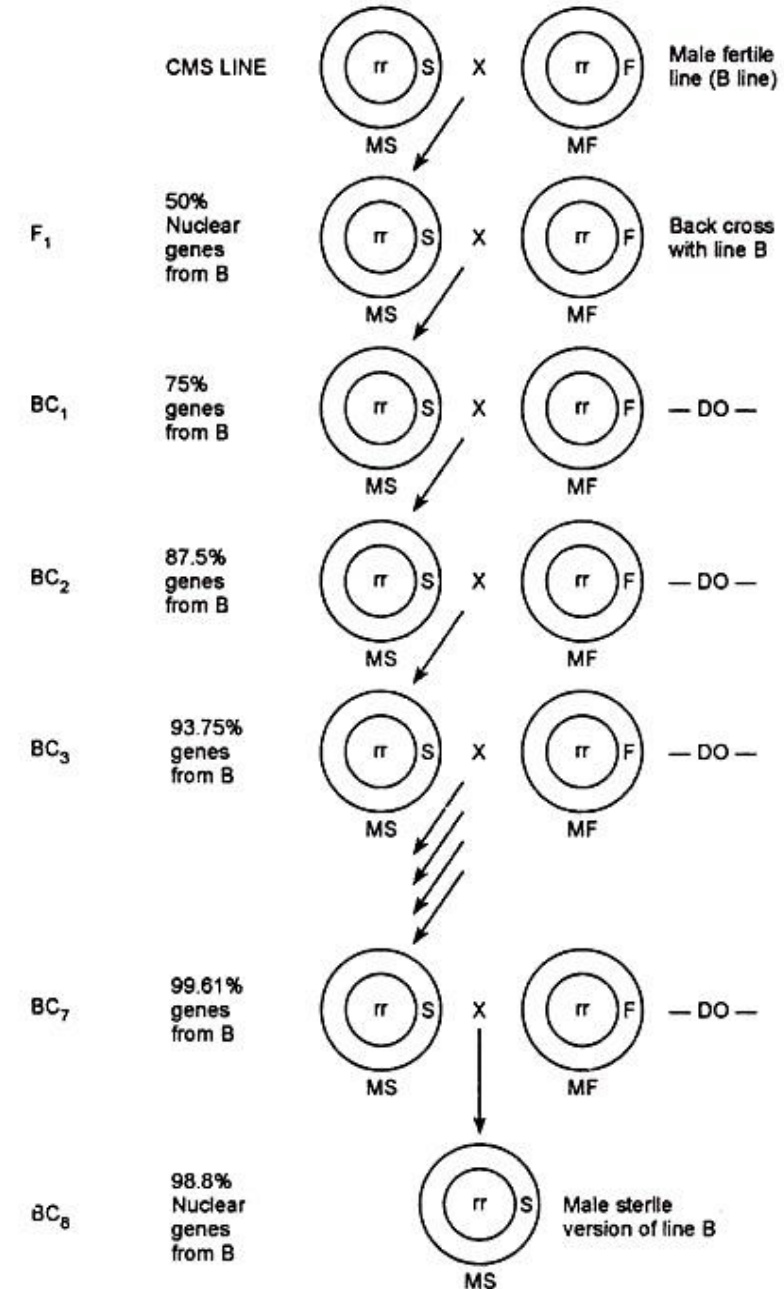
- ▶ CYTOPLASMIC MALE STERILITY (CMS) This type of male sterility controlled by cytoplasmic gene. Cytoplasm of a zygote comes from egg cell, the progeny of such plants would always be male sterile.
- ▶ This system consists of A line and B line.
- ▶ A line:- It is male sterile line which is used as female parent in hybrid seed production.
- ▶ B line:- It is a male fertile line which is used to maintain male sterile A line called maintainer line & used as male parent. Cytoplasmic male sterile line maintained by crossing of A line with B line.
- ▶ CMS cannot be utilized for hybrid seed production without use of restorer line, because F1 seed produce only male sterile plants.



# Cytoplasmic Male Sterility (CMS)



**FIG. 6.3.** Cytoplasmic male sterility. Male sterility is caused by the cytoplasm (depicted by *S*). The *F* cytoplasm is the normal cytoplasm. If a nuclear restorer gene (the dominant allele of *r*) becomes available, the male sterility will be included in the cytoplasmic-genetic group. This type of male sterility shows strict cytoplasmic inheritance.



Transfer of CMS from one line into another one (B) through repeated back crossing. After 6–8 back crosses, the CMS line will contain the same nuclear genes as the male fertile line B. The male fertile line B is used to maintain this new CMS line, therefore, it is called the maintainer line. (MS = male sterile; MF = male fertile).

► Advantages:-

- Highly stable because not influenced by environmental conditions such as temperature and day length.
- Less area requires, because the breeder has to maintains A & B line.

► Disadvantages:-

- Cannot be used for developments of hybrids in these crops where seed is economic product.
- It is impossible to restore fertility in hybrid due to governed by plasma genes.

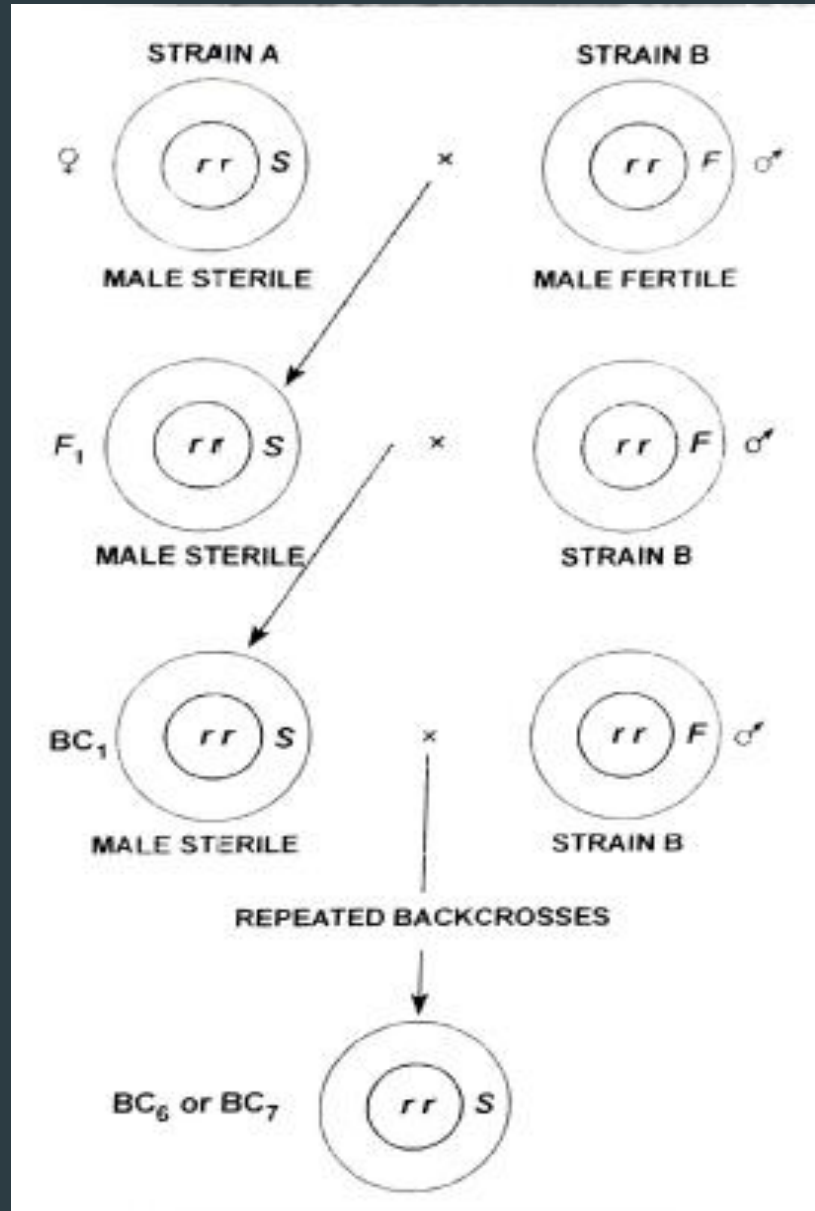
► Utilization In Plant Breeding:-

- CMS has limited application. It cannot be used for development of hybrid, where seed is the economic product.
- But it can be used for producing hybrid seed in certain ornamental species or asexually propagated species like sugarcane, potato, and forage crops.

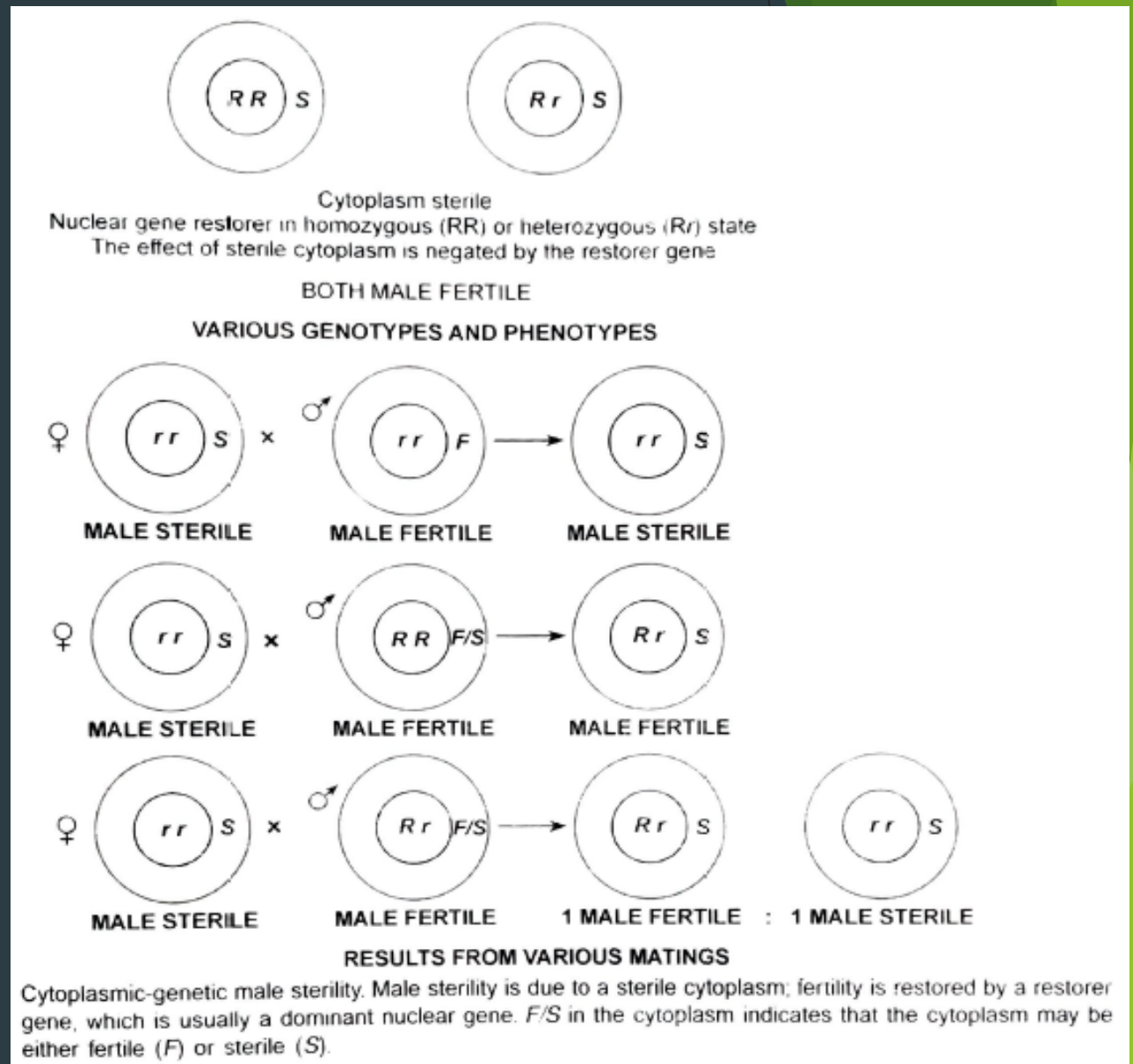
# Cytoplasmic-genetic Male Sterility(CGMS)

- ▶ CYTOPLASMIC GENETIC MALE STERILITY (CGMS) First time reported by Jones and Davis in 1944 in onion. Controlled by both plasma genes and nuclear genes, called cytoplasmic genic male sterility.
- ▶ Reported in both sexually propagated and asexually propagated species such as pearl millet, sorghum, cotton, maize. This system includes A, B & R lines.
- ▶ A line:- It is male sterile line which is used as female parent in hybrid seed production.
- ▶ B line:- It is a male fertile line which is used to maintain male sterility in A line called maintainer line.
- ▶ R line:- Which is used to restore male fertility in male sterile plant, used as male parent in hybrid seed production.

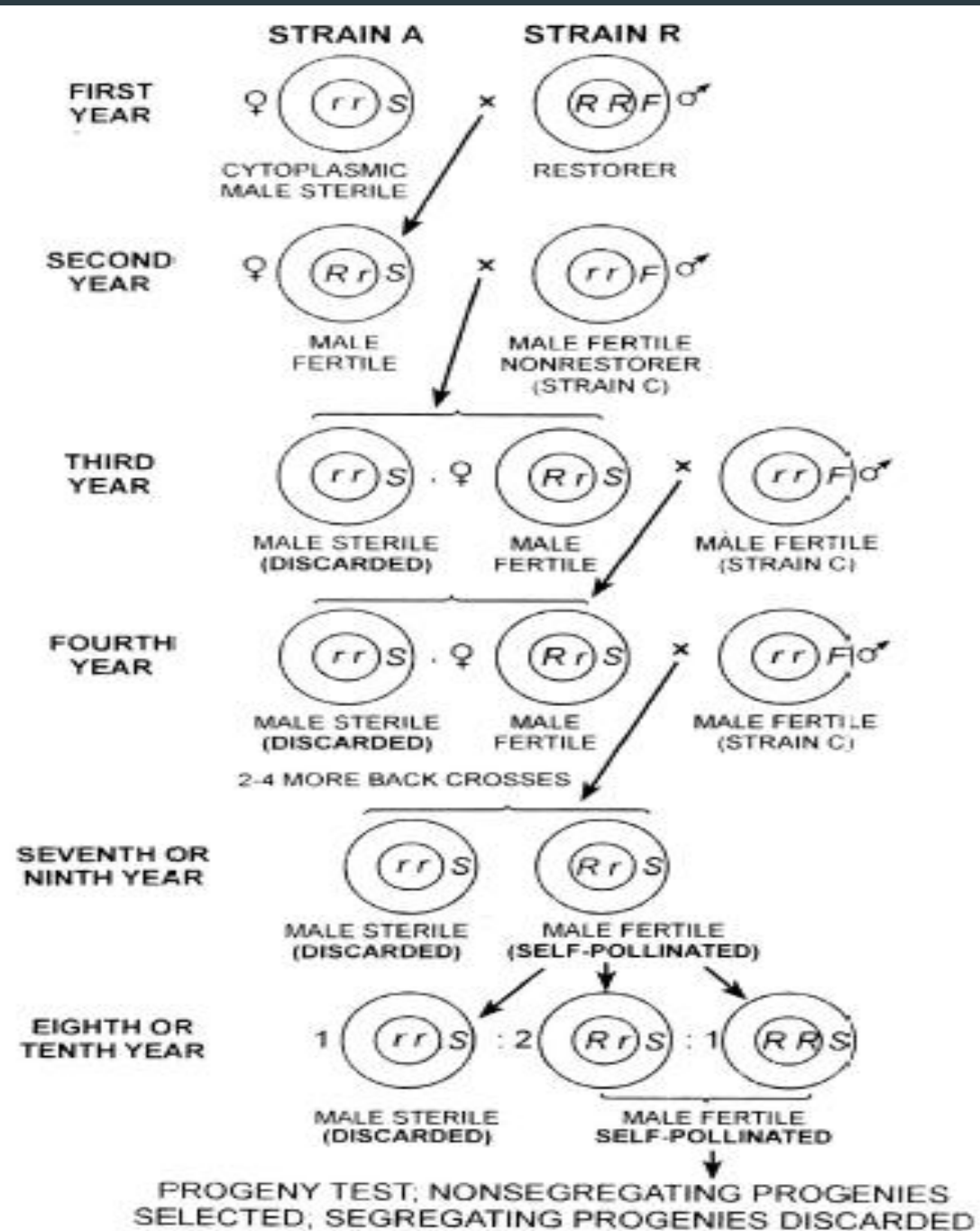
# Cytoplasmic-genetic Male Sterility (CGMS)



Transfer of Cytoplasmic Male Sterility to a New Strain







### Origin of Male Sterile Cytoplasm:

1. Spontaneous Mutation.
2. Interspecific Hybridization.
3. Mutation Induction through Ethidium Bromide.

▶ **Advantages :-**

- Widely used for hybrid seed production in both seed propagated & vegetatively propagated species.
- Highly stable and reliable.
- Not affected by environmental factors.

▶ **Disadvantages:-**

- Its requires more area and labour, because the breeder has three types of material, viz., A, B & R line.
- Moreover, sometimes CGMS line has inferior performance.

▶ **Utilization In Plant Breeding :-**

CGMS can be successfully utilized for the development of commercial hybrids in both seed propagated and vegetatively Propagated crops. CGMS has been effectively used for commercial production of hybrids in maize, sorghum, onion, sugarbeet, pearlmillet and other crops.



# CHEMICALLY INDUCED MALE STERILITY

- ▶ A chemical hybridizing agent (CHA) is a chemical that induces artificial, nongenetic male sterility in plants so that they can be effectively used as female parents in hybrid seed production.

<i>Chemical hybridizing agent (CHA)</i>	<i>Critical stage for application</i>	<i>Effective in crop</i>	<i>Remarks</i>
<b>Arsenicals</b>			
Zinc methyl arsenate (MG1) Sodium methyl arsenate (MG2)	5 days before heading	Rice	MG2 is extensively used in China in rice hybrid seed production
DPX3778	Late tillering/early boot + late boot stages	Wheat and triticale	Very high application rates required
Ethephon or ethrel	Depends on crop	Barley, oats, pearl millet, rice, etc.	Variable male sterility in different tillers
Mendok (FW450)	In cotton, complete sterility for 35 days; application every 35 days in sugarbeet	Cotton, pearl millet, chillies, sesamum, sugarbeet	Female fertility affected; phytotoxic effects
<b>Gibberellic acid</b>			
LY195259	1-3 days prior to onset of meiosis Soil surface treatment or foliar spray when spike of main shoot is 5 mm	Maize, barley, wheat, rice, sunflower Wheat	Excessive internode elongation; in sunflower, reduced female fertility Commercially promising; no known side effects
<b>Maleic hydrazide</b>			
RH0007 (Hybrex)	Early microsporogenesis	Maize, wheat, cotton, onion, etc. Wheat	Phytotoxicity, flower abscission, etc. No effect on female fertility; used commercially in wheat
WL84811 (Shell)	— Booting stage	Wheat, oat, barley, maize	Hybrid purity 88%; may reduce female fertility

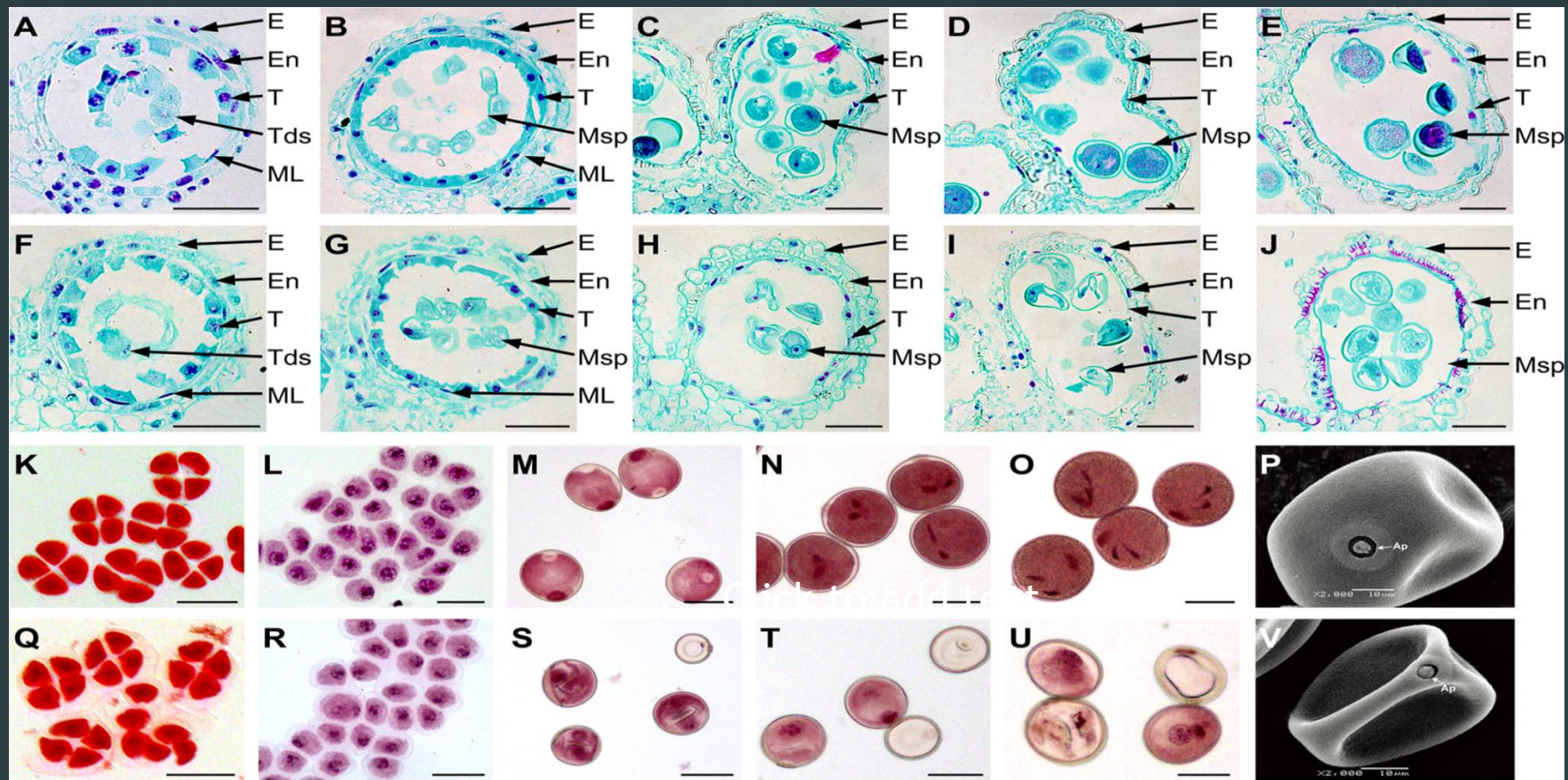


# Features of an ideal CHA

- ▶ Highly male and female selective.
- ▶ Economical.
- ▶ Flexible time.
- ▶ Should not be mutagenic.
- ▶ Should not be carried to F1.
- ▶ Should cause 0% reduction in seed set.
- ▶ Eco friendly.

## Hybrid Seed Production based on CHAs

- 1) Proper Environmental Condition.
- 2) Synchronization of Flowering of Male and Female parents.
- 3) Effective Chemical Emasculation and Cross-Pollination.



**Development of anthers and microspores in untreated (A to E and K to P) and chemical hybridization agent (CHA)-SQ-1-treated wheat plants (F to J and Q to V).**

(A to J) safranin O/fast green-stained transverse sections. (K to O and Q to U) 1% acetocarmine-stained microspores. (P and V) a scanning electron micrograph was used to analyse the mature pollen grains. (A, F, K and Q) the tetrad stage. (B, G, L and R) the early-uninucleate stage. (C, H, M and S) the later-uninucleate stage. (D, I, N and T) the binucleate stage. (E, J, O and U) the trinucleate stage. E, En, ML, T, Tds, Msp and Ap indicate the epidermis, the endothecium, the middle layer, the tapetum, the tetrads, the microspore and the germination aperture, respectively. Scale bars are 50  $\mu\text{m}$  in A to O and Q to U.

# Advantages of CHAs

- ▶ **Any line can be used as the female parent.** Further, the lengthy and cumbersome production of CMS or GMS lines for hybrid seed production becomes unnecessary.
- ▶ **Any line can be used as the male parent** of hybrid, and restorers, etc. are not required.
- ▶ The hybrid seed production is based on only two lines.
- ▶ Maintenance of the parental lines of hybrids is readily achieved by self-pollination.
- ▶ **CHA-based F2 hybrids are fully fertile**, while some plants in such hybrids based on CMS or GMS will be sterile. This would allow commercial cultivation of the F2 generations of such hybrids whose F2 generation shows higher vigour and yield; this would reduce the Cost of hybrid seed substantially.

# Limitations of CHAs

- ▶ The expression and duration of CHA-induced male sterility is very **stage-specific**.
- ▶ CHA-induced male sterility is very **vulnerable to the prevailing environmental conditions**
- ▶ **Incomplete male sterility might lead to the production of selfed seed** on the female parent; this would reduce hybrid seed purity and may cause problems in seed certification
- ▶ **Many CHAs are toxic to plants and animals.**
- ▶ Some CHAs e.g., arsenicals and WL84811, may produce **carryover residue effect** in F1 seeds
- ▶ Certain CHAs, eg. RH531 and RH532, **interfere with cell division**.
- ▶ Some CHAs stimulate neoplastic growth and affect human growth. Efforts are being made to develop a new generation of toxicity-free, effective and low-cost CHAs.
- ▶ CHAs are generally genotype-, dose- and application stage-specific.







## HYBRID SEED PRODUCTION IN SORGHUM

### Breeding technique for Commercial production

#### Cytoplasmic genetic male sterility (CGMS)

#### Seeds produced in different stages

Nucleus seed stage	:	Maintenance of basic source by seed to row progenies.
Breeder Stage	:	A (AxB), B and R line are multiplied
Foundation Stage	:	A (AxB) and R line are multiplied
Breeder and foundation seed stage	:	Multiplication of male sterile line or maintenance of A and B line
Certified seed stage	:	A x R – F1 hybrid produced.
Certified seed stage	:	Production of hybrid seed

#### Stages of Seed Production

Breeder seed ---> A x B - B - R

Foundation seed ---> A x B - B - R

Certified seed ---> A x R

**Popular hybrids of their parents:** The first hybrid (CSH 1) was released in 1964. In 1969, the Coordinated Sorghum Improvement Project was established. Now there are more than 30 hybrids. Some popular are

CSH1	CK 60 A x IS 84
CSH5	2077A x CS3541
CSH 9	MS 296 A x CS 3541
COH2	2219A x IS3541(Kovilpatti Tall)
COH3	2077A x CO21
COH4	296A x TNS30
CSH 13 R	296 A x RS 29
CSH 14	AKMS 14A x AKR 150
CSH 16	27 A x C 43
CSH 15 (R)	104 A x R 585
CSH 17	AKMS 14A x RS 673

- Stages of seed multiplication** : Breeder seed – foundation seed – certified seed.
- Foundation seed production : A and B line are raised in 4:2 ratio with 4 rows of B line as border row and allowed for cross pollination. The seeds from A line will be collected as A line seeds (multiplied).
- Certified seed production : Hybrid seed production

**Commercial in Hybrid seed production techniques**

	Isolation distance	
	FS	CS
Normal	200	100
On presence of Johnson grass	400	400
On presence of forage sorghum	400	200
Hybrids	300	200

**Johnson grass**



**Forage sorghum**



### **Seeds and sowing**

Seed rate	:	A line : 8 kg ha <sup>-1</sup> R line : 4 kg ha <sup>-1</sup>
Spacing	:	A line : 45 x 30cm R line : 45 x solid row spacing.
Planting ratio	:	Foundation seed stage: 4:2 (A: B) Certified seed stage : 5.2 (A:R)
Border rows	:	4 rows of male (either B or R line) to, supply adequate pollen.
Live markers	:	<ul style="list-style-type: none"><li>• Live plants used for identification of male line live markers are used.</li><li>• It should have distinguishable</li></ul>

morphological characters.

- Live markers can be sunflower, daincha etc.

### Manures and Fertilizers

Compost	:	12.5 t / ha
NPK	:	100:50:50 kg ha <sup>-1</sup>
Basal	:	50:50:5 kg ha <sup>-1</sup>
Top dressing	:	25kg N after last ploughing 25kg N after boot leaf stage (45 days)

### Synchronization technique

1. Staggered sowing: Sowing of male parent and female parents are adjusted in such a way that both parents come to flowering at the same time.
  - ✓ CSH-5, MS 2077 A must be sown 10-15 days earlier to the male CS 3541,
  - ✓ CSH 6, the female parent MS 2219 A can be sown simultaneously with CS 3541
  - ✓ CSH 9, the female parent MS 296 A must be sown 7-10 days earlier than male CS 3541 in November- December season.
2. Spraying growth retardant MH 500 ppm at 45 DAS, delays flowering in advancing parent. MH wont dissolve in water and hence dissolve it in NaOH and then mix with water.
3. Urea spraying 1% to the lagging parent.
4. Withhold one irrigation to the advancing parent.
5. Spraying CCC 300 ppm will delay flowering.

parents.



**Roguing:** Do it in both

**Off types**

- In female line remove : off types, wild types, pollen shedders, rogues, partials, volunteer plants, diseased plants, R line, mosaic plants, late / Early flowering plant
- In male line remove : Rogues, A line, Diseased plants, Late / early flowering plants, Wild types

### **Types of contamination**

Presence of B line in A line called as pollen shedders

Presence of A line in B line called as off type

Presence of R line in B line called as rogue

Presence of B line in B line called as rogue

Presence of B line in R line called as rogue

Presence of B line in R line called as rogue

Pollen shedders and off type cause physical contamination, whereas, rogue cause physical and genetical contamination.

### **Pollen shedders**

Presence of B line plants in A line are called pollen shedders.

### **Partials**

In certain A line plants, a part of the earhead-shed pollen due to the removal of sterility due to parental impurity (or) developmental variation or temperature.

### Field Standards

	Isolation distance	
	FS	CS
Offtypes (max) Varieties	0.05	0.10
Hybrids	0.05	0.10
Pollen shedders (max)	0.05	0.10
Designated diseased plants (max) (Ergot and smut)	0.05	0.10

### Designated disease

1. Kernel smut
2. Head smut
3. Sugary disease of sorghum
  - ❖ It is specific to hybrid
  - ❖ Occur due to low seed set
  - ❖ Spray rogor 0.03% (or)
  - ❖ Endosulfan 0.07%

### Method of harvesting

Male and female lines should be harvested separately. The male rows are harvested first and transported to separate threshing floor. Like that female rows are harvested and threshed separately.

### Threshing

- ✓ At the time of threshing the seed moisture content should be reduced around 15-18%. Threshing can be done by beating the earheads with bamboo sticks.
- ✓ While using the mechanical threshers, care should be taken to avoid mechanical damage.

### Drying

Seed should be dried to 12% for short term storage and 8% for long term storage.

### Processing

The sorghum seeds can be processed in OSAW cleaner cum grader using 9/64" round perforated metal sieve.

### Seed treatment and storage

- ✓ The seeds are treated with captan or thiram @ 2 g/kg of seed and pack it in cloth bag at 12% moisture content for short term storage and 8% moisture content in 700 gauge poly ethylene bag for long term storage (or)
- ✓ The seeds can also be treated with halogen mixture @ 3 g/kg of seeds. The halogen mixture is prepared by mixing  $\text{CaOCl}_2$  and  $\text{CaCO}_3$  + *Albizzia amara* at the rate of 5:4:1 and this mixture is kept in an air tight plastic container for 1 week. After one week the mixture is used for seed treatment.
- ✓ The treated seeds can be stored upto 12 months under open storage and upto 18 months in moisture vapour proof containers, provided it is not infested by the storage insects.

**Seed yield** : 3000 kg ha<sup>-1</sup>

### Seed standards

	Foundation seed	Certified seed
Physical purity (%)	98	98
Inert matter (%)	2	2

Other crop seed	5 kg <sup>-1</sup>	10 kg <sup>-1</sup>
Weed seed	10 kg <sup>-1</sup>	20 kg <sup>-1</sup>
Other distinguishable variety	10 kg <sup>-1</sup>	20 kg <sup>-1</sup>
Ergot disease by number	0.020%	0.040%
<b>Moisture content</b>		
Moisture pervious container	12	12
Moisture vapour proof container	8	8

**Others – as in varieties**



## HYBRID SEED PRODUCTION IN MAIZE

- Crossing technique : Manual emasculation by detasseling
- Detasseling : Removal of male inflorescence from the monoecious crop
- Time for detasseling : The time taken for shedding of pollen from the tassel in 1-2 days after emergence. Hence the tassel should be removed before the shedding of pollen.

### Detasseling

Detasseling is the removal of tassel from female parent. Detasseling is done when the tassel emerged out of the boot leaf, but before anthesis have shed pollen. Anthers take 2-4 days to dehisce after complete emergence. Only in few cases, the anthers start dehisce before its complete emergence. In such case detasseling should be done earlier. Detasseling is done every day from the emergence of tassel upto 14 days.

### **Method**

- Hold the stem below the boot leaf in left hand and the base of the basal in right hand and pull it out in a single pull.
- Grasp entire tassel so that all the pollen parts are fully removed.
- Do not break or remove leaves as removal will reduce yields and will result in lower quality of seed.



### **Precautions to be adopted during detasseling**

- No part should be left on the plant as it causes contamination.
- It should be uniform process done daily in the morning in a particular direction.
- Donot break the top leaves as the field may be reduced due to the earning of source material to accumulate in sink [seed ] as removal of 1 leaf course 1.5% loss 2 leaves 5.9% loss and 3 leaves 14% loss in yield.
- Detassel only after the entire tassel has come out and immature detasseling may lead to reduced yield and contamination.
- Mark the male rows with marker to avoid mistake in detasseling
- Look out for shedders [shedding tassel] in female rows as the may cause contamination.
- After pulling out the tassel drop it there itself and bury in soil. Otherwise late emerging pollen from detasseled tassel may cause contamination.
- Do not carry the tassel through the field as any fall of pollen may lead to contamination.
- Donot practice, improper, immature and incomplete detasseling.
- **Improper detasseling:** A portion of the tassel is remaining in the plant while detasseling.
- **Immature detasseling:** Carrying out detasseling work when the tassel is within the leaves.
- **Incomplete detasseling:** The tassel is remaining in lower or unseen or unaccounted in within the whole of leaves.
- There should not be any shedding tassel.
- **Shedding tassel:** Either full or part of tassel remain in female line after detasseling and shedding pollen which may contaminate the genetic purity of the crop.



### **System of Hybrid seed production**

- Detasseling ( Manual creation of male sterility )

### **Types of hybrids**

#### **Single cross hybrid**

It is a cross between 2 inbreds.  $A \times B$ . A genotype will be detasseled and crossed with B genotypes.

- ✓ COH 1- UMI 29 x UMI 51
- ✓ COH 2- UMI 810 x UMI 90
- ✓ CoH(M) 5-UMI 285 X UMI 61

#### **Double cross**

- ✓ It is a cross between two single crosses.
- ✓ It is a cross between 2 hybrids  $(A \times B) \times (C \times D)$   $(A \times B)$  single cross hybrid will be produced by detasseling A and by crossing with B  $(C \times D)$  hybrid will be produced by detasseling C and crossing with D.
- ✓ Then  $(A \times B)$  will be detasseled and crossed with  $(C \times D)$  hybrid.



**Field standards for isolation (modification based on situation)  
For (foundation single crosses and hybrid of certified class)**

	<b>Foundation stage</b>	<b>Certified stage</b>
• Same kernal color	400	200
• Different kernal colour	600	300
• Field of single cross / inbreds not confirming to varietal purity	400	200
• Single cross with same male parent confirming to varietal purity	5	5
• Single cross with other male parent not confirming to varietal purity	400	200
❖ Differential blooming dates are permitted for modifying isolation distance provided 5.0% or more of the plants in the seed parent do not have receptive silk when more than 0.20% of the plants in the adjacent field within the prescribed isolation distance are having shedding pollen.		
❖ In hybrid seed production (certified seed stage) alone the isolation distance (less than 200 meter) can be modified by increasing the border rows of male parent, if the kernal colour and texture of the contaminant are the same as that of the seed parent.		

The number of border rows to be planted all around the seed field to modify isolation distance less than 200 m shall also be determined by the size of the field and its distance from the contaminant as shown below.

Area in ha.	Isolation distance (m)	Border rows
< 4 ha	200	1
< 4 ha	150	5
< 4 ha	100	9
< 4 ha	50	13
10-12 ha	180	1
10-12 ha	130	5
10-12 ha	80	9
10-12 ha	30	13
> 16 ha	165	1
> 16 ha	115	5
> 16 ha	65	9
> 16 ha	15	13

### Seed production stages and production of parental lines / hybrids

Stage of seed	Single cross	Double cross	Three way cross	Double top cross	Top cross
Breeder seed	A, B	A, B, C, D	A, B, C	A, B, variety	A, variety
Foundation seed	A, B	(AxB) (Cx D)	(AxB), C	(AxB) variety	A, variety
Certified seed	A X B	(AxB) x (Cx D)	(AxB) x variety	(AxB) x variety	Ax variety

## Spacing

Seeds are sown in ridges and furrows

Hybrids	:	60x 25 cm
Seed rate	:	Female : 7 -10 kg ha <sup>-1</sup>
	:	Male : 3 -4 kg ha <sup>-1</sup>
Spacing	:	Female : 60 x 20 to 75 x 30 depending on the area.
		Male : 45 x 30 cm

## Planting ratio

Single cross	4:2
Double cross	6:2
3 way cross	6:2
Border rows	a. Inbreds & single cross - 4 rows
	b. Others - 3 rows

## Fertilizer

NPK kg / ha	:	200 : 100 : 100
Basal	:	100 : 100 : 50
1 <sup>st</sup> Top	:	50 : 0 : 0 (20 <sup>th</sup> days -vegetative phase)
2 <sup>nd</sup> Top	:	50 : 0 : 50 (Boot leaf stage at 45 days)
Foliar	:	DAP 2% at 50% flowering
In Zn deficient soil	:	ZnSO <sub>4</sub> @ 25 kg ha <sup>-1</sup>

## Roguing

Should be done periodically based on position of cob, colour of silk, arrangements of seeds in cob, leaves etc. Shedding tassels are to be removed in roguing . It refers to the tassels in female parents rows, shedding pollen or that has shed pollen in hybrid maize plots. During field inspection a tassel whose main spike or any side branch or both have shed pollen or shedding pollen in more than 5 cm

of branch length is counted as a shedding tassel during inspection the shedding tassels are taken into count for acceptance or rejection of production plot.

**Field standard (%)**

	FS	CS
Off types	0.2	0.5
Shedding tassel	0.5	1.0 (when receptive silk is 5% or more)

- Inseparable other crop : Nil (both stage)
- Objectionable weed : Nil (both stage)
- Designated diseases : Nil (both stage)

**Field standards –specific**

Specific factors	Certified stage
Off types shedding pollen when 5 % or more of seed parent in receptive silk	0 .50 %
Seed parent shedding pollen when 5 % of the seed parent is having receptive silk	1.0 %
Total of pollen shedding tassel including tassel that had shed pollen for all 3 inspections conducted during flowering on different dates	2 .0 %
Off types in seed parent at final inspection	0 .5 %

- Number of inspection** : Four
- (Seed certification officers) : One : Before flowering
- : Three : During flowering

**Harvest**

- ✓ Harvest when the moisture content falls to 20-25%
- ✓ Harvest male first and remove from the field and then harvest female



## **Threshing**

- a. Dehusking** - The husks are removed manually.
- b. Cob sorting** - Remove ill filled, diseased cobs and cobs having kernel colour variation.

## **Zenia**

The direct/visible effects of pollen on endosperm and related tissues in the formation of a seed colour. e.g. seed colour. In maize, the gene present in sperm cell contributes in the expression of colour of hybrid seeds.

## **Matazenia**

Is the effect of pollen on the maternal tissues of fruit.

## **Shelling**

Cob sorting should be the first operation it is a post harvest, evaluation for genetic purity. The sheath is removed and check for kernel colour, shank colour, diseased cobs, kernel arrangement. The cobs are shelled either mechanically or manually at 15-18% moisture content. Improper shelling leads to 48% damage to kernel. Growth of storage fungal Pericarp damage. Crack on pericarp can be identified by  $\text{FeCl}_3$  or Tz test. Shelling is done mechanically using cob sheller and manually by rubbing with stones.

## **Drying**

Seeds are dried to 12% moisture content.

## **Grading**

Grade the seeds using 18/64" (7.28 mm) sieve.

## **Seed treatment**

Slurry treat the seeds with 8% moisture content either with captan or thiram 75% W.P. @ 70 g/100 kg with 0.5 litre of water. Treated seeds can be stored for 1 year in cloth bag.

**Others:** As in varietal seed production

**Seed yield** : 2.5 - 3.6 t/ha

## Seed standard inbred, varieties and hybrids

Parameters	Inbreds	Hybrids	
		FS	CS
1. Physical purity (%) (min)	98	98	98
2. Inert matter (%) (max)	2	2	2
3. Other crop seed (max)	5 /kg	5 kg <sup>-1</sup>	10 kg <sup>-1</sup>
4. ODV seeds (max)	5/kg	5 kg <sup>-1</sup>	10 kg <sup>-1</sup>
5 Germination % (min)	80	80	90
6. Moisture content (%) (max)			
a. Moisture pervious	12	12	12
b. Moisture vapour proof	8	8	8

## Production of Synthetic cultivars

Breeding of cereal and other agronomic crops has contributed significantly to the growth of agribusiness worldwide. In normally self fertilized crops, new variability may be created by [hybridisation](#), followed by the selection of desired cultivars in which desirable characteristics from two or more parents are combined. The type of hybrid cultivar obtained will depend upon the genetic background of the chosen parents as well on the method of selection used. A similar situation arises when new variability is artificially induced through mutations.

In pure-line theory of classic plant breeding, a pure line is defined as all the descendants of single homozygous individual by continued self-fertilization, resulting in a homogeneous cultivar. Hybridization, however, results in significant heterogeneity. The multiplication of such heterogenous progeny in bulk to select homozygous individuals would be gigantic task. Most modern hybrid cultivars are, therefore, selected at an early stage (F<sub>2</sub>) as subsequent lines and probably released at the F<sub>8</sub> and F<sub>12</sub> generations. These are obviously not as homogeneous as a pure line.

Cultivars can also be selected by producing multilines. Whereas normal line selection seeks to produce a new cultivar on the basis of one line or a few lines that are very similar, multiline cultivars are essentially different from each other in their characteristics, such as resistance to pests and diseases or environmental stresses. Thus, by incorporating different sources of resistance, the newly synthesized cultivar is buffered against changes brought about by virulent pathogenes. These cultivars are however, not very stable compared to those produced by the conventional methods of selection. A change in the prevalence of a virulent pathogen may eliminate certain lines from the cultivar. It is, therefore, necessary to return the cultivar to the plant breeder for its reconstitution. This may be advantageous, because it enables plant breeders to substitute new sources of resistance in the material.

Alternatively, the plant breeder can create a composite cross by bulking the  $F_2$  generations of several crosses. The composite is allowed to develop for several generations during which natural selection may occur. If the composite is grown at more than one location, a locally adapted cultivar may be developed in time. The composite constitutes a gene pool from which the plant breeder can select a cultivar with desirable characteristics for further multiplication.

An alternative to the composite is the synthetic or artificial method of plant breeding in which a number of lines are put together by the plant breeder in predetermined proportions. A synthetic line generally has a limited life, because the proportions of the constituent lines are likely to change over number of generations. The plant breeder must plan for seed production of limited generation basis. This system can be extended by using mixtures of cultivars claimed to be advantageous in some species over a single cultivar, especially if different resistant genes are present in each cultivar. This method adds to the cost of mixing, which can be reduced by growing a seed crop for one or two generations after mixing before using it for crop production.

A hybrid cultivar results from a controlled cross between a male and female parent, the seed being harvested from female parent only and used for crop production.

In self fertilized crop species, it is easy to produce hybrid cultivars if male sterile lines are available that can be used as female parents. There are certain substances that act as a gametocides, destroying the pollen of desired female parent, or as inhibitors that prevent pollen produced by the female parent from effecting fertilization. The advantage of the synthetic hybrid cultivar lies in heterosis. Special expensive measures are required to produce seed that is harvested from the female parent only. The resultant heterosis therefore must have a profitable effect to compensate for the cost of production of synthetic hybrid cultivars in the self pollinating crop species.

In the cross pollinated crop species, plant breeders look for parent plants that have good combining ability. These plants, when allowed to multiply together, produce a desirable combination of characteristics. Cross fertilization results in greater heterozygosity in these plants than in the self fertilized plants and therefore less homogeneity. Each generation of an open pollinated cultivar is thus a mixture of hybrids. The open pollinated cultivars are generally grown for a limited number of generations and returned to the plant breeder's maintenance material after each cycle of seed production to produce commercial quantities of seeds.

Putting together a large number of parent plants and allowing random pollination to occur can create composites. A composite in a cross fertilized species is generally the product of the first generation of such random pollination.

Production of synthetic cultivars begins with a limited number of specific parents, which are permitted to interpollinate. The number of generations of multiplication is strictly limited so as to recreate the synthetic/artificial cultivar at the end of each multiplication cycle. As with the self fertilized species, synthetic hybrid cultivars of cross fertilized species are created by controlling pollination to ensure that seed is produced from a desired crossing. This can be achieved by the following methods.

- 1) By emasculating the female parent, as is done in monoecious plants like maize, by removing the male flowers before the release of pollens.
- 2) By using [male sterility](#) in the female line, so as to avoid the physical removal of male flowers.

3) By using [self incompatibility](#). In this system, the seed crop is harvested as a whole, since all plants are contributing and receiving pollen. The self incompatibility, however, is not always complete, and there may be production of some inbred plants. With the excessive production of such plants, the advantage of heterosis in the subsequent crop is diminished.

The advantage of the synthetic hybrid cultivar in cross pollinated species is not restricted only to heterosis. Most hybrids are based upon inbred lines. Normally, cross fertilized plants require inbreeding for several generations to reduce heterozygosity and to include desirable genes in synthetic cultivars. A controlled cross between two such inbreds produces heterosis and desirable combination of genes in the form of a synthetic cultivar.

The major disadvantage of the production of synthetic cultivars is the higher cost of plant breeding and seed production, requiring considerable time consuming work to produce desirable inbreds, which alone can be used to synthesize new artificial hybrids. The final seed crop is not fully productive when male sterility or emasculation is used, because only the female parent is harvested for seed.

Therefore various other hybrids have been produced. The hybrid resulting from the cross of two inbred lines is a single cross, whereas the F1 resulting from the cross of two single cross hybrids as parents is known as a double cross. In a three way cross, an inbred is mated with an f1 hybrid. A top cross is the F1 resulting from a cross between an inbred or a single cross and an open pollinated cultivar. All of the forms of hybrid cultivars require a particular cycle of seed production to produce the seed used in crop production.

## HYBRID SEED PRODUCTION IN PADDY

Breeding technique for commercial

hybrid seed production : Cytoplasmic genetic male sterility system

Stages of seed production for seed certification : Breeder seed – foundation seed certified

### Seed Multiplication work at different Stages

Breeder Seed stage : A (AxB), B, R lines are raised separately under isolation.

Foundation Seed stage : A (AxB) and R lines raised separately under isolation.

Certified seed stage : A and R line are crossed under isolation to get hybrid.

### Systems of hybrid seed production

- ❖ Three line method or CGMS system (popular)
- ❖ Two line method or environmental genetic male sterility (EGMS) system that involve PGMS (photosensitive genetic male sterility) and TGMS (Thermosensitive male sterility system was developed in China and low temperature hilly areas of Tamil Nadu)

### Popular hybrids

CORH1 : (IR 62829A x IR 10198- 66–2R)

CORH2 : IR 58025A x C 20R

CORH3 : TNAU CMS 2A X CB 87 R (110-115 days)

ADTRH1 : IR 58025A x IR 66R

### **Genes involved in EGMS**

- ❖ One or two pairs of recessive nuclear genes (cytoplasm involved)

### **Advantages of EGMS system**

- ❖ Maintainer lines are not involved
- ❖ Choice of parents are more.
- ❖ No negative effect on sterile cytoplasm

Genes for fertility restoration in CGMS system : Rf1 and Rf2

## **COMMERCIAL SEED PRODUCTION TECHNIQUE**

**Land requirement** : similar to variety

### **Isolation**

Space isolation : Foundation seed stage : 20  
Certified seed stage : 100 m  
Time isolation : 20 days either earlier or later for other varieties compared with MS line.  
Barrier isolation :

- 30m of wood lot / tall crops
- plastic sheets of 2m height

### **Season**

Kharif (May- June sowing)

Rabi (December- January sowing)

Rabi is more suitable than kharif.

### **Favourable climatic conditions during flowering for higher seed set.**

- ✓ Daily mean temperature 24 - 30°C
- ✓ Relative Humidity 70 - 80 %
- ✓ The difference between day and night temperature should be 8-10°C.
- ✓ Sufficient sunshine and moderate wind velocity of 2-3 m / second.





Between A line - (15 x 15cm)

Between A and R line - (20 x15cm)

Between R line - (30 x 15cm)

### **Age of transplanting**

A line : 25 days

R line : 14,18,20 days

### **Fertilizer**

Hybrids : 150:60:60

N & K applied in 3 splits

(1) during basal (2) active tillering (3) Panicle initiation.

### **Staggered sowing of parents for synchronization**

As the seed set on CMS line depends on cross pollination it is most important to synchronize the heading date of the male and female parents, especially for the hybrid combinations having parents with quite different growth duration.

In addition, in order to extend the pollen supply time, the male parent is usually seeded twice or thrice at an interval of 4-5 days.

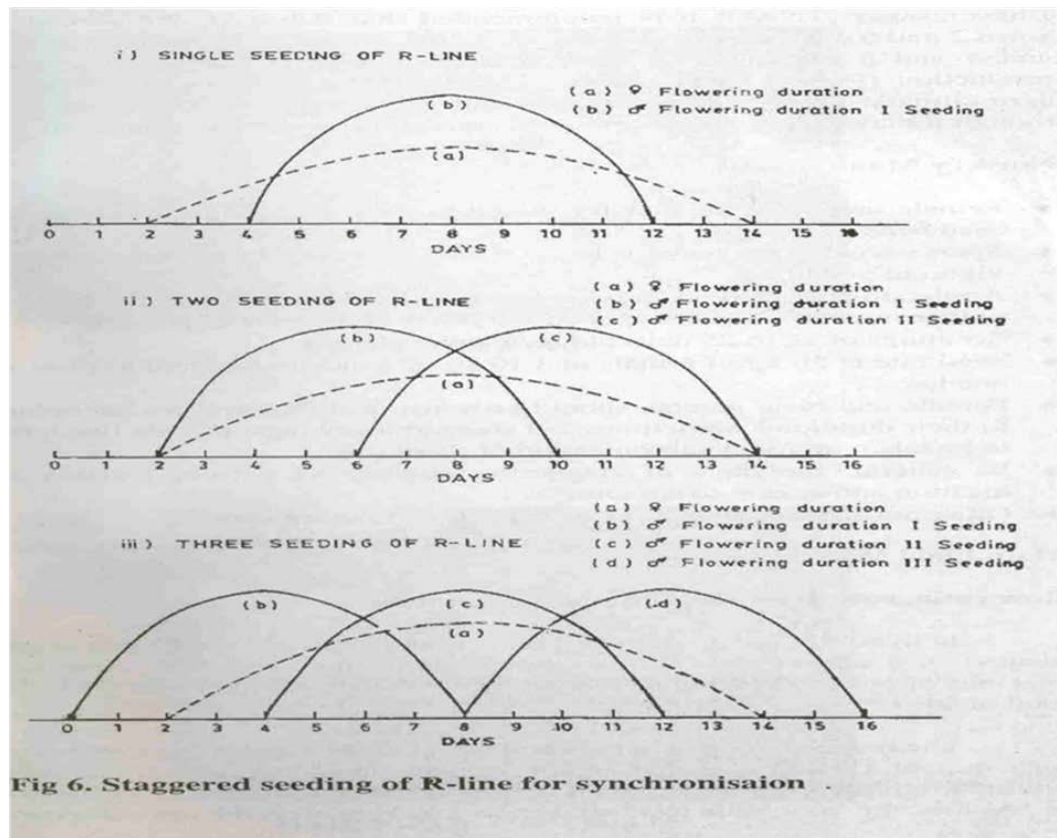
The following 3 methods can be used to determine the differences in seedlings date for synchronization between male and female parents.

1. Growth Duration Difference (GDD) method
2. Leaf Number Difference (LND ) method
3. Effective Accumulated Temperature (EAT) method

Among these 3 methods though the LND method is more reliable one, the GDD method is mostly followed since it is rather simple and easy to adopt. In GDD method by checking the previous data on the difference in duration from seedling to heading between male and female parents, the proper seeding date of both parents in current season can be determined. This method is suitable in seasons or regions where the temperature fluctuation is small.

## Staggered seeding of R line for synchronization.

1. Single seeding of R line
2. Two seeding of R line
3. 3 seeding of R line.



**Row ratio:** 8:2 or 10:2

### Factors influencing row ratio

1. Plant height of the pollinator
2. Growth and vigour of the pollinator
3. Size of the panicle and amount of residual pollen
4. Duration and angle of floret opening in CMS lines
5. Stigma exertion of CMS line.

### Layout for transplanting



•	•	X	X	X	X	X	X	X	X	•	•
R	R	A	A	A	A	A	A	A	A	R	R

Female: Male ratio = 8:2

wind direction :  $\longleftrightarrow$

### Transplanting of the 'A' line

Transplant the 'A' line seedlings in blocks of 8 rows in between the paired rows of 'R' line seedlings. Transplant with one or two seedlings per hill with inter and intra row spacing of 15 x 15 cm in 145 cm wide block or 10 x 15 cm in 110 cm wide block according to the fertility of field. Leave a 20 cm spacing between the 'A' line rows and the nearest 'R' line rows.



### Prediction of heading date

The method, which is widely used and found to be effective, is by examining the development of young panicles. Based on the morphological features, the young panicles are classified into 8 development stages. The synchronization in flowering can be predicted by using such criteria. In practice, about 30 days before heading, the male and female parents in the

seed production field are sampled and their young panicles within the main clumps and tillers are carefully observed with a magnifying lens every three days. Usually female and male parent will take 27 and 32 days respectively from panicle initiation to heading in 8 stages.

#### **Method of observing panicle initiation**

- Select the main tiller (the longest one) and cut at the base where stem and root join.
- Make a longitudinal slit from the base upto the top of the tiller
- Open the slit just above the nodal portion
- Observe the developing panicle with the help of a magnifying lens.

#### **Adjustment of flowering date**

If it is found during the first 3 stages of panicle differentiation that synchronization of flowering will not be attained, the earlier developing parent should be applied with quick releasing nitrogen fertilizer (2% urea spray) or apply 35 kg /ha of urea with knapsack sprayer at 500 lit /ha and the later developing parent should be sprayed with 2% solution of DAP. By this measure a difference of 4 to 5 days may be adjusted.

If it is found during the later stages of panicle differentiation that synchronization of flowering will not be attained a difference of 3-4 days may be adjusted by drainage or irrigation because the R lines are more sensitive to water than CMS lines. For instance, if R line is found to be earlier, draining water from the field will delay the panicle development. On the other hand if R line is found to be late, higher standing water would facilitate rapid panicle development.

If the difference in flowering period between the two parents reaches 10 days or more it is necessary to remove the panicles from early developing parent and



apply nitrogen fertilizer subsequently, thus making it late emerging tillers or unproductive tillers bear panicles and subsequently achieve synchronization of flowering.

Further during the **flowering stage** if the blooming time is found not to be synchronized (usually the R line flowers earlier than CMS line) adjustments can be made in blooming time by improving the microclimate in the field through drainage, removing dew drops from the CMS plants and spraying cold water to the R lines.

### **Application of Gibberellin (GA<sub>3</sub>)**

GA<sub>3</sub> plays an important role in rice hybrid seed production. It can adjust physiological and biochemical metabolism of rice plant especially stimulating the elongation of young cells. About 25-30% spikelets of a panicle are inside the flag leaf sheath in most of the indica CMS lines than that of the Japonica CMS lines. GA<sub>3</sub> has a definite role in exertion of panicle. In general, it is recommended that 50 g /ha with knapsack sprayer in two split doses, i.e. spray on 15-20% earhead emergence and 2<sup>nd</sup> spray in the next day for enhanced seed set.

GA<sub>3</sub> will not dissolve in water and hence it should be dissolved in 75-90% alcohol (1g in 20-25 ml of alcohol) and make the required solution. Spraying should be done at 8 to 10 a.m. and 4-6 p.m.

### **Advantages of GA<sub>3</sub> application**

- Enhances panicle and stigma exertion
- Adjust plant height of seed and pollen parents
- Speed up the growth of later tillers and increases the effective tillers
- Sets uniform panicle ear.
- Flag leaf angle is increased
- Increases 1000 grain weight
- Reduces unfilled grains
- Remarkably enhances seed setting and seed yield



## Supplementary pollination

Natural outcrossing was recorded less than 10% by Ramlingam et al. (1994). However, this depends upon the wind direction and its velocity.

Shaking the R line panicles by rope pulling at panicle level or rod driving during anthesis can make their anthers dehisce and spread the pollen widely and evenly thus the outcrossing rate could be increased. It is more effective especially on calm or breezy days.

Generally, supplementary pollination is carried out at 30 minutes interval for 5 times daily both morning and evening during peak anthesis (10-12 am and 2-4 p.m.) until no pollen remains on the R line. It is not needed when the wind is greater than moderate breeze.



## Foliar spray

Foliar spray of 2% DAP increases yield and qualities of seed

- ✓ Short duration:

Ist Spray	on 60 DAS
II nd "	80 "
  
- ✓ Medium duration:

Ist Spray	on 80 DAS
II nd "	100 "

## Roguing

Remove the undesirable plants either in A or R line rows that differ from plants that are true to type. The pollen shedders and off types are removed.

The undesirable plants come from many sources. They may be volunteer plants from the previous cropping.

The most important stages for roguing are at maximum tillering, at flowering and just before harvesting.

### Roguing in hybrids

In A line remove pollen shedders. In A line only 40-50% of seed set is possible. If > 60-70% seed is noticed and the panicle is drooping it would be R line (or) other varieties.

<b>Plants to be removed</b>	<b>A line</b>	<b>B line</b>	<b>R line</b>
Diseased plants	All	All	All
Parental lines	R line & B line	A line & B line	R line & A line
Early flowering plant	All	All	All

Rogues / off types : Based on variation in phenotypic Characters

### Harvesting, threshing & drying

- ✓ Turning of 90% green seeds to straw yellow colour is the stage of physiological maturity
- ✓ Moisture content will be 17-20%.
- ✓ Male parent should be harvested first .



- ✓ Care should be taken to avoid admixture of male line with female line while harvesting.
- ✓ The female parent should be threshed at 16-17% moisture content separately in a well cleaned threshing floor.
- ✓ The threshed seed should be winnowed and dried to reduce the seed moisture content to 12%
- ✓ The seed should not be dried under direct sun between 12 to 3.00 p.m. during hot sunny days.

### **Seed treatment**

Seeds are treated with thiram / captan @ 4 g/kg. or with 5 gm halogen mixture. The halogen mixture is prepared by mixing  $\text{CaOCl}_2$  +  $\text{CaCO}_3$  for 1 week in air tight container.

### **Storage**

- ✓ For short term storage use gunny bag or cloth bag.
- ✓ For long term storage use polythene bag of > 700 gauge and dry the seeds to 8% moisture content.
- ✓ When compared with varieties, the hybrids and parental lines A & B lines are poor in storability.
- ✓ The order of the storage potential is  $R > F1 > B > A$ .

**Others** - As in variety

### **Seed Yield**

Hybrid yield ( $F_1$ ) : 800-1200  $\text{kg ha}^{-1}$

### **General Tips**

- Nursery period, spacing, seed rate, fertilizer dose and days to maturation vary with short, medium and long duration varieties.

- Grain of paddy could be (visual) graded as long slender, short, medium bold based on shape but could not be separated on mechanical grading minding.
- Textures variation though not permanent exists in paddy seeds.
- Seeds of paddy have carbohydrate as the main storage reserve in the form of amylose and amylopectin which differentiates the japonica and indica varieties.
- SPLIT HUSK: Problem of split husk occur in hybrid rice seed production where the lemma and palia are not closed properly at tip portion. Occurrence is claimed to nutrient deficiency synchronization defects and genetic factors, as it
- Occurs more in female line than male line. Split husk reduces the germination due to heavier load of fungal colonies. Seed multiplication ratio 1:152
- Seed renewal period : three times

## Botanical description and floral biology

Wheat – *Triticum sp.* ( $X = 7$ )

Wheat is the most important cereal in the world, giving about one-third of the total production, followed closely by rice. In temperate regions it is the major source of food. The chief use of wheat is the flour for making bread.

### Systematic position:

- ✓ **Division** : Phanerogams
- ✓ **Sub-Division** : Angeosperms
- ✓ **Class** : Monocotyledon
- Series : Glumacea
- Sub class : Glumiflorae
- ✓ **Family** : Poaceae
- Tribe : Triticeae
- ✓ **Subfamily** : Pooideae

### Chromosome number:

**Diploid** :  $2n = 14$ , **Tetraploid** :  $2n = 28$ , **Hexaploid** :  $2n = 42$

**Diploid**: Asia minor, **Tetraploid** : Abyssinia, North Africa, **Hexaploid** : Central Asia

### Structure of Wheat Seed:

Fruit is a dry, one seeded indehiscent fruit known as caryopsis. The dorsal (back side) convex surface of kernal is smooth except at the base where the fruit coat is wrinkled indicating the position of embryo, it may be either hard or soft in texture with a creamy white, the ventral surface (front side) is flat and characterized by a deep furrow or groove.

### The following 4 structures are recognized in wheat grain

i. Seed coat, ii. Nucellar epidermis, iii. Endosperm and iv. Embryo.

## Reproduction

### Sexual reproduction

The time and duration of flowering is dependent upon geographical location. Sunny weather and temperatures of at least 11 - 13°C are required for flowering (OECD 1999). Florets on the spike of the main tiller open first and flowering commences in the middle of each spike and proceeds synchronously towards the tip and the base. In a study of wheat sown in May in Narrabri (northern NSW) the time from sowing to flowering was approximately 105-120 days and the time from flowering to maturity was approximately 35-45 days (in the ten year period 1990-2000; Sadras & Monzon 2006).

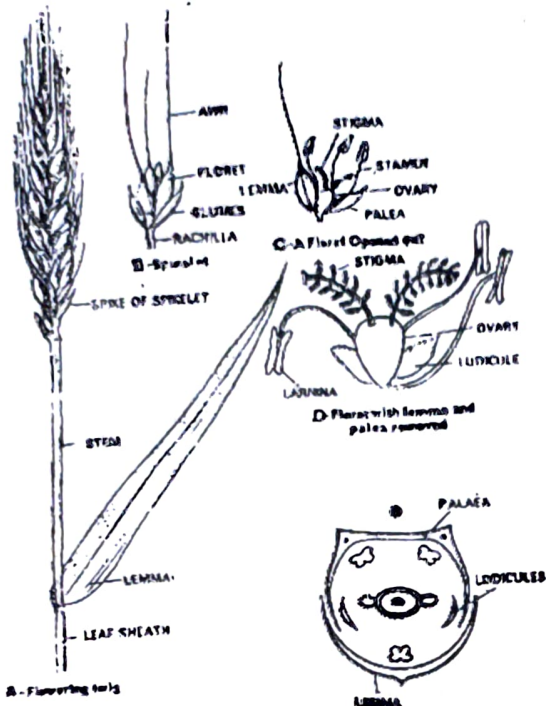
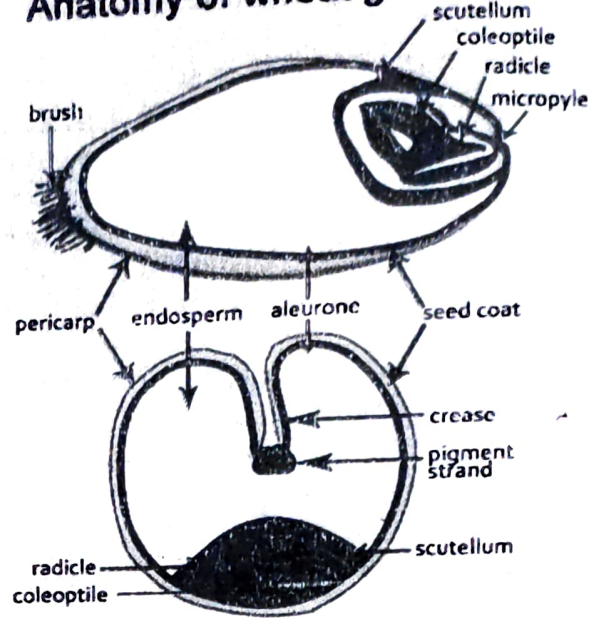


Fig. 11B.1. *Triticum aestivum*.

### Anatomy of wheat grain



#### • PERICARP/FRUIT COAT

##### Outer pericarp

- Beard/Hairs of brush
- Epidermis/Beeswing
- Hypodermis

##### Inner pericarp

- Cross cells/Mesocarp
- Tube cells/Endocarp

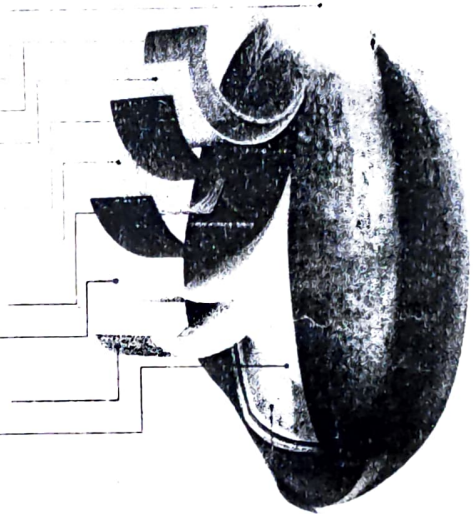
#### • SEED COAT

- Testa/Seed coat/Spermoderm
- Hyaline layer/Nucellar layer

#### • ENDOSPERM

- Aleurone cells/Aleurone layer
- Starchy endosperm/Flour

#### • EMBRYO



### Pollination and pollen dispersal

Wheat is largely cleistogamous, which means that pollen is shed before the flower opens (Frankl & Galun 1977) and thus wheat is primarily self-pollinating with low rates of out-crossing. Any out-crossing that may occur is facilitated by wind dispersal. Generally, wheat flowers lack nectaries to attract insects and the role of insects in cross-pollination is considered to be minimal (Glover 2002).



## Seed development

The rate of endosperm cell division is influenced by light intensity, water stress, temperature and genotype (Wardlaw 1970; Brocklehurst *et al.* 1978). Starch deposition begins 1-2 weeks after anthesis and initiates a 2-4 week period of linear increase in kernel dry weight. This process is also influenced by water stress, temperature and genotype (Simmons 1987). The growth and final weight of an individual kernel depends on the spikelet and floret position, the kernels formed in central spikelets and proximal florets within an individual spikelet are usually largest (Kirby, 1974; Simmons, 1987). Each wheat ear can produce approximately 30 to 50 kernels while the number of ears a wheat plant produces depends on the number of tillers produced and the number of tillers that produce a mature ear (Tennant *et al.* 2000).

## Seed Production Technology:

1. **Time of sowing:** The seed must be sown at optimum time of sowing i.e. between 15<sup>th</sup> to 30<sup>th</sup> November when average of day and night temperature is about 25<sup>o</sup>c. Wheat sowing can be extended upto late December but desired result may not be achieved.
2. **Suitable land:** Wheat seed production can be taken up in any kind of soil with good drainage system. Clay loam to sandy loam soil with neutral pH is most ideal for seed production. Avoid repeated cultivation of wheat over seasons to minimize the weed problem usually caused by wild oat and *Phalaris minor*. Sometimes volunteer plants of previous crop may exist and contaminate the seed plot. Practicing long term crop rotation is also considered helpful in minimizing risk of Karnal bunt disease problem. Karnal bunt is known to be soil borne and seed borne in nature and primary infection to the standing crop occurs at flowering stage when bunt sporidia are blown from soil surface to the wheat floret.
3. **Isolation requirements:** Crop must be kept away from undesirable pollen source. Though wheat is self pollinated crop, out crossing ranged from 1 to 4% may occur. To avoid the out crossing, the seed must be isolated with 3m strip all around the seed plot. Maintain 150m isolation from any other wheat plot where loose smut infection is exceeding 0.5%.
4. **Preparation of seed field:** One to ploughing and two harrowing is required before irrigating the seed plot. For good and uniform germination of seeds, presowing irrigation is necessary.
5. **Source of seed:** For certified seed production, seed have to collect from any authentic source as approved by seed certification agency.
6. **Seed treatment:** The entire seed have to treat with Vitavax @2.55g/ Kg if already not treated.
7. **Seed rate:** 80 to 100 Kg seed is required for one ha of land.
8. **Fertilizer requirement:** Wheat requires about 120 kg nitrogen, 60 kg phosphorus and 60 kg potassium per hectare depending upon the soil test values. Half amount of N and full amount of P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O fertilizers are applied just before the final land preparation. The remaining half of N i.e. 60 <sup>kg</sup> applied at 25 days after sowing.
9. **Spacing:** Row to row have to maintain at a distance 23 <sup>(22-25 cm)</sup> cm and continuous planting in 3cm depth.

10. **Irrigation:** For higher seed production six irrigations are needed. The six stages are (i) crown root initiation (ii) tillering stage (iii) stem extension stage (iv) booting stage or flag leaf stage (v) flowering stage (vi) milk stage/ dough stage. Much care should be adhered while irrigating the crop is post flowering stages. Even a mild wind may cause lodging in loose soils. Prefer to apply irrigation during night's hours when wind is generally calm.
11. **Weed control:** Timely weeding and interculture are desirable at initial growth stage. Weeds are becoming great nuisance in intensive wheat cropping areas and many times over dominate the crop resulting very poor yields. Pendamethelin @ 1kg a.i. per hectare in 750 liters of water just after sowing or Isoproturon @ 1kg a.i. per hectare in 750 liters of water just after 35 days of sowing may be used to control the weed.
12. **Rouging:** Two to three rouging is essential for removal of off type plants. The variant plant may have differences for morphological characters or susceptibility to disease like rust (*Puccinia* sp). The first rouging must be completed before the flowering initiation. The diagnostic characters of importance at this stage are plant growth habit, size shape and angle of flag leaf, colour of flag leaf, anthocyanin pigmentation of auricles, hairyness on flag leaf sheath and leaf blade, plant height etc. The second rouging may be started just at heading stage and should be completed quickly to avoid any chance of cross pollination from off type plants should be removed by uprooting. Third rouging should be done once the crop is reaching to maturity and heads have turned the colour. Character which should be looked at these stages is colour of ear head, awns and pubescence on glumes.
13. **Harvesting:** Once the crop is dry mature and seeds are hard and give cracking sound on pressing between teeth in mouth the crop is ready for harvest. At this stage the seed moisture is expected to be around 10-12%. Harvesting should be done quickly to avoid shattering and losses due to uncertain weather. Harvesting may be done by sickles or by combine harvester. In combine harvester the seeds are automatically harvested.
14. **Yield:** 34-38 quintal hectare

**Minimum field standard of wheat:**

Classes of seed	Minimum		Maximum%			
	Isolation (m), / iso for loose sowing affected plant(m)	No. of field inspection	Off types	Inseparable other crop plants	Objectionable weed plants	Plants affected by designated diseases
FS	3, /150	2	.05	.01	-	.10
CS	3, /150	2	.20	.05	-	.50

**Minimum seed standard of wheat:**

Class es of seed	Minimum					Maximum%			Moisture	
	Germin ation%	Pure seed%	Innert mater%	Other crop seed (no./kg)	Weed seed (no./kg)	Obj. Weed seed (no./kg)	Disease d seeds (% by no.)	ODV seeds (no./kg)	Ordinary pack (%)	Vapour prop pack (%)
FS	85	98	2	10	10	2	.05*, none**	-	12	8
CS	85	98	2	20	20	5	.25*, none**	-	12	8

Note: \* karnal bunt, \*\*nematode galls of earcockle & tundu



## SEED PRODUCTION TECHNIQUES IN PADDY VARIETIES

### Phenology

Botanical Name	:	<i>Oryza sativa</i>
Chromosome number [2n]	:	24
Family	:	Poaceae
Inflorescence	:	Panicle
Pollination	:	Self-Pollination
Panicle Emergence	:	4 –5 days after boot leaf emergence
Flower Opening Pattern	:	Tip of primary & secondary branches and proceeds downward
Duration of Flowering	:	6-8 days
Time of Anthesis	:	7.00 –10.00 A.M
Speciality with flowering	:	Flower remain open for 10 minutes and afterwards it closes.
Anther dehiscence	:	Either before or after flower opening [independent of spikelet opening]
Temperature favorable for flowering	:	24 -28 <sup>0</sup> C
Favourable RH for flowering	:	70-80%
Difference between day and Night temperature	:	8-10 <sup>0</sup> c
Stigma receptivity	:	3 days
Pollen viability	:	10 minutes

### Varietal seed production



## **Stages of seed production**

In paddy depending on the demand 3 or 4 or 5 stages of seed multiplications are permitted under seed certification programme as follows.

- Breeder seed - foundation seed - certified seed
- Breeder seed - foundation seed stage 1- foundation seed stage 2 – certified seed
- Breeder seed - foundation seed stage 1- foundation seed stage 2 - certified seed 1- certified seed 2

## **Land requirement**

The land should be free of volunteer plants (crop of previous season occur in this season) and the same crop or the other varieties of the same crop should not have been grown for the previous season, if it is the same crop it (previous) should be the same variety that has been certified. This selection is highly important for maintenance of genetic purity. They should have adequate irrigation and drainage facilities and the problem soils are not suitable for seed production.

## **Isolation**

The crop should have 3meters of isolation at all sides of the seed production plot for maintenance of genetic purity.

## **Selection of seed**

Seed should be from an authenticated source (SAU, NSC, State Department).For production of certified seed, foundation seed (FS) should be used as source seed which should be purchased with bill and tag (white for FS seed)

## **Seasons practiced at Tamil Nadu**

In Tamil Nadu the availability of water in canals, depends on the monsoon. Based on this in different districts, different sowing seasons are adapted as follows:

Month of sowing	Seasons	Duration of varieties
December - January	Navarai	Below 120 days
April – May	Sornavari	Below 120 days
April – May	Early kar	Below 120 days
May – June	Kar	Below 120 days
June – July	Kuruvai	Below 120 days
July - August	Early samba	130 -135 days
August	Samba	130-135 & above 150 days
September – October	Late samba / thaladi / pishanam	130 - 135 days
November – October	Late thaladi	115 -120 days
November - October	Late pishanam	130 -135 days

### Selection of season

Season should be selected based on duration of the variety and the water availability.

VARIETIES	SEASON	DURATION	POPULAR VARIETIES
Short duration varieties	November- December (Karthikai –Margazhi)	Below 120 days	TKM9 ,CO 36, ADT 36
Medium duration varieties	November (Iyppasi- Karthikai)	130-135 days	Bhavani ,CO43,
Long duration varieties	August (Adi-Avani)	More than 135 days	White Ponni,
Upland rice	July –August ---on receipt of showers .TKM9 and IR 50 should be sown Before 15 <sup>th</sup> of July (direct seeding)	All durations but variety specific	MDU1,PKM1 Co 43,IR 20

Rainfed rice	June-July and September – October	Specific to location	ADT 38 ADT39 (Medium Duration Varieties)
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### Seed Rate

It varies with varieties and type of cultivation.

Variety / type of cultivation	Seed rate
LOW LAND CULTIVATION (transplanting)	
Short duration varieties	60 kg /ha
Medium duration varieties	40kg /ha
Long duration varieties	30kg/ha
For low land cultivation by broadcasting	80-100 kg/ha
For rainfed rice	75-100 kg/ha

### Seed Management Technique

#### Dormancy

Paddy exhibits dormancy which varies for duration of 0-30/45days depending on the variety. This could be broken by either soaking in  $\text{KNO}_3$  0.5 % for 16 hr or soaking in 0.1N  $\text{HNO}_3$  for 16 hrs. However the duration and concentration vary with varieties (e.g.) ADT36 exhibit 20-30 days of dormancy period from days to physiological maturity period which could be broken by soaking the seeds in 0.5% $\text{KNO}_3$  for 16 hrs. Practically the intervening duration between the harvesting, and threshing, and further drying will remove the dormancy.

#### **Seed Upgradation Technique (Egg Floatation Technique)**

Either before processing or after storage or due to improper processing Paddy seed may have less vigorous seed such as immature, ill filled and insect damaged seed which may adversely affect the planting value of the seed.

Removal of this seed will favour better establishment and higher production potential. These seed may be removed by adaptation of a simple water floatation technique based on specific gravity using salt water as a dissecting solution for separation of good quality seed from low quality seed, and egg is used as an indicator for specification of specific gravity measurement of 1.03 (120g of salt in 1000ml of water)

### **Methodology**

A bucket of potable water has to be taken and in that water o fresh egg which sinks to the bottom has to be taken. To the potable water with egg outside slowly the common salt was added to a level at which the egg floats at top exposing 2.5 cm of its shell outside (check the egg floatation now and then on addition of salt to the solution). The egg is removed and the paddy seed are dropped into the solution which separates as sinker and floater .the sinkers are good seeds while the floaters are less vigorous and dead seeds. The floaters are removed and used as feed and sinkers are used for further multiplication.

### **Caution**

- Egg is only for measurement of specific gravity and has no work to do with separation.
- If the density of water is more, more portion of egg will float if less egg will be inside the solution.
- If the density of water is more loss of quality seed may occur ,lesser density the separation will not be perfect

### **Sprouting of seeds (pre germination)**

Paddy seeds are sown at nursery in pre germinated condition for better establishment for supply of oxygen at waterlogged condition. Seeds are soaked in big tough for 24 h in gunny bags tied loosely for easy transmission of water and for ensuring soaking of each and every seed. Seeds are then tied tightly and incubated in dark for 12h (overnight). White protrusion of radices by the seed exposed to outside expresses the pre germination of seeds and these seeds are sown in nursery by broadcasting.

## Hardening and other seed management techniques

- In case of implementation of fortification treatment, seed could be soaked in equal volume of water to ensure that none of the solution is left unimbibed by the seed
- For dry land and upland paddy, seed hardening with KCl (1%) and pelleting with *Azospirillum* (600g /ha) could be adopted (e.g.) MDU 1, Paramagudi1.
- Seed colour variation occurs due to bacterial infection at later stages of maturation. Seed coloring with polycoat @3g kg<sup>-1</sup> of seed could improve the initial quality and marketability of such discolored seed.
- Polymer coating of Seed also will help to identify the brand name of seed and to identify the varietal variation among the cultivars by even the illiterate labours.

## Nursery Management

For raising one hectare of paddy, 20 cent (800m<sup>2</sup>) nursery is needed. The area should be prepared by floating the area one or two days before ploughing and allowed the water to soak in. The soil should be kept at shallow sub emergence. Before ploughing the water should be allowed to a depth of 2.5cm. Then the land is ploughed and brought to a puddling condition. The optimum size of the nursery bed will be 2.5 meters broad and with channels of 30cm width in between. In paddy, on raising more varieties in a same place **separate irrigation channels** are to be prepared for each variety to avoid the admixture of seeds and to maintain the genetic purity.

## Nutrient Management

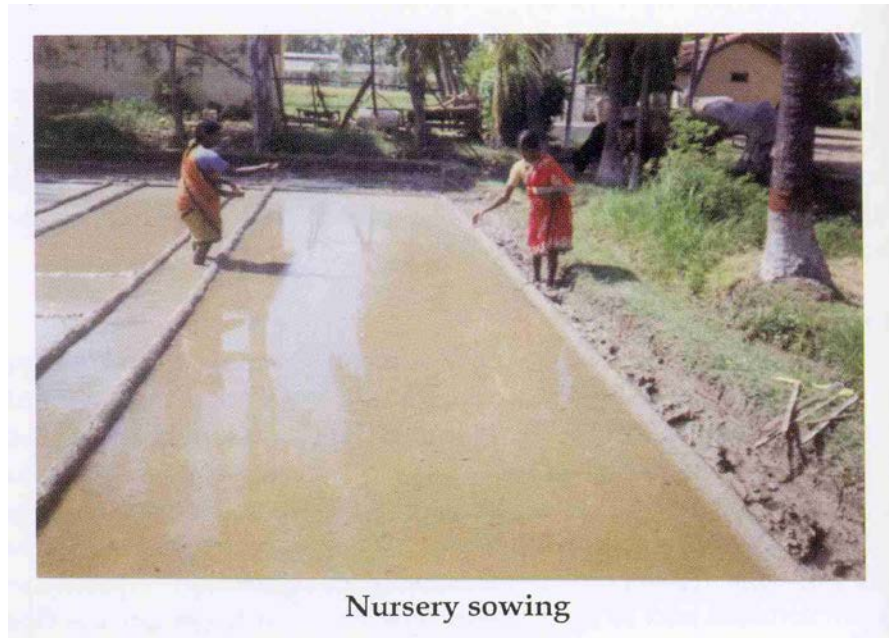
Before the last puddling apply 40kg of DAP and if not readily available apply straight fertilizers @16 kg of urea and 120kg of super phosphate.

Basal application is required (DAP) if the seedlings are to be pulled out at 20 to 25 days after sowing. If the seedling are to be pulled out after 25 days application of DAP is done 10 days prior to pulling out of the seedling.

Basal application of phosphorus to the nursery enables the seedling to store phosphorus and utilize it even in later stages of growth and application of DAP to the nursery is highly economical.

### **Sowing**

A thin film of water should be maintained in the nursery, and the sprouted seeds of paddy should be sown uniformly on the seed bed.



### **Water Management**

- Drain the water 18 to 24 hours after sowing and if there are pockets where water is stagnating, drain it into the channel as germination will be affected in the places where the water is being stagnated
- Allow the water to saturate the soil from the third to fifth day
- From the fifth day onwards increase the quantity of water to a depth of 1.5 cm depending on the height of the seedling
- Afterwards, maintain the water level to a depth of 2.5 cm

### **Weed Management**

Apply any one of the pre emergence herbicides viz. butachlor 2l per ha, thiobencarb @ 2l/ ha, pendimethalin @ 2.5l/ha on 8<sup>th</sup> day after sowing to

control weeds in the low land nursery. Keep a thin film of water and allow it to disappear. Avoid drainage of water. This will control germinating weeds.

### **Pest Management (NURSERY)**

<b>INSECTS /DISEASE</b>	<b>CONTROL MEASURES</b>
Army worm	Spray Cholophyriphos 20EC 80ml or endosulphan 35 EC80ml during the evening
Thrips	Phosphamidon85 WSC 25 ml(or)Monocrotophos 36 WSC 40ml (or) Endopsulfan 35 EC 80 MI
Green leaf hopper	As above or maintain 2.5 cm of water in the nursery and broadcastanyone of the following Carbofuran3g3.5kg or Phorate 10G1.0kg or Quinalphos 5g 2.0kg
Case worm	Mix kerosene in standing water and remove the cases and destroy and spray Monocrotophos 36 WSC 40ml (or) Quinalphos 25 EC 80 ml
White tip nematode	Sun drying of seeds for two days at 6h interval
Rice root nematode	Carbofuran3g at 3.5kg / 20cents
<b><i>Diseases</i></b>	
Blast	Spray with insecticide Copper oxy chloride100g or Mancozeb 80 g
Brown spot	Carbendazim 40 g
Tungro disease	Applly carbofuran 3g at the rate of 3.5 kg ten days after sowing or spray two rounds of Monocrotophos 36 WSC 40ml or Phosphamidon 85 WSC 25 ml

### ***Age of transplanting***

The age of transplanting vary with varieties as follows

<b>DURATION OF VARIETIES</b>	<b>AGE OF TRANSPLANTING</b>
Short duration varieties	18-22days

Medium duration varieties	25-30days
Long duration varieties	35-40days

### ***Pulling out of seedling***

- Pull out the seedling at appropriate time
- Do not remove the adhering soil with a hard surface
- Tie the seedling in convenient size for easy handling
- Do not allow the seedling to dry



### ***Main field preparation***

- Puddle the soil well
- Apply 12.5tonnes of FYM or compost per ha
- Incorporate green manure into the field by *in situ* ploughing
- Dig the corners and prepare the bunds well with plastering for effective stagnation of water
- Apply the phosphorus and potasic fertilizers at last ploughing for effective availability of nutrients to plants
- Keep a thin film of water at the time of transplanting and raise the water level to 2.5 cm on the next day

### **Fertilizer Requirement**

<b>CROP DURATION</b>	<b>FERTILIZER REQUIRMENT ( Kg / ha )</b>
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	<b>Nitrogen ( N )</b>	<b>Phosphorus ( P )</b>	<b>Potash ( K )</b>
Short duration	120	38	38
Long and medium duration	150	50	50
Bio-fertilizer	Azolla @ 1t/ha 3-5 days after weeding		

### Transplanting

- Dip the root in phosphamidon 0.02 % against rice root nematode 20 minutes prior to planting
- Plant the seedling at optimum spacing and optimum depth
- Transplant the seedling at 4-5 leaf stage



### Details on transplanting

<b>Specifications</b>	<b>Duration of cultivars</b>		
	<b>Short</b>	<b>Medium</b>	<b>Long</b>
No. of seedling per hill	2-3	2	2
Depth of planting (cm)	3	3	3
Spacing ( cm)	20 x10	20 x15	20 x20
No. of hills/m <sup>2</sup>	50	33	25

Breeder seed multiplication	Adopt double row planting with a spacing of 15 x 10 cm for easy roughing
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- Adjust the sowing in such a way that harvesting does not coincide with rain

## Weed Management

### Pre emergence herbicide

Use butachlor 2.5l/ha or thiobencarb 2.5l/ha fluchloralin2l/ha or pendimethalin3l/ha as pre emergence on third day and is to be followed by hand weeding on 30-35days. On the failure of pre emergence application, hand weed at 15 days and spray 24Dsodium salt with a high volume sprayer 3 weeks after transplanting when the weds are in3-4 leaf stage

### Gap Filling

It is to be taken up between 7-10days after transplanting

### Pest and disease management

Insects	Control measures
Stem borer	Fenthion100EC @ 500ml
Thrips	Phosphamidon85 WSC @ 300ml
Brown plant hopper	MonocrotophosWSC @ 500ml
Leaf folder	Endosulfan 35EC @ 60ml
Stemborer (white ear 2 %)	Quinalphos 25EC @ 1000ml
Mealy bug	Phosphamidon85 WSC @ 300ml
Earhead bug	Quinalphos 25EC @1000ml
Rice root nematode	Carbofuran3g 16.25kgin standing water
<b>Diseases</b>	
Blast	Carbendazim @ 250g/ha
Brown plant hopper	Mancozeb @ 1000g/ha
Sheath rot	Carbendazim @ 250g/ha

Sheath blight	Difolatan @ 200
Bacterial leaf blight	Streptomycine Sulphate+Tetracycline@300g+Copper Oxychloride @ 1250g/Ha
Grain discolouration	Mancozeb@1000g/ha

### **Water Maintenance of Paddy**

- 5cm of water should be stand in the field. Normally once in 2 days for loamy soils and once in 3 days for clay soils.
- Excess water leads to yellowing of plant. So drain the water
- The critical stages of irrigation are primordial initiation, booting, heading and flowering

### **Top Dressing**

Apply 25% of N and k as basal and remaining 75 % in 3 split doses at active tillering, panicle initiation, and at heading stage in equal proportion of 1:1.

### **Foliar Spray**

- Spray  $\text{FeSO}_4$  0.5% to prevent yellowing of plants in calcareous soils.
- Spray DAP 2% to enhance seed set in paddy cultivars (BEST).
- Spray  $\text{GA}_3$  three times at panicle initiation stage for complete exertion of panicle (hybrids).
- Spray panchakavya 1% for organic seed production to enhance seed set.
- Spray 0.5 % zinc sulphate thrice during crop growth on 20<sup>th</sup> 30<sup>th</sup> and 40<sup>th</sup> day of planting for short duration varieties or 30<sup>th</sup> 40<sup>th</sup> and 50<sup>th</sup> day for medium and long duration varieties in case of zinc deficient soils.

### **Rouging**

- Is important to maintain for maintenance of genetic purity.

- Remove all off types (deviant of the variety) and rouges (variant of the variety).
- Remove when suspected is the thumb rule of roughing.
- Rouging should be done from the sowing up to harvest and remove the as and when it come across.

### **Physiological maturity**

- ✓Seeds attain maturity with the visual symptom of turning of ear heads to golden yellow color and when the ear heads exhibit drooping symptomsi.e 28 days after 50% flowering in short and 31 days in medium and 35 in long duration.
- ✓When 80% of the plants are exhibiting the symptom the crop is ready for harvest
- ✓The moisture content of the seed will be 18-20-%.

### **Pre-harvest Sanitation Spray**

Ten days prior to harvesting spray endosulphan 30EC 70ml / ha against storage pests. Spraying of 10 % prosopis leaf extract is recommended against grain discolouration.

### **Harvesting**

- Lodged plants should not be selected for seed purpose.
- Withhold irrigation one week before harvest.
- Delayed harvest may lead to heavy shattering
- Bundled plants should be stacked as ear heads facing outside to avoid heat damage.
- Threshed produce should be clean and free of admixture in cracks and crevices.
- Birds scaring are also practiced in places of requirement.

### **Threshing**

- Thresh the seed by beating the plants on a hard surface ,but take care that the seeds are not mechanically damaged.

- In tractor and machine threshing avoid mechanical damage by proper adjustment of speed/machine setting.
- Thresh at proper moisture content to avoid crushing / cracking (16-17 per cent).
- Clean the floor, equipment, containers to avoid genetic and physical mixture.

### **Winnowing and Drying**

Threshed produce are cleaned and winnowed to remove the dirt and other unwanted physical material. Winnowing should be done in a cleaned surface. The seeds are dried in a threshing floor with adequate stirring which is known as tempering. The seeds are dried to 13 % moisture for better storage .On drying in a threshing avoid drying between 12 noon to 2pm to avoid the ill effects of ultra violet rays of noon sun. Through not for bulk for prolonged storage this practice should be adopted. Seeds are also can be dried in mechanical driers in places of high humidity like areas of sea shore.

### **Grading**

The bulk seeds are normally processed through seed cleaner cum grader and the seeds of middle sieve are selected for seed purpose.

<b>Size of seed</b>	<b>Sieve size</b>
Long slender (Ponni, whitePonni)	= 1/16 x 3/4 " (1.3mm x 19 mm)
Slender - IR 50	= 1/15 x 3/4" "
Medium slender (IR 20, CO 43)	= 1/14 x 3/4" (1.5 mm x 19 mm)
Short bold (ADT 36, 37,38,39, TKM 9,Ponmani)	= 1/13 x 3/4" (1.8 mm x 19 mm)

### **Seed Treatment**

Normally paddy seeds are not treated with chemicals owing to their economic utility. But for long term storage, treat it with captan or thiram or bavistin @ 2-4g / kg of seed, Halogen mixture treatment (Chlorine based halogen mixture @3 g /kg of seed) is a eco-friendly treatment. As a prophylactic

measure seed can be fumigated with celphos @ 3-6g/m<sup>3</sup>. But the moisture content of the seed should not be above 10-12% which may interfere with the seed quality in terms of germination.

### **Seed Yield**

The yield of crop varies from 3000 to 7000 kg /ha depending on genotypes, location, season management practices and pest infestation.

### **Storage**

Paddy is a good storer. Generally paddy seeds store well up to 12-36 months depending on the genotypes but heavy infestation of storage pests reduce the storability of seed even to a month or two. For prolonged storage HDPE and polylined gunny bags are used, while for normal storage jute canvas bags are used. However the bags should not be stirred for more than 8 bags height to avoid pressure on seeds of lost bag which may cause damage to the seed. Polythene bags of 700 gauge is not highly preferable for paddy as the sharp edge may pierce the bag and convert moisture vapor proof container as moisture pervious container.

### **Mid storage Correction**

Seeds from storage are given with mid storage correction when the seed standard reduce to 5-10% lesser than recommended. The seeds are soaked in double the volume of disodium phosphate solution (3.60g dissolved in 100l of water) for 16h and the seeds are dried back to original moisture content (12-13 percent).

### **Seed Certification**

#### **Land Requirement**

The previous crop should not be the same crop and if to be the same crop it has to be the same variety and should be certified and has to be accepted for certification. The field should not have any volunteer plants.

## Number of Inspections

A minimum of two inspections is needed, one at the time of flowering and another at the time of or before harvest.

## Field Standards

General: Paddy field should be isolated from contaminants as follows

Contaminants	Minimum distance(meters)	
	Foundation stage	Certified stage
Fields of other varieties	3	3
Fields of same variety not confirming to varietal purity requirements for certification	3	3

Specific standard: These are verified at the final inspection

Factor	Maximum permitted (%)	
Off types	0.050	0.20
Objectionable weed plants*	0.010	0.020

\*Objectionable weeds are Wild rice (*Oryza sativa* L.*var.fatua* Prain (*Syn.O.satva* L.f. *spontanea* Rosch.)

## Seed Standard

Factor	Standards for each class	
	FOUNDATIO	CERTIFIED
Pure seed ( maximum)	98.0%	98.0%
Inert matter (maximum)	2.0%	2.0%
Huskless seed (maximum)	2.0%	2.0%
Other crop seed (maximum)	10/kg	10/kg
Other distinguishable varieties (maximum)	10/kg	10/kg
Total weed seed (maximum)	10/kg	10/kg
Objectionable weed seed (maximum )	2/kg	2/kg
Seeds infected with paddy bunt ( <i>Neovossia horrida</i> (Tak.) ( maximum)	0.10% (By number)	0.50% (By number)

Germination ( Minimum)	80%	80%
Moisture (maximum)	13.0%	13.0%
For vapour proof containers (maximum)	8.0%	8.05%

### **Paddy Bunt**





## SEED PRODUCTION IN MAIZE

Maize is common millet of India with wider industrial and household utility. It is used a feed, food and raw material in soft drink industry. Botanically it is known as *Zea mays* and belongs to the family poaceae.

### Floral biology

Botanical name	:	<i>Zea mays</i>
Chromosome number	:	2n=20
Botanical Family	:	Poaceae
Inflorescence	:	Panicle cob, as the crop is monoceious in nature
Type of flowers	:	Female : Cob (axillary inflorescence in the middle portion of plants) Male : Tassel (terminal inflorescence)
Husk	:	Enlarged leaf sheaths from each node, forming a protective covering around the inflorescence.
Pollination	:	Cross pollination
Special character	:	<a href="#">Protandry</a>
Flowering pattern	:	Top to bottom (Tassel) Bottom to top (Cob)
Anthesis	:	Pollen shedding begins 1 to 3 days before the silk emerge from the cob.
Fertilization	:	Within 12 to 18 hrs after silk emergence The entire silk is receptive. Silk will be pinkish and sticky at the beginning (receptive) after fertilization it will be chocolate / brown colour.
No. of pollen in tassel	:	2,50,00,000
Pollen viability	:	12-18h
Silk receptive	:	8-10 days
Male flower anthesis	:	6.00 am to 8.00 a.m
Duration of flowering	:	2-14 days

Tassel



Cob



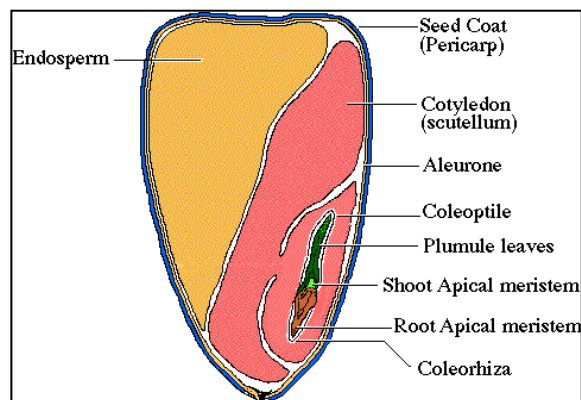
Husk



Silk



Seed



## **Types and Methods of seed production in maize**

In maize, open pollinated varieties, synthetics, composites and hybrids are available.

### **a. Open pollinated varieties**

Raise the varieties under isolation of 400 m in foundation seed stage and 200 m in certified seed stage and allow the plants to openly pollinate among themselves and set seed.

### **b. Synthetics**

In cross pollinated species, a variety obtained by in mating in all possible combinations, a number of lines (>5) that combine well with each other. COBC 1 (Baby corn).

### **c. Composite varieties**

These are produced by open pollination among a number of outstanding strains usually not selected for combining ability with each other e.g. K1, Jawahar, Vikram, Sona, Amber, CO 1 and Kisan.

### **d. Inbreds**

It is relatively true breeding strain resulting from repeated selfing (5 times.)

## **Varietal seed production technique**

Open pollination under isolation is the common method of varietal seed production.

## **Stages of seed multiplication**

In maize seed (varieties composites and synthetics) is multiplied adopting three generation system, as breeder seed, foundation seed and certified seed as the crop is highly cross pollinated crop , where the chances for genetic contamination is high.

## **Popular varieties**

In Tamil Nadu, CO1, K1, COH3, COH4, are the popular varieties for grain purpose, while African tall is a fodder maize.COBC1 is a variety identified for salad purpose.

## **Season**

The best season for production is June - July, November- December and

January – February and the flowering should not coincide either with rain or high RH and the maturation should coincide with dry weather. The temperature of 37°C is favourable for better seed setting.

### **Land requirement**

The land required for open pollinated variety, composites and synthetics should be fertile and problem soils will lead to low pollen fertility and will adversely affect the quality and the seed set will be poor. The previous crop should not be the same crop to avoid the occurrence of volunteer plants and if to be the same crop it has to be the same variety and should be certified and has to be accepted for certification. The field should not have any volunteer plants.

Isolation distance and Modification of isolation distance

Composite, Synthetics and OPV = (FS:CS 400 : 200 m)

Differential blooming dates are permitted for modifying isolation distance provided 5.0% or more of the plants in the seed parent do not have receptive silks when more than 0.50% of plants in the adjacent field (s) within the isolation distance are shedding pollen.

Distances less than 200 meters may be modified by planting border rows of male parent, if the kernel colour and the texture of the contaminant are the same as that of seed parent. The number of border rows shall be determined by the size of the field and isolation distance from the contaminant.

### **Selection of Seed**

For production of foundation seed, breeder seed is used as the base material, while for certified seed, foundation seed should be used as the base material. The seed used should be from authenticated source with tag and bill. The required seed rate will be 20kg /ha or 8kg/ acre.

### **Pre sowing seed treatment**

The seeds are given with any one of the seed treatment or in combination. Seeds are soaked in 2%  $\text{KH}_2\text{PO}_4$  for 16h with a seed to solution ratio of 1:0.06

and are dried back to their original moisture content of 8-9% .This management could be used both for dryland agriculture as well as gardenland.

Seeds are also treated with 5% carbofuran 3G to protect the seed from shoofly infection. Seed treatment with chlorpyriphos @4 ml /kg is also recommended against the attack by shootfly.

Seeds are dry dressed with bavistin @2g/kg of seed to protect against seed borne pathogens and soil borne pathogen.

Seeds are also treated with azospirillum @50g/kg of seed to fix atmospheric N. Any one of these treatment or combination of treatment is adopted for better productivity.

Seeds are also treated with polycoat @ 3g/kg of seed diluted in 5ml of water to invigourate the seed towards better marketability and production. Pink coloured polycoat performed better than other colour polymers. On adoption of sequence of treatment physiological should be followed with physical seed treatment.

### **Sowing**

The seed are sown at a spacing of 45 x 10 cm or 60 x 20 cm at a depth of 2-4 cm based on the specific features of the variety. Nursery production will not be suited to this crop. In the main field seeds are sown either in ridges and furrows or under beds and channels. The seedlings are thinned and gap filled should be done 7-8 days after sowing.

**Plant spacing**



**Row spacing**



## **Seed rate**

Varieties : 20 kg /ha

## **Nutrient application**

At last ploughing apply 12.5 tonnes of compost per hectare

## **Fertilizers(varieties) 150:75:75**

- ✓ Basal 40:75:40 NPK kg/ha
- ✓ 1<sup>st</sup> top 20 DAS 50:0 :0 kg/ha
- ✓ 2<sup>nd</sup> top 40 DAS 60:0:35 kg/ha.

## **Micronutrients**

2% DAP is sprayed at 50% flowering stage to enhance uniform flowering and increased seed set

If Zn deficiency is found apply 20 kg of zinc sulphate / ha.

If Fe deficiency is found apply 12.5 kg /ha micronutrient mixture

- ✓ The crop is mostly affected by micronutrient deficiencies by N,P,Mg,Mn,Zn,Fe and K. Apply 12.5kg of micro nutrients in furrows and the mixture in the soil.

## **Weeding**

Application of atrazine @ 500g per ha as pre-emergence herbicide control the growth of weeds upto 20-25 days.(If pulses is used as intercrop do not use atrazine) One hand weeding at 17-18 days after sowing keep the field free of weeds.Weeding after boot leaf stage is not economical and shade will also minimize the weed flora . On organic production, 2 hand weeding at seedling stage and other at boot leaf formation will keep the field weed free.

## **Irrigation**

The crop should be irrigated once in 10-15days for enhanced seed set and formation of bolder grains. The critical stages of irrigation are primordial initiation stage, vegetative stage , flowering, milky and maturation stage. If the irrigation is withheld in these stages seed set will be poor and seed size will be reduced.

## Pest and disease management

Shoot fly	Monocrotophos 0.03%
Stem borer	Rogar 0.3% / Carbaryl 50 WP 1kg.per hectre on 20 <sup>th</sup> day
Lesion nematodes	Carbofuran 3 G@30kg./ha.in seed holes at the time of sowing.
Downy mildew	Mancozeb @ 1kg/ha.
Leaf spot	Mancozeb or captan @ 1kg/ha
Cob borer	Apply carbaryl 10% dust @ 25kg/ha. At milky stage repeat it 15 days thereafter.(50 lts. Spray fluid per ha)

## Roguing

It is specific to seed crop and is done from seedling stage to harvesting stage based on the phenotypic characters. Off types can be identified through stem colour, plant structure, number of leaves, auricles, nodal colour, tassel colour, sheath colour, grain colour etc. The field standard for seed crop is as follows

## Seed Certification

### Number of Inspections

A minimum of two inspections shall be made at flowering and another during flowering.

### Field Standards

General: Maize field should be isolated from contaminants as follows

Contaminants	Minimum distance(meters)	
	Foundation stage	Certified stage
Fields of other varieties	400	200
Fields of same variety not confirming to varietal purity requirements for certification and teosinte	400	200

In maize hybrid alone increasing the border row and minimising the isolation is permitted

Specific standard: These are verified at the final inspection

Factor	Maximum permitted (%)	
	FS	CS
Off types plants that have shed are or shedding pollen at anyone of the inspections during flowering when 5% or more of the plants in the seed field have receptive silks .	1.0	1.0

### Preharvest sanitation spray

Spraying of endosulphan @ 0.07% and bavistin@10g /lit 10 days prior to harvest prevent the seed weevil ( Sitophilus oryzae) infestation at storage.

### Seed maturation

- 14-20 DAA milky stages (starch in fluid stage)
- 35 DAA : Soft dough stage
- 45 DAA : Glazed dough stage
- 55 DAA : Ripe dough stage

### Symptom of Physiological maturation

- Cob sheath turn straw yellow colour
- The funicular degeneration
- Formation of dark layer
- Moisture content of seed 35%



**Matured cob**



**Dunken layer**



### **Harvesting**

The crop attains physiological maturity 30-35 days after 50% flowering and the seed moisture at this stage will be around 25-30%. The crop is harvested as cob harvesting when the sheath of cob dries and attains straw yellow color. The crop is harvested as once over harvest for seed purpose.

### **Dehusking**

After harvest manually the sheath are removed, which is known as dehusking.



## **Cob sorting**

Based on the kernel arrangements on the shank as irregular discoloured, diseased and ill filling the Cobs are sorted out and cobs with characteristic kernel colour and shank colour and regular row arrangements are selected for seed purpose. The kernel discolouration should not 10% for certification.



## **Zenia and metazenia**

The discolouration in cobs may be due to disease infection or genetic contamination. The effect of foreign pollen on kernel colour is known as Zenia, metazenia effect which causes genetic contamination in the seed lot. Zenia is the effect of foreign pollen of same generation and metazenia is the effect of foreign pollen in next generation.



## **Shelling**

The cobs are dried under sun and threshed with flialle stick for extraction of seeds the moisture content of seed at the time of threshing will be 15-18%. On large scale production cob shellers are used, but care should be given to avoid mechanical damage, which in turn will reduce the seed quality and storability.

## **Drying**

The seeds are dried to 8 to 10 % moisture content either under sun or adopting mechanical driers for long term storage as the seeds is orthodox in nature.

## **Processing**

Mechanical grading can be done with cleaner cum grader, which will remove the undersized immature and chaffy seeds .The middle screen size should be 18/64" round perforated sieves. The size can vary depending on the variety from 14/64 to 20/64 inch round perforated sieves.

## **Seed treatment**

The seeds are infested with several storage pests, to protect against these pests the seeds are given protective treatment with bavistin @2g/kg of seed with carbaryl @200mg/kg of seed as slurry treatment. Bifenthrin @5mg /kg of seed or diflubenzuran @ 200 ppm per kg of seed or imidachlopride @ 3 ml per kg of seed is also recommended for better seeds storage .

## **Seed packing**

Seeds are packed in gunny bag for short term storage while in HDPE and polylined gunny bag for long term storage.

## **Storage**

The treated seed can be stored up to 12 months provided the seeds are not infected with storage pests. Seed can be stored up to 3 years if the seeds are packed in moisture containers and are stored at low temperature .The godown should be kept clean as the possibility of secondary infestation with Trifolium (red

flour weevil ) is much in these crop. The major problem in storage is incidence of grain weevil which will powder the seed material in a short period.

**Seed yield:** 3 to 4.0 tones

### **Seed standard**

The processed seed should have the following seed quality characters both for certification and labeling.

A. Seed ears inspected after harvest shall not contains in excess of 1.0% of offtype ears including the ears with off-coloured kernels.

B. Shelling

Shelling of the seed ears is to be done after obtaining approval from the Certification Agency

<b>Factor</b>	<b>Standards for each class</b>	
	<b>FOUNDATION</b>	<b>CERTIFIED</b>
Pure seed ( maximum)	98.0%	98.0%
Inertmatter(maximum)	2.0%	2.0%
Other crop seed (maximum)	5/kg	10/kg
Weed seed	None	None
Other distinguishable varieties based on kernel colour and texture (max)	10/kg (by number)	20/kg (by number)
Germination ( Minimum)	90%	90%
Moisture (maximum)	12.0%	12.0%
For vapour proof container (maximum)	8.0%	8.0%

### **Mid storage correction**

The seeds loose their quality during storage due to deterioration and pest infestation, when the germination falls below 5-10 % of the required standard the seeds are imposed with midstorage correction, where the seeds are soaked in double the volume of 10-4 M solution of potassium dihydrogen phosphate (3.6mg/lit of water) for 6 hours and the seeds are dried back to original moisture content (8-9%).

## BOTANICAL DESCRIPTION

Family : Leguminoceae

sub-family : Papilionoideae

: Fabaceae

Common Name : Soyabean

Scientific Name : *Glycine max-Linn*

Origin:

- Domestication of soybean has been traced to the eastern half of North China in the eleventh century B.C. or perhaps a bit earlier soybean production was localized in China until after the Chinese-Japanese war of 1894-95.



# Package of practices for Soyabean

- Globally legumes play vital role in human nutrition since they are rich source of protein, calories, certain minerals and vitamins. Among which soybean is probably the largest source of vegetable seed oil (20%) and protein (40%). Owing the nutritional and health benefits of soybean. It excited the growers in recent years. US, Argentina, Brazil and China claims as *the* biggest producers of this supercrop, the modern technologies and changes in their agronomic practices is worth to discuss on its possibility in Indian scenario.

# SEASON AND CLIMATE

- Two cropping seasons of soybean kharif and spring.
- It is self pollinated crop.
- In case of kharif season most common time of sowing is onset of monsoon or last week of June to first week of July while spring sowing is done between 15th of February and 15th of March.
- Soybean has been adopted under wide range of climate and soil with better performance under Vertisols with good organic content.
- The crop requires about 60-65 cm annual rainfall drought at flowering or just before flowering results in flower and pod drops, while rains during maturity impairs the grain quality of soybean harmful.



## CROP DESCRIPTION

- Despite being rich source of protein, it is categorized as an oilseeds rather than a pulse crop.
- Oil contents varies from 15 to 21 % in soybean seeds.
- Crop generally reach a height of around 1 m (3.3 ft).
- Capable of transforming nearly 60-100 kg atmospheric nitrogen into 30-40 kg nitrogen in the soil.

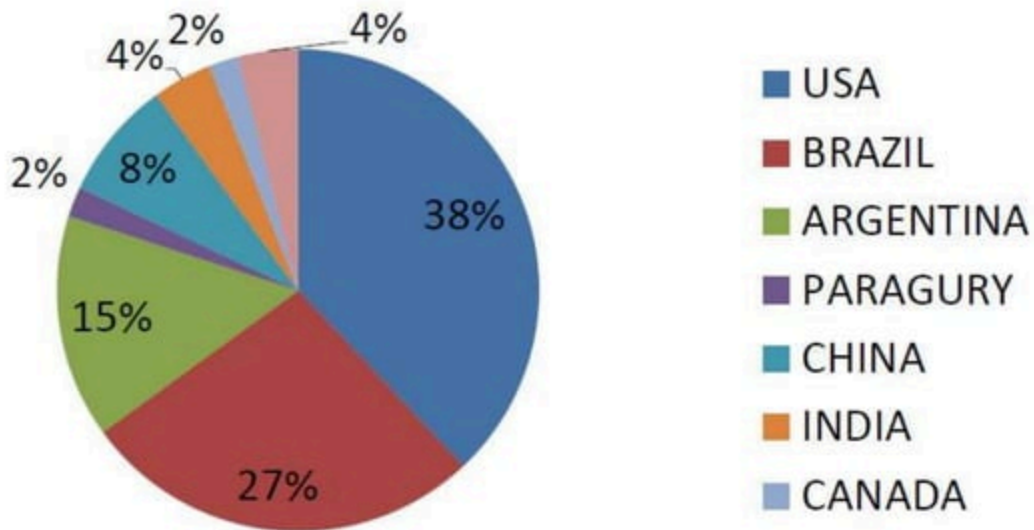


# GLOBAL SCENARIO OF SOYBEAN (2013-2016)

Country	Avg. Area (lakh ha)	Avg. Production (lakh tonnes)	Avg. Yield (Kg/ha)
USA	324.01	1010.74	3119
Brazil	310.22	918.00	2959
Argentina	194.30	558.35	2874
China	68.33	120.83	1768
India*	114.92	103.27	899
Paraguay	32.00	87.45	2733
Canada	20.87	58.29	2794
Ukraine	17.64	35.35	2004
Uruguay	11.77	28.30	2405
Russia	17.38	22.35	1286
Others	54.24	98.32	1813
World	1164.84	3030.62	2602

Source: FAO/USDA. \*As per the estimates of DES, DAC&FW

# Top Producer Of Soya Bean in the World

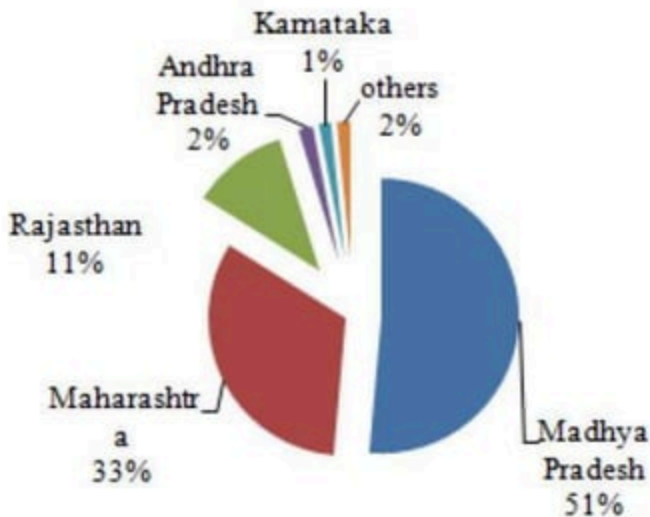


# NATIONAL SOYBEAN SCENARIO (2013-16)

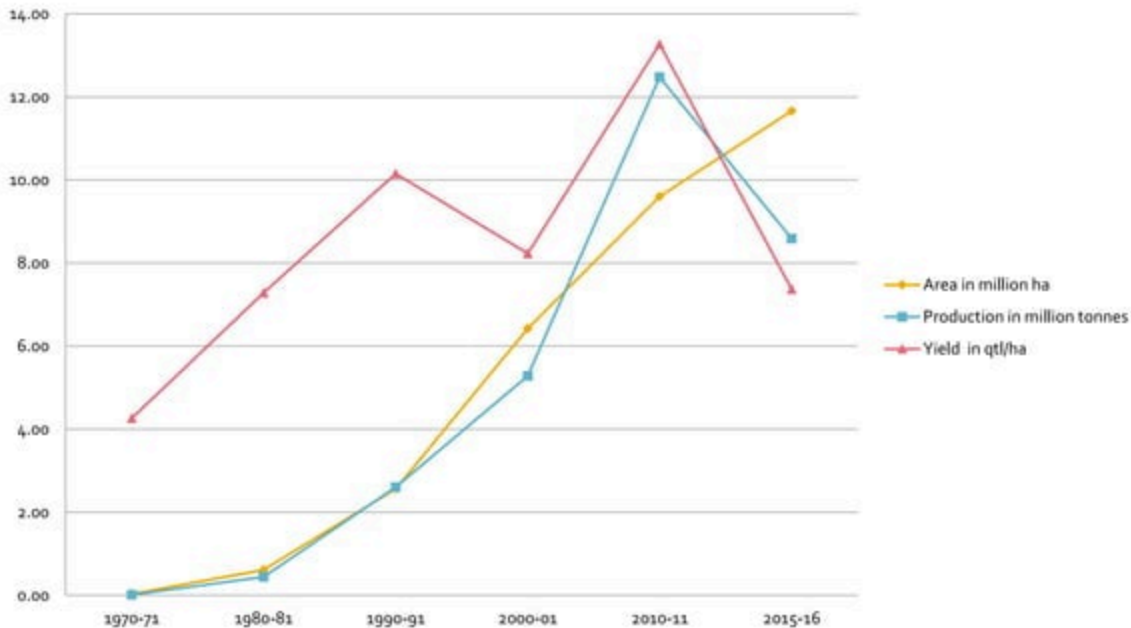
State	Avg. Area (lakh ha)	Avg. Production (lakh tonnes)	Avg. Yield (Kg/ha)
MP	59.32	54.99	927
Maharashtra	37.05	31.14	840
Rajasthan	11.02	9.76	886
Telangana	2.42	2.56	1058
Karnataka	2.41	2.12	880
Others	3.58	3.56	993
All India	114.92	103.27	899

# Top Producer Of Soya Bean in the India

Major producing states



# AREA, PRODUCTION AND YIELD TRENDS OF SOYBEAN IN INDIA



# POTENTIAL DISTRICTS (60) OF SOYBEAN

State	Potential district (>50,000 ha area)
Madhya Pradesh (30)	Ujjain, Sehore, Dewas, Dhar Shajapur, Sagar, Vidisha, Harda, Indore, Rajgarh, Chhindwara, Betul, Mandsaur, Hoshangabad, Guna, Ratlam, Raisen, Bhopal, Narsingpur, Shivpuri, Seoni, Neemuch, Khandwa, Ashoknagar, Damoh, Tikamgarh, Jhabua, Khargone, Satna. Chhatarpur
Maharashtra (20)	Amravati, Nagpur, Latur, Buldhana, Yavatmal, Nanded, Washim, Hingoli, Akola, Wardha, Kolhapur, Chandrapur, Sangli, Parbhani, Nasik, Satara, Ahemdnagar, Jalna, Beed, Osmanabad
Rajasthan (5)	Jhalawar, Baran, Pratapgadh, Kota, Bundi
Chhattisgarh (1)	Rajnandgaon
Karnataka(2)	Belgaum, Bidar
Telangana (2)	Adilabad, Nizamabad

# Soil for soybean cultivation

- Well drained and fertile loam soils with a pH between 6.0 and 7.5 are most suitable for the cultivation of soybean.
- Sodic and saline soils inhibit germination of seeds.
- Water logging is also injurious to the crop.



# Field Prepration

- Deep summer ploughing once in 2-3 years or one normal summer ploughing followed by 2-3 cross harrowing or cultivation for ideal seed bed of good tilth for soybean crop.

There should be optimum moisture in the field at the time of sowing.





# Sowing of soyabean

- The sowing should be done in lines 45 to 60 cm apart with the help of seed drill or behind the plough.
- Plant to plant distance should be 4-5 cm. The depth of sowing should not be more than 3-4 cm under optimum moisture conditions.
- Seed rate of soybean depends upon germination percentage, seed size and sowing time.

# POPULAR VARIETIES OF SOYBEAN

S.No.	State	Varieties
1	MP	JS-95-60, JS-97-52, JS-93-05, JS-335, MACS-1188, MACS-1281, NRC-7, , NRC-37, NRC-86
2	Maharashtra	MAUS-81, MAUS-61-2, MACS-450,MACS-1188, MACS-1281, JS-335, KDS-344, RKS-18
3	Rajasthan	RKS-45, JS-335, JS-93-05, JS-95-60
4	Karnataka	MAUS-2, RKS-18, DSb-1, DSb-21, JS-93-05, JS-335
5	Telangana	JS-335

# Seed and Sowing

S.No.	Input/practices	Central Zone
(i).	<b>Seed Rate</b>	Bold seeded-80-90Kg/ha Medium seeded-70-75kg/ha Small seeded-55-60 kg/ha
(ii).	<b>Seed treatment</b>	i) Fungicidal/Bio-agent: Thiram 75 WP + Cabendazim 50 WP (2:1) @ 3 g/kg seed or <i>Trichoderma viride</i> @ 4-5 gm/kg seed. ii) Microbial: About 500 g/75 kg seed <i>Bradyrhizobium japonicum</i> culture + PSB/PSM 500 g/ 75 Kg seed
(iii).	<b>Sowing time</b>	Middle of June to Middle of July
(iv).	<b>Spacing</b> (Depending on Sowing time)	30-45 x 5-8 cm
(v).	<b>Depth of sowing</b>	3 to 5 cm
(vi).	<b>Plant population</b>	0.4-0.6 million /ha
2	<b>Storage</b>	Store in moisture proof bags at seed moisture of about 9-10 %.

# Growth Stages of Soyabean Crop



Erect



Flowering



Pod Formation

# Fertilizer and Nutrient Management

- For obtaining good yields of soybean apply 15-20 tonnes of farm yard manure or compost per hectare.
- An application of 20 kg nitrogen per hectare as a starter dose will be sufficient to meet the nitrogen requirement of the crop in the initial stage in low fertility soils having poor organic matter.
- Soil test is the best guide for the application of potash in the soil. In the absence of soil test, 60 kg CO per hectare should be applied.
- N:P<sub>2</sub>O<sub>5</sub>: K<sub>2</sub>O:S Kg/ha - 20:60: 20: 20

# Water Management in soya crop

- The soybean crop generally does not require any irrigation during Kharif season.
- However, if there were a long spell of drought at the time of pod filling, one irrigation would be desirable.
- During excessive rains proper drainage is also equally important.
- Spring crop would require about five to six irrigation.



# Weed Management

- Two hand weedings at 21 and 45 DAS or Fluchloralin or Trifluralin @ 1 kg a.i./ha as **pre-plant incorporation** or Alachlor @ 2 kg a.i./ha or Pendimethalin @ 1 kg a.i./ha or Metolachlor @ 1 kg a.i./ha or Clomazone @ 1 kg a.i./ha as **pre-emergence** or Imazethapyr @ 75 to 100 g a.i./ha or quizalofop ethyl @ 50 g a.i./ha as **post-emergence** (15 -20 DAS) in 750 to 800 liters water/ha.

## No podding/ Bud proliferation syndrome

- Apply Phorate 10 G @ 10 Kg/ha as soil application followed by spray of either Triazophos 40 EC @ 0.8 l/ha or Ethion 50 EC @ 1.5 l/ha or Methomyl 12.5 L @ 2.0 l/ha or Quinalphos 25 EC @ 1.5 l/ha.

# Disease Management

- **For foliar diseases** like Myrothecium, Cercospora leaf spot and Rhizoctonia aeria blight: Two spray of carbendazim 50 WP or thiophanatemethyl 70 WP @ 0.5 kg in 1000 l water/ha at 35 and 50 DAS.
- **For Bacterial pastule:** Spray of Copper oxychloride 2 Kg + Streptocycline 200 g /1000 l water at the appearance of the disease.
- **For the control of Yellow Mosaic :** Spray of thiomethoxam 25 WG @ 100 g/ha or methyl deinaton @ 0.8 l/ha.
- **For rust:** Two to three sprays of hexaconazole or propiconazole or triadimefon or ocycarboxin @ 0.1%. First spray at the time of appearance of rust followed by subsequent sprays at 15 days control. For hot spot areas one prophylectic spray of any of above fungicide at 35 to 40 days after sowing.



# SOYBEAN MOSAIC VIRUS

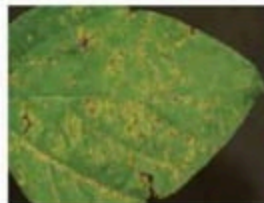


# SOYBEAN RUST

# CERCOSPORA LEAF SPOT (PURPLE STAIN)



Bacterial Pustule



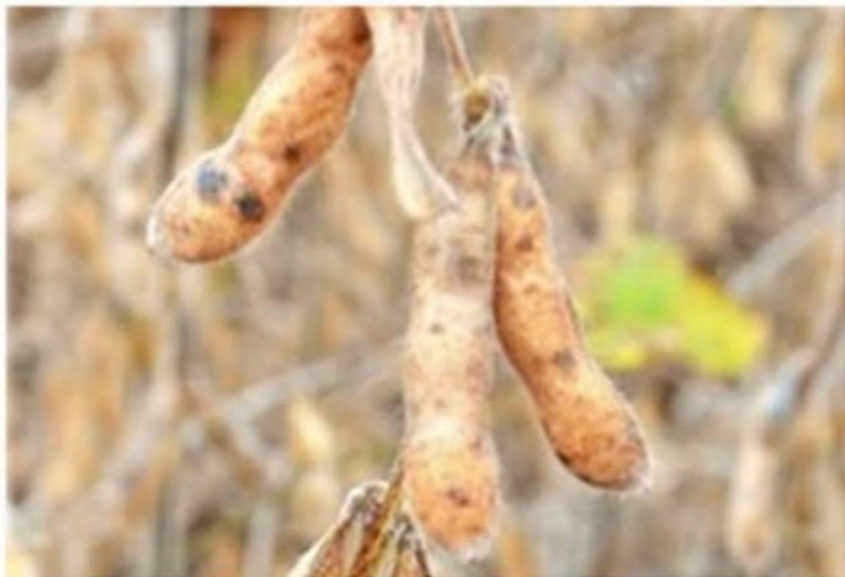
# Insect Pest Management

- Furrow application of Phorate 10G @ 10 kg/ha, followed by 1 or 2 sprays of Quinalphos 25 EC (1.5 lit./ha) or Endosulfan 35 EC @ (1.5 lit./ha) or Monocrotophos 36 SC (0.8 lit./ha) or Triazophos 40 EC ( 0.8 lit./ha) or Methomil 40 SP (1 kg/ha) or Chlorpyriphos 20 EC (1.5 lit./ha) or Ethofenprox 10 EC (1 lit./ha), depending on the insect pest and intensity of damage.
- For one ha, the spray volume has to be 750 to 800 lit.

# Harvesting

- The maturity period ranges from 50 to 140 days depending on the varieties.
- When the plants reach maturity, the leaves turn yellow and drop and soybean pods dry out quickly.
- There is a rapid loss of moisture from the seed. At harvest, the moisture content of the seeds should be 15 per cent.
- Harvesting can be done by hand. breaking the stalks on the ground level or with sickle.
- Threshing can be done either with the mechanical soybean thresher or some conventional methods.

# Harvesting Stage



Harvesting stage

# QUALITY SEED PRODUCTION IN SOYABEAN

# CLASSES OF SEED

- **Breeder Seed**  
Small pure seed quantity directly produced by the originating plant breeder or institution.
- **Basic (Foundation) Seed**  
The progeny of breeder seed or pre-basic seed
- **Certified Seed**  
Progeny of foundation seed

# SITE SELECTION

- Choose areas:
  - ✓ With deep well drained fertile soils
  - ✓ That are fairly flat – with gentle slopes
  - ✓ That are easily accessible
  - ✓ That are well isolated from fields planted to same species - especially for cross pollinated crops
  - ✓ Where possible, that have easy access to water – that may be needed to spray pesticides.
- Avoid areas that have large shady trees, ant hills and termite colonies

# Land requirement

- Land should be free of volunteer plants.
- The previous crop should not be the same variety or other varieties of the same crop
- It can be the same variety if it is certified as per the procedures of certification agency



- **Isolation**

For certified / quality seed production leave a distance of 3 m all around the field from the same and other varieties of the crop.

- **Harvest**

Seeds attained physiological maturity 27 –30 days after flowering  
Harvest the pods as they turn yellow in colour

- **Threshing**

Thresh the pods either manually or mechanically using pliable bamboo stickse and other varieties of the crop.

- **Seed grading**

Grade the seeds using 14/64" (5.6mm) to 12/64" (4.8mm) round perforated metal sieve based on varieties.

- **Drying**

Dry the seeds to 7- 8% moisture content

- **Storage**

Store the seeds in gunny or cloth bags for short term storage (8-9 months) with seed moisture content of 10-12%

Store the seeds in polylined gunny bag for medium term storage (12- 15 months) with seed moisture content of 8 – 10%

Store the seeds in 700 gauge polythene bag for long term storage (more than 15 months) with seed moisture content of less than 7%

# Seed Certification Standards

- Field Inspection
  - A minimum of two inspections shall be made, the first during flowering, and the second before harvesting after the leaves have shed
- Field Standards
  - A. General requirements
    - 1. Isolation

Contaminants	<i>Minimum distance (meters)</i>	
	<i>Foundation</i>	<i>Certified</i>
1	2	3
Fields of other varieties	3	3
Fields of the same variety not conforming to varietal purity requirements for certification	3	3

- B. Specific requirements

Factor	<i>Maximum permitted (%)*</i>	
	<i>Foundation</i>	<i>Certified</i>
Off-types	0.10	0.50

- \*Maximum permitted at the final inspection

# Seed Standards

Factor	<i>Standards for each class</i>	
	<i>Foundation</i>	<i>Certified</i>
Pure seed (minimum)	98.0%	98.0%
Inert matter (maximum)	2.0%	2.0%
Other crop seeds (maximum)	None	10/kg
Weed seeds (maximum)	5/kg	10/kg
Other distinguishable varieties (maximum)	10/kg	40/kg
Germination (minimum)	70%	70%
Moisture (maximum)	12.0%	12.0%
For vapour-proof containers (maximum)	7.0%	7.0%

# Thanks



# Introduction

- Chick peas are one of the oldest pulses known and cultivated from ancient times both in Asia and in Europe.
- It is assumed that gram is originated either from Himalayas or Mediterranean region.
- At present it is grown in Pakistan, India, Italy, Greece, Rumania, Russia, Egypt, North Africa and many other countries of world.
- Chickpea is valued for its nutritive seeds with high protein content, 25 – 28%.
- Chickpea seeds are eaten fresh as green vegetables, parched, fried, roasted, and boiled.

# Origin

- Chickpea is the only domesticated species under the genus *Cicer*, which was originally classified in the tribe vicieae of the family Leguminosae and sub family, papilionoideae.
- Based on the pollen morphology and vascular anatomy, *Cicer* is now set aside from the members of Vicieae and is classified in its own monogeneric tribe, Cicereae Alef.
- The genus *Cicer* comprises 43 species and is divided into two subgenera.



# Scientific Classification

- Kingdom: Plantae
- Division: Magnoliophyta
- Class: Magnoliopsida
- Order: Fabales
- Family: Fabaceae (Leguminosae)
- Subfamily: Faboideae( Papilionaceae)
- Genus: Cicer
- Species: *C. arietinum*

# Health Benefits

- Chickpeas are a good source of fiber so helps in weight loss.
- Chickpeas are a good source of protein and energy.
- Chickpeas help in stabilizing sugar levels in blood.
- Chickpeas may help in reducing LDL cholesterol.
- Chickpeas may boost energy levels due to their iron content.
- Chickpeas have low glycemic index (GI) which is good for diabetic patients

# Soil type

- The plant requires fertile soil with good drainage system.
- Chickpeas generally grow on heavy black or red soils.
- soil pH of 6.0 to 7.0.
- They prefer soil with good residual soil moisture content.
- This crop is grown on moderately heavy soils, black cotton soils, and sandy loam soils.

# Climate & Temperature

- Chickpea crop grows well under good moisture conditions with ideal temperatures between 24°C and 30°C.
- Chickpeas are cultivated under both irrigated and rained condition. Basically this crop is winter season crop.
- Chickpea is a self-pollinated crop and usually grown as a rain-fed cool-weather crop or as a dry climate crop in semi-arid regions.
- The optimum daily temperature ranges from 18 to 29°C

# Varieties

There are two different types of chickpea that are grown worldwide- Desi and Kabuli.

- Desi -Desi chickpeas have colored and thick seed coat. The seed colors of Desi chickpeas are brown, yellow, green or black.
- Kabuli --The Kabuli type chickpeas are characterized by white colored seed with ram-head to rounded shape. The seed coat is thin with smooth seed surface. The Kabuli type generally has large seed size and receive higher market price than Desi type.

# Seed rate & Sowing

- Seed rate of 60kg/ha and plant density of 25 to 30 plants per square meter is ideal for chickpea farming. An average seed rate of 70-100kg/ha will ensure good growth of the crop.
- Chickpeas are propagated from seeds. Sowing is usually done on conserved soil moisture.
- A pre-sowing irrigation may be needed, if the available soil moisture is not adequate for germination. Drilling is the best sowing method for chickpeas.
- Row to Row spacing 25 – 40 cm and plant to plant spacing 10 cm at the depth of 2 – 12 cm with soil well pressed down.

# Preparation of Field

- Chickpea is highly sensitive to soil aeration.
- This imposes a restriction for its cultivation on heavy soils and calls for special care in seedbed preparation.
- A rough seedbed is required for chick pea. In case the chickpea crop is taken after a kharif fellow.
- It would be desirable to go for a deep ploughing during the monsoon as the same would help in larger conservation of rain water in the soil profile for subsequent use by this crop. Very fine and compact seedbed is not good for chickpea but it requires a loose and well aerated seedbed.

# Fertilizer Application

- It all depends on fertility of soil.
- In case of poor soils, this crop requires well rotten farm yard manure (F.M.Y) and in organic fertilizers like Urea (50kg/ha), Phosphorus (150kg/ha) MOP (70kg/ha).
- These manures and fertilizers should be applied before sowing the seeds.
- Apply these fertilizers using drillers with depth about 8cm in soil.



# Irrigation

- Chick pea is mostly sown as a rainfed crop.
- However, where irrigation facilities are available, give a pre-sowing irrigation.
- It will ensure proper germination and smooth crop growth. If winter rains fail, give one irrigation at pre-flowering stage and one at pod development stage.
- In no case first irrigation should be given at flowering time of gram crop. A light irrigation should be given because heavy irrigation is always harmful to gram crop. Excess of irrigation enhances vegetative growth and depresses chick pea yield.

# Weed control

- Chick pea being a stature crop suffers severely by infestation of weeds.
- One hand weeding or inter culture with hand hoe or wheel hoe after 25-30 days and second if needed after 60 days of sowing may take care of weeds.
- Fluchloralin (Basalin) 1 kg per hectare in 800-1000 liters of water as pre-planting spray may be used as an effective herbicide.
- It should be well incorporated in the soil before sowing

# Pest & Diseases

- Diseases of Chickpea
- Wilt
- Blight
- Cercospora Leaf Spot
- Root and Stem Rot
- Anthracnose
- Pest of Chickpea
- Two main pest in chickpea cultivation.
- Cutworm.
- Pod Borer

# Harvesting

- Chickpea crop will be ready for harvesting after leaves turn reddish-brown and start shedding from the plant.
- Using sickle or hand, plants should be plucked.
- Should allow the crop to dry in sun for about a week and threshing should be carried out by beating the plant with sticks.

# Threshing

- Vines along with the pods are harvested from the field and dried in the threshing floor under sunshine.
- Threshing is done by beating with stick when sufficiently dry.
- Care should be taken during threshing so that the seed coats are not injured.

# Drying

- Threshed seeds are cleaned by winnowing, dried to reduce seed moisture content to 12% for temporary storage.
- For longer storage pea seed should be stored in sealed containers at 10% moisture content and in air cooled rooms.

# Storing

- Desi chickpeas will darken considerably and seed germination and vigour will decline in storage.
- The rate of quality decline is accelerated by high seed moisture content, high temperatures, high relative humidity, and condition of the seed at harvest.
- Seed subject to field weathering prior to harvest will deteriorate quicker in storage, even when stored under acceptable conditions of temperature and relative humidity.

# INTRODUCTION

**Botanical Name:**

*Cajanus cajan* (L.)

**Family:**

Fabaceae (Leguminosae)

**Chromosome Number:**

$2n=2x=22$

**Origin:**

Hindustan.

**Pollination:**

Often-cross pollinated

**Common Name:**

Pigeon Pea, Congo Pea,  
Red Gram, Arhar, Tur

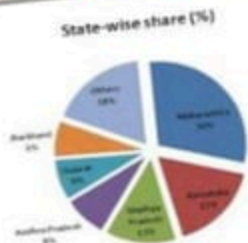




## Distribution of pigeonpea



- ❑ Worldwide pigeonpea was grown in about 4.23 million hectares with a production and productivity of 4.68 million tons and 751 kg/ha, respectively (Pal *et al.*, 2016).
- ❑ India is the largest producer of pigeonpea accounting for 66 percent of total production. Other major pigeonpea producing countries are Myanmar (17.09%), Malawi (6.15%), Kenya (4.36%), and United Republic of Tanzania (5.29%).
- ❑ Pigeonpea ranks second after chickpea among all the pulses in the country and normally cultivated during *kharif* season. In India, it occupies an area of 3.81 million hectares with a production and a productivity of 3.07 million tons and 806 kg/ha, respectively (Pal *et al.*, 2016).
- ❑ In Gujarat, it occupies an area of 0.23 million hectares with a production and a productivity of 0.26 million tons and 1127 kg/ha, respectively (Anon., 2017).



# IMPORTANCE

- An ideal plant for sustainable agriculture



**Food crop (dried peas, flour, or green vegetable peas)**



**Green manure, providing up to 90 kg nitrogen per hectare and forage purpose**



**The woody stems of pigeon peas can also be used as firewood, fencing.**



## Why hybrid technology in pigeon pea?

- ✓ The national demand of pigeonpea in India always scores over the production, and in spite of decades of research and development programs, the mean productivity of the crop could not cross the barrier of 800 kg/ha.
- ✓ To break this yield plateau, SDAU and ICRISAT developed a hybrid breeding technology, globally the first in any food legume.
- ✓ This technology is based on cytoplasmic nuclear male sterility (CMS) and natural out-crossing.
- ✓ One commercial hybrid from CERP, SDAU, Sardarkrushinagar and three commercial hybrids from ICRISAT have been released and these hybrids demonstrated 30-50 per cent yield advantage over the most popular local cultivars in farmers' fields.
- ✓ To enhance the adoption of these hybrids, it is necessary that quality hybrid seed is produced in large quantities and made available to the farmers at reasonable cost.
- ✓ The hybrid seed technology is profitable and easy to adopt. However, for its sustainability and to understand the production constraints, it was found necessary to validate this technology in famers' fields under diverse environments.



# The commercial hybrids

## GMS based hybrid released in India

**Table 1: Genetic male sterility based pigeonpea hybrids released in India**

Character	ICPH 8	PPH 4	CoH 1	CoH 2	AKPH 4104	AKPH 2022
Adaptability	Central Zone	Punjab	Tamil Nadu	Tamil Nadu	Central	Maharashtra
Year of release	1991	1994	1994	1997	1997	1998
Parentage	MS Prabhat DT x ICPL 161	MS Prabhat DT x AL 688	MS T21 x ICPL87109	MS CO5 x ICPL83027	NA	NA
Days to maturity	125 (CZ)	137 (NWPZ)	117 (SZ)	120-130 (SZ)	130-140	180-200
Yield (q/ha)	17.8	19.3	12.1	10.5	NA	NA
Superiority over check	30% over TAT 10, 41% over UPAS120	14% over UPAS 120, 14% over H82-1	22.3% over Vamban 1, 19.4% over ICPL87	35% over CO5	64% over UPAS120	34.9% over BDN2, 28.2% over C 11, 25% over ICPL 87119

# ICPH 8

**First commercial GMS based pigeonpea hybrid**

High yield potential

Vigorous growth

Matures in 115-135 days

Wide adaptation

Drought tolerance

GMS based world first Pigeonpea hybrid ICPH-8



**Table 2: Seed yields of pigeonpea hybrid ICPH 8 compared with those of the control cultivar UPAS 120, central zone, India, 1984-89.**

Year	No. of trials	Seed yield (t/ha)	
		ICPH 8	UPAS 120
1984	7	2.58	1.93
1985	2	1.52	1.01
1986	3	1.09	0.79
1987	7	1.50	1.13
1988	10	1.48	1.15
1989	12	1.94	1.21
<b>Weighted mean</b>		<b>1.78</b>	<b>1.26</b>



# CGMS based hybrid released in India

## GTH-1 : CGMS BASED WORLD'S FIRST HYBRID

- World first CGMS based hybrid of pigeonpea developed by SDAU by utilizing the cytoplasm of wild species of *Cajanus* (*Cajanus scarabaeoides*)
- Released from SDAU in 2004 for cultivation in Gujarat state and central zone of India.

### Important characteristics of GTH-1

- Parents : GT288 A (CMS line/cytoplasm of *Cajanus scarabaeoides*) and GTR-11 (restorer/male)
- Indeterminate Growth habit
- Early in maturity durations
- Very much stable fertility restoration
- Yellow color flower
- Green pod with streaks at base
- Bold and large white seed
- Better dal recovery (87.2%) and grain yield 32 and 42% higher than GT 101 and AKP-4101
- Yield potential : 2827 kg/ha



**Table 3: Performance of pigeonpea hybrid GTH-1 in comparison to check hybrid (AKPH 4101) and check variety (GT 101) in Gujarat state during *kharif* 2000 to 2003**

Season & year of testing	Name of trial	Location of trial	Grain yield of hybrid/ varieties (kg/ha)			
			GTH 1	AKPH 4101 (Ch.)	GT-100 (Ch.)	GT-101 (Cv.)
<i>Kharif</i> 2000	PHT	S K nagar	2827	1224	1218	-
		Mean	2827	1224	1218	-
<i>Kharif</i> 2001	SSHT	S K nagar	1852	1279	1431	-
		Ladol	644	679	707	-
		Anand	450	825	770	-
		Mean	982	928	969	-
<i>Kharif</i> 2002	LSHT	S K nagar	2057	1543	-	1381
		Anand	2106	1759	-	1562
		Bharuch	1906	1662	-	1759
		Vadodara	849	548	-	540
		Derol	2547	1666	-	1782



Conti....

Season & year of testing	Name of trial	Location of trial	Grain yield of hybrid/ varieties (kg/ha)			
			GTH 1	AKPH 4101 (Ch.)	GT-100 (Ch.)	GT-101 (Cv.)
<i>Kharif</i> 2002	LSHT	Navsari	2346	1698	-	2022
		Mean	1969	1479	-	1508
<i>Kharif</i> 2003	LSHT	S K Nagar	2537	1444	-	1620
		Bharuch	1144	1130	-	1017
		Vadodara	1111	868	-	910
		Junagadh	2516	2161	-	2344
		Derol	938	608	-	573
		Navsari	1013	390	-	448
		Mean	1543	1100	-	1152
<b>over all mean</b>			<b>1830</b>	<b>1183</b>	<b>1094</b>	<b>1330</b>
Mean (2000-2001)			1905	-	1094	-
Mean (2002-2003)			1756	-	-	1330
% increase over			-	54.70(overall)	74(2000-01)	32 (2002-03)

## ICPH 2671 (ICPA 2043 x ICPR 2671)

- The new hybrids developed on an improved A-line (ICPA 2043) showed promise with respect to yield, seed size and disease resistance.

<b>Growth habit</b>	Indeterminate and semi Spreading
<b>Days to flowering</b>	114-120 days
<b>Days to 75% pod maturity</b>	166-184 days
<b>yield</b>	2.5-3 tonne/ha
<b>Flower color</b>	Yellow with dense red streaks
<b>Pod color</b>	Dark purple
<b>Seed color</b>	Dark brown
<b>Superiority over check</b>	30-40%
Highly resistant to <i>Fusarium</i> wilt and sterility mosaic disease	



Field View of ICPH-2671

**Table 4: Performance of hybrid ICPH 2671 in multi location trials**

Year	Location	Fertility Restoration(%)	ICPH 2671(kg)	Maruti (control)	SEm	CV (%)	Heterosis %
2005	Medchal (JK Seeds)	100	2996	1041	$\pm 331.6$	21	188
	Coimbatore(TNAU)	98	4262	2538	$\pm 252.7$	17	71
	Patancheru (ICRISAT)	100	2671	1677	$\pm 207.7$	14	59
2006	Jalna (MAHYCO)	100	3416	2541	NR	07	34
	Parbhani (MAU)	98	4779	2648	$\pm 173.4$	0.6	80
	Jalna (Krishidhan)	100	1948	1092	$\pm 91.8$	10	78
	Coimbatore(TNAU)	100	1823	1100	$\pm 324.7$	28	66
	Phaltan (Nimbkar seeds)	-	3208	2243	$\pm 147.3$	20	43
	Patancheru (ICRISAT)	100	2660	1919	$\pm 140.7$	08	39
	Bangalore (UAS)	-	1603	1462	$\pm 289.9$	20	-



# ICPH 2740 (ICPA 2047 × ICPL 87119)

<b>Growth habit</b>	Determinate
<b>Days to flowering</b>	125-130
<b>Days to 75% pod maturity</b>	176-189 days
<b>Seed color</b>	Brown
<b>Yield</b>	2.7-3 tonne/ha
<b>Superiority over check</b>	30-40%
Highly resistant to <i>Fusarium</i> wilt and sterility mosaic diseases	



# ICPH 3762

<b>Days to maturity</b>	180 to 190 days
<b>Yield</b>	1.8 t/ha
<b>Seed color</b>	Brown
<b>Seed size</b>	Medium bold
<b>Growth habit</b>	Determinate
<b>Superiority over check</b>	40-50%
Highly resistant to <i>Fusarium</i> wilt and sterility mosaic disease	
Tolerant to terminal drought due to deep root system	



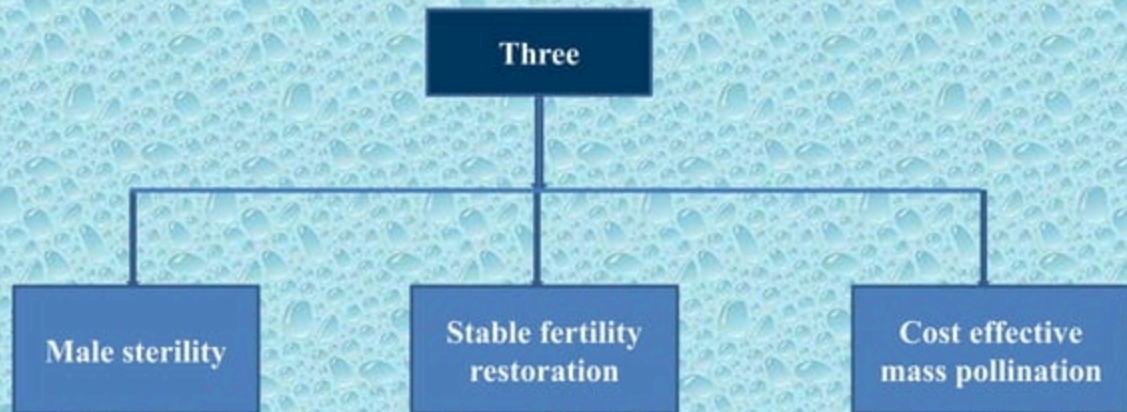
**Table 5: Some promising medium duration pigeonpea hybrids developed at ICRISAT**

Hybrid (ICPH)	Yield(kg/ha)	Standard heterosis (%)	100-seed weight (g)	* Wilt (%)	*Sterility mosaic (%)
<b>3371</b>	<b>3013</b>	<b>62</b>	<b>11.50</b>	<b>0</b>	<b>0</b>
3491	2919	57	13.40	0	0
3497	2686	44	10.90	0	15
2740	2900	57	12.30	0	0
3481	2637	41	11.60	0	0
3494	2586	39	12.40	0	9
<b>2671</b>	<b>2509</b>	<b>37</b>	<b>12.20</b>	<b>0</b>	<b>0</b>
3762	3000	62	11.90	0	0
Check	1864	-	11.10	0	0
SEm	±205.7	-	± 0.33	-	-
CV (%)	11.9	-	3.98	-	-

\*Data from disease nursery



# Major components of hybrid technology



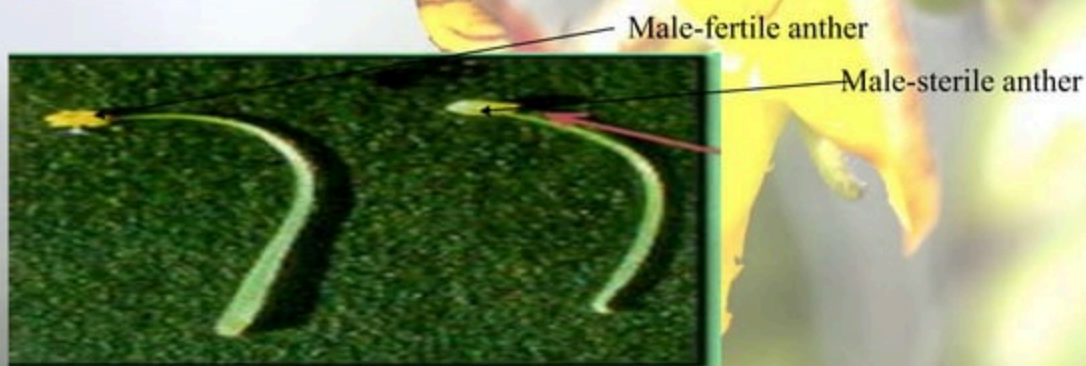
# Male sterility

Male sterility is a situation where its male reproductive parts are either absent, aborted, or non-functional; and fail to reproduce through sexual means. This abnormality could be natural, induced by mutagens, or bred by crossing genetically diverse genotypes. This reproductive inefficiency has been exploited by plant breeders to produce hybrid seed at commercial level.



## Male sterility systems in pigeonpea

- **Genetic male sterility**
- **Temperature sensitive male sterility**
- **Cytoplasmic nuclear male sterility**



# Genetic male sterility

- In pigeonpea, two types of genetic Male sterility, each contribute by single recessive gene has been reported.
- Reddy *et al.*, (1978) identified a white translucent male sterile anther.
- Six male sterile plants were identified at ICRISAT in 1978, derived from totally two unrelated species.

Ms-3A	From ICP-1555
Ms-3B	
Ms-3C	
Ms- 3D	From ICP-1596
Ms- 3E	
Ms-4A	



# Genetic male sterility

- Male sterility is governed by a single recessive gene. Maintenance of male sterility is done by sowing male sterile and fertile plants observed in the same population.
- The visible marker, i.e. white translucent anther provides an efficient way of recognizing these ms plants in the field.

## Genetic male sterility system was not accepted by farmers due to

1. The economics of large scale seed production.
  2. The major drawback was roguing of fertile counterpart from the female plot, which was time and labor consuming.
- Cytoplasmic-genic male sterility system usually was a better option for large scale seed production
  - Pigeonpea (*cajanus cajan*) display considerable natural out crossing and now CMS lines are available with different cytoplasmic backgrounds.



## Cytoplasmic genetic male sterility

- ❖ The first workable CMS system in pigeonpea was produced at GAU, Sardarkrushinagar by Tikak *et al.* (1997) from **wild cytoplasm *C. scarabaeoides***.
- ❖ The second breakthrough in this technology was achieved when a CMS system was developed by **crossing *C. cajanifolius* (a wild species) and a cultivated line ICP 28** (Saxena *et al.*, 2005).
- ❖ This CMS system stable across diverse environments and has an excellent fertility restoration system.
- ❖ After the development of a stable CMS system, several experimental hybrids were produced and evaluated.
- ❖ Kandalkar (2007) found that CMS-based hybrids recorded standard **heterosis up to 156% for grain yield**.
- ❖ Saxena (2007) reported **yield advantage of 50-100%** over the popular varieties/checks.



**Table 6: List of CMS sources derived from different wild relatives of pigeonpea**

Sr. No.	Cytoplasm	Donor	Characters
1	A1	<i>Cajanus sericeus</i>	Envt sensitive, stable in long photoperiod, low restores
2	A2	<i>Cajanus scarabaeoides</i>	Stable CMS, inconsistent fertility
3	A3	<i>Cajanus volubilis</i>	Fertility problem
4	A4	<i>Cajanus cajanifolious</i>	Best stable CMS, many fertility, good pod set and yield
5	A5	<i>Cajanus cajan</i>	Maintainer from wild
6	A6	<i>Cajanus lineatus</i>	Natural hybrid from wild
7	A7	<i>Cajanus platycarpus</i>	Tertiary gene pool, embryo rescue

ICRISAT

Saxena *et al.* (2010)



# Cytoplasmic genetic male sterility



## TGMS - Temperature – Sensitive Male Sterility

- Some environmental factors such as temperature and photo period are known to play a key role by inducing male sterility in pigeonpea.
- This approach popularly known as **two parent hybrid** breeding.
- In pigeonpea, TGMS material derived from an inter-specific cross involving *C. sericeus* (Benth, ex Bak.), a wild relative of pigeonpea and a cultivar **ICPA 85010**, a cultivated species *C. cajan*. This is the first report of Temperature–Sensitive Male Sterility system in pigeonpea

**Table 7: Field observations recorded in three months on male sterility and fertility in four temperature sensitive selection (ICRISAT, Saxena, 2014)**

Year	Selection	September		November		February	
		Sterile plants	Fertile plants	Sterile plants	Fertile plants	Sterile plants	Fertile plants
2007	Envs s-1	13	1	2	12	11	0
	Envs s-2	11	2	1	12	11	2
	Envs s-3	9	1	2	8	8	0
	Envs s-5	13	3	2	14	12	2
	<b>Total</b>	<b>46</b>	<b>7 (13.2%)</b>	<b>7</b>	<b>46 (86.8%)</b>	<b>42</b>	<b>4 (8.7%)</b>
2008	Envs s-1	22	0	1	21	22	0
	Envs s-2	8	0	1	7	8	0
	Envs s-3	10	0	0	10	7	0
	Envs s-5	18	0	3	15	16	0
	<b>Total</b>	<b>58</b>	<b>0(0.0%)</b>	<b>5</b>	<b>53 (91.4%)</b>	<b>53</b>	<b>0 (0.0%)</b>
2009	Envs s-1	37	0	0	37	37	0
	Envs s-2	32	0	0	32	32	0
	Envs s-3	27	0	0	27	25	0
	Envs s-5	23	0	0	22	21	0
	<b>Total</b>	<b>119</b>	<b>0 (0.0%)</b>	<b>0</b>	<b>118 (100.0%)</b>	<b>115</b>	<b>0 (0.0%)</b>



## Fertility restoration

- ✓ **Perfect male fertility restoration** of hybrid plants is important to get good yields.
- ✓ According to Kaul (1988), once a fertility restorer (R-) line is crossed with male sterile (A-) plant, the dominant fertility restoring nuclear gene produces **certain proteins in F<sub>1</sub> plants** and thus, **repairs the defective mitochondrial genome** of the plant to produce **male fertile hybrid plants**.
- ✓ In pigeonpea two **dominant genes (*Rf<sub>1</sub>* and *Rf<sub>2</sub>*)** have been identified (Saxena *et al.*, 2011), which impart **fertility restoration** to the hybrid plants.
- ✓ In the primary gene pool the frequency of fertility restoring genes is fairly high and so far over **150 good restorers** have been identified in different maturity groups (Saxena *et al.*, 2014).

**Table 8: Segregation for male-sterility and fertility in F<sub>1</sub>, F<sub>2</sub> and BC<sub>1</sub>F<sub>1</sub> populations of crosses involving CMS line ICPA 2039 and five fertility restorers in pigeonpea**

Cross	Number of plants								
	F <sub>1</sub> generation			F <sub>2</sub> generation					
	Total	Fertile	Sterile	Total	Fertile	Sterile	$\chi^2$ (expected)	$\chi^2$ (calculated)	P (0.01)
ICPA 2039 × ICP 12320	27	27	0	428	317	111	3:1	0.20	0.66
ICPA 2039× ICP 11376	30	30	0	430	312	118	3:1	1.37	0.24
ICPA 2039× HPL 24-63	25	25	0	471	373	98	3:1	4.42	0.04
Pooled	82	82	0	1329	1002	327	3:1	0.11	0.74
ICPA 2039 × ICP 10650	32	32	0	179	166	13	15:1	0.31	0.58
ICPA 2039 × ICP 13991	30	30	0	518	275	243	9:7	2.1	0.15

**Table 8: Conti....**

Cross	Number of plants					
	BC <sub>1</sub> F <sub>1</sub> generation					
	Total	Fertile	Sterile	$\chi^2$ (expected)	$\chi^2$ (calculated)	P (0.01)
ICPA 2039 × ICP 12320	103	42	61	1:1	3.50	0.06
ICPA 2039 × ICP 11376	158	68	90	1:1	3.06	0.08
ICPA 2039 × HPL 24-63	115	68	47	1:1	3.83	0.05
Pooled	376	178	198	1:1	1.06	0.30
ICPA 2039 × ICP 10650	108	78	30	3:1	0.44	0.50
ICPA 2039 × ICP 13991	112	37	75	1:3	3.86	0.04

**Table 9: Fertility restoration of extra early maturing pigeonpea hybrids at four location during the rainy season**

Hybrid	parentage	Fertility restoration				
		Gurdaspur	Faridkot	Patancheru	Ludhiana	Mean
PHP 32	ICPA 2089 × PHR21	37.5 (16)*	30.8 (13)	35.0 (20)	21.7 (23)	31.3 (72)
PHP 33	ICPA 2089 × PHR22	60.0 (10)	50.0 (12)	55.6 (18)	50.0 (26)	53.9 (66)
PHP 34	ICPA 2089 × PHR23	66.7 (15)	73.3 (15)	75.0 (20)	47.6 (21)	65.7 (71)
PHP 35	ICPA 2089 × PHR24	37.5 (8)	56.3 (16)	63.2 (19)	36.4 (22)	48.3 (65)
PHP 36	ICPA 2089 × PHR25	60.0 (10)	33.3 (6)	30.0 (20)	23.1 (26)	36.6 (62)
PHP 37	ICPA 2089 × PHR26	83.3 (6)	60.0 (15)	31.6 (19)	29.4 (17)	51.1 (57)
PHP 38	ICPA 2089 × PHR27	83.3 (6)	56.3 (16)	68.4 (19)	26.1 (23)	58.5 (64)
PHP 39	ICPA 2089 × PHR28	42.9 (7)	57.1 (14)	47.4 (19)	58.8 (17)	51.5 (57)
PHP 40	ICPA 2089 × PHR29	71.4 (7)	55.6 (9)	27.8 (18)	43.5 (23)	49.6 (57)
PHP 41	ICPA 2089 × PHR30	75.0 (4)	62.5 (16)	55.6 (18)	10.5 (19)	50.9 (57)
PHP 42	ICPA 2089 × PHR31	100.0 (11)	70.6 (17)	94.4 (18)	70.0 (20)	83.8 (66)
Location mean		65.2 (100)	55.1 (149)	53.1 (208)	37.9 (237)	52.8 (694)



**Table 10: Segregation for male fertility and sterility in  $F_1$ ,  $F_2$ , and  $BC_1F_1$  generations and their chi-square tests.**

Crosses	Generation	No. of plants					
		Total	Fertile	Sterile	Expected ratio	$\chi^2$ calculated	Probability
<b>Extra-early-maturing hybrid</b>							
ICPA 2089 × PHR 31	$F_1$	18	17	01	1:0	-	-
	$F_2$	147	115	32	3:1	0.82	0.37
	$BC_1F_1$	187	107	80	1:1	3.90	0.05
<b>Early-maturing hybrids</b>							
ICPA 2039 × ICPR 2438	$F_1$	175	175	0	1:0	-	-
	$F_2$	225	212	13	15:1	0.09	0.77
ICPA 2039 × ICPR 2447	$F_1$	170	170	0	1:0	-	-
	$F_2$	222	210	12	15:1	0.27	0.60

**Table 10: Conti...**

Crosses	Generation	No. of plants					
		Total	Fertile	Sterile	Expectd ratio	$\chi^2$ calcul- ted	Probabi- lity
<b>Late-maturing hybrids</b>							
ICPA 2043 × ICPR 2671	F <sub>1</sub>	138	138	0	1:0	-	-
	F <sub>2</sub>	238	223	15	15:1	0.00	0.97
	BC <sub>1</sub> F <sub>1</sub>	138	98	40	3:1	1.17	0.28
ICPA 2043 × ICPR 3467	F <sub>1</sub>	90	90	0	1:0	-	-
	F <sub>2</sub>	230	216	14	15:1	0.01	0.92
	BC <sub>1</sub> F <sub>1</sub>	189	140	49	3:1	0.09	0.77

# COST EFFECTIVE

## Mass cross-pollination

- ✓ In most legumes, self-pollination is a common event due to their cleistogamous flower structure, but pigeonpea and a few other crops are an exception with partial natural out-crossing, often mediated by insects.
- ✓ Pathak (1970) identified *Megachile bicolor* and *Apis florea* as pollinating insects in pigeonpea.
- ✓ Williams (1977) identified 48 insect species foraging on pigeonpea, but the common foraging insects were *Apis dorsata* and *Megachile spp.*



**Table 11: Effect of spraying with bee-attractants on honeybee visitation**

Treatments	Number of honeybees / 10 flowers /5 minutes			
	Bee attractants spray (10% flowering)			
	1 DAS	2 DAS	3 DAS	4 DAS
T <sub>1</sub> – Bee-Q 10 g / l	3.66 c	4.06 c	4.00 c	3.26 c
T <sub>2</sub> –Bee-Q 12.5 g/ l	5.26 a	5.53 b	5.20 b	4.86 b
T <sub>3</sub> –Bee-Q 15 g/ l	4.73 b	3.93 c	3.86 c	4.40 c
T <sub>4</sub> –Fruit boost 0.5 ml/ l	3.96 b	3.80 c	3.53 d	3.66 c
<b>T<sub>5</sub>–Fruit boost 0.75 ml/ l</b>	<b>5.93 a</b>	<b>6.46 a</b>	<b>6.13 a</b>	<b>5.80 a</b>
T <sub>6</sub> –Fruit boost 1 ml/ l	4.66 b	5.00 b	5.13 b	4.40 b
T <sub>7</sub> –Open pollination (control)	2.93 c	2.86 d	2.86 d	2.93 d
F-Value	*	*	*	*
SEm	0.357	0.273	0.246	0.175
CD at 5%	1.032	0.789	0.711	0.506

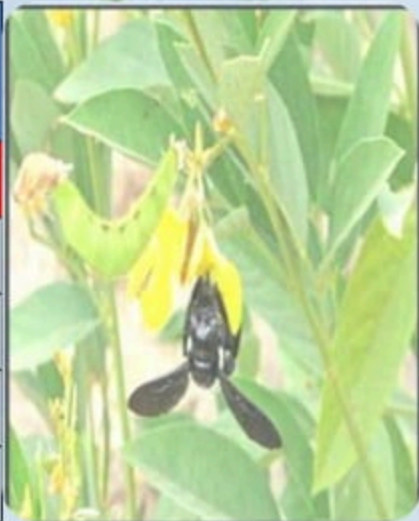
\* significant  $p < 0.05$

**Table 12: Effect of bee attractants on yield parameters**

Treatments	Number of seeds/Pod		100 seed weight (g)		Seed Yield / plant (g)	
	Mean $\pm$ SE	% increase/Decrease over Op	Mean $\pm$ SE	% increase / Decrease over Op	Mean $\pm$ SE	% increase/Decrease over Op
T <sub>1</sub> - Bee-Q 10g / l	5.00 b	7.29	13.50 b	3.44	135 c	13.44
T <sub>2</sub> -Bee-Q 12.5 g/ l	5.33 a	14.37	13.80 c	5.74	146 a	22.68
T <sub>3</sub> -Bee-Q 15 g/ l	5.00 b	7.29	13.45 b	3.06	130 b	9.24
T <sub>4</sub> -Fruit boost 0.5ml/ l	5.00 b	7.29	13.55 a	3.83	138 b	15.96
<b>T<sub>5</sub>-Fruit boost 0.75ml/ l</b>	<b>5.33 a</b>	<b>14.37</b>	<b>13.95 a</b>	<b>6.89</b>	<b>150 a</b>	<b>26.05</b>
T <sub>6</sub> -Fruit boost 1ml/ l	5.00 b	7.29	13.25 b	1.53	140 b	17.64
T <sub>7</sub> -Open pollination (control)	4.66 c	-	13.05 d	-	119 c	-
F-Value	*		*		*	
SEm $\pm$	0.561		0.881		1.174	
CD at 5%	1.654		2.598		3.462	

**Table 13: Proportions of four important insect species recorded in pigeonpea fields and their activity on flowers**

Pollinator insect species	Proportion of insects present (%)	Flowers visited/10 min	Stay on each flower (sec)
<i>Megachile</i> spp.	49.04	4.5	6.6
<i>Xylocopa</i> spp.	11.06	8.9	2.4
<i>Apinae</i> spp.	10.10	2.5	14.8
<i>Catopsilia</i> spp.	7.21	4.0	12.4
Others (15 spp.)	22.59	-	-



**Table 14: Flower-visiting frequencies of insects on primary branches of A-line and R-line (times per 10 min)**

Day	A-line						R-line					
	1	2	3	4	5	Mean	1	2	3	4	5	Mean
First day	3.8	2.0	5.2	3.6	1.2	3.2	10.2	4.4	4.8	3.6	4.4	5.5
Second day	2.8	1.4	3.6	3.2	1.0	2.4	6.4	6.6	4.4	3.8	2.8	4.8
<b>Mean</b>	<b>3.3</b>	<b>1.7</b>	<b>4.4</b>	<b>3.4</b>	<b>1.1</b>	<b>2.8</b>	<b>8.3</b>	<b>5.5</b>	<b>4.6</b>	<b>3.7</b>	<b>3.6</b>	<b>5.2</b>

Numbers 1 to 5 refer to the 5 plants of each line.



## Hybrid seed technology

- The hybrid technology in pigeonpea is **new** and there are no recommended national seed standards for this product.
- In general, the production of hybrid seed in this crop is **complex** because cross-pollination is entirely dependent on certain insect species; and their population and the resultant degree of natural out-crossing are inconsistent across locations to locations.

# Isolation requirements

Table 15: Natural out-crossing in pigeonpea reported from various locations/countries.

Country /place	% Out-crossing		Country /place	% Out-crossing	
	Mean	Range		Mean	Range
In India			In Kenya		
Pusa	-	1.6–12.0	Katumani	17.7	-
Nagpur	25.0	3.0–48.0	Kibos	12.6	-
Niphad	16.0	11.6–20.8	Makueni	21.0	-
West Bengal	30.0	-	Mtwapa	22.0	-
Ranchi	-	3.8–26.7	Kabete	45.9	23.3-45.9
Coimbatore	13.7	-	In other countries		
Varanasi	-	10.3–41.4	Hawaii	15.9	5.9-30.0
Badnapur	-	0.0–8.0	Puerto Rico	-	5.5-6.3
Coimbatore	-	10.0–70.0	Trinidad	26.4	-
Hyderabad	27.9	0.0–42.1	Australia	-	2.0-40.0
			China	24.6	15.0-30.0

**Table 16: Isolation distance (meters) recommend for seed production of various seed classes of pigeonpea**

Source	Seed Class			
	Breeder	Foundation	Certified	Truthfully labelled
FAO (Ariyanayagam, 1976)	-	-	180–360	-
Agrawal (1994)	-	400	200	-
Bhatia <i>et al.</i> (1981)	300	-	200	-
Tunwar and Singh (1988)	-	200	100	100
Sudewad <i>et al.</i> (2004)	200	200	100	-



**Table 17A: Field Standards****A. General requirements**

## 1. Isolation

Pigeon pea seed fields shall be isolated from the contaminants shown in column 1 of the Table below by the distances specified in column 2 and 3 of the said Table:

Contaminants	Minimum distance (meters)	
	Foundation	Certified
Fields of other varieties	250	100
Fields of the same variety not conforming to varietal purity requirements for certification	250	100

**B. Specific requirements**

Factor	Maximum permitted (%)*	
	Foundation	Certified
Off-types	0.10	0.20

\*Maximum permitted at and after flowering

## Table 17B: Seed Standards

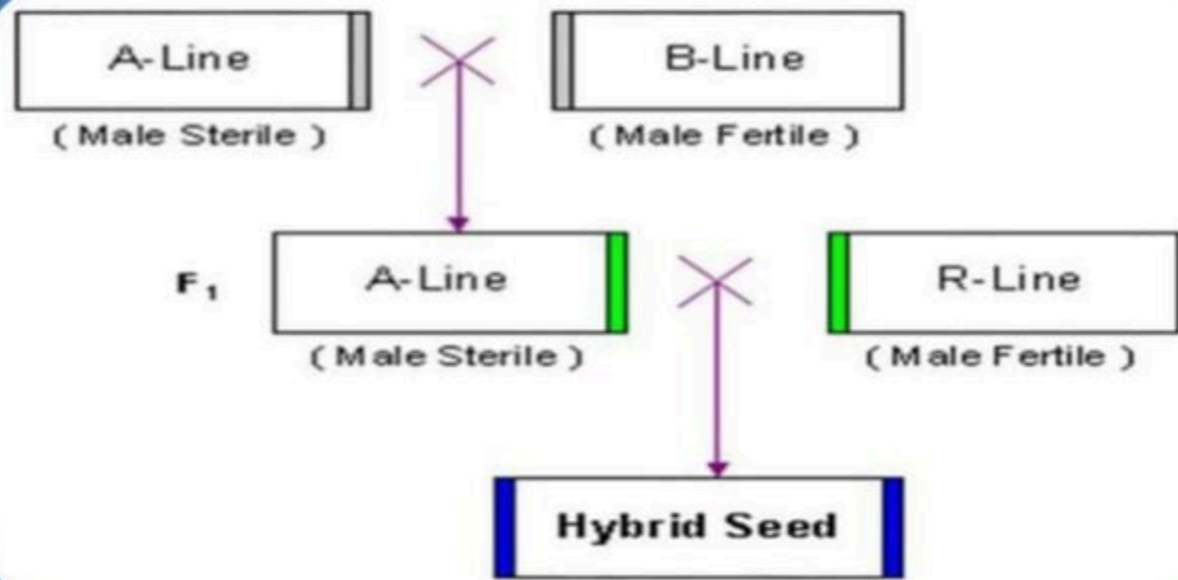
Factor	Standards for each class	
	Foundation	Certified
Pure seed (minimum)	98.0%	98.0%
Inert matter (maximum)	2.0%	2.0%
Other crop seeds (maximum)	5/kg	10/kg
Weed seeds (maximum)	5/kg	10/kg
Other distinguishable varieties (maximum)	10/kg	20/kg
Germination including hard seeds (minimum)	75%	75%
Moisture (maximum)	9.0%	9.0%
For vapour-proof containers (maximum)	8.0%	8.0%



## Field plot technique

- ✓ The critical point that should be given highest consideration in the field lay out is the availability of fresh pollen for a longer period. This will ensure more visits of the pollinating insects for extended periods to enhance pod setting on the male sterile plants.
- ✓ In general, a row ratio of **4 female: 1 male** is recommended, but it can be reduced to 3 female: 1 male, if the population of pollinating insects in the target areas is less.
- ✓ To ensure better pollen availability, the net seed production plot should be surrounded by a 2-3 meter belt of pollen parent; planted 2-3 weeks after the sowing of the net plot. This technique has worked well and in most places with small (< one acre) plots.
- ✓ In larger production plots, a slight modification in the design has given good results. For such locations, the entire isolation plot **is divided into 3-4 sub-plots**; and each sub plot is treated as one unit for seed production and planted with 4 female and 1 male rows and also surrounded by a belt of male parent. The sowing of each sub-plot should be **staggered by two weeks**. This treatment ensures extended pollen availability and good pod set.

## Schematic production of hybrid seed production



# A standard field layout plan for seed production of a CMS line

BBBBBBB	B	BB	B	BBBBBBB
BBBBBBB	B	BB	B	BBBBBBB
BBBBBBB		AA		BBBBBBB
BBBBBBB		AA		BBBBBBB
BBBBBBB		AA		BBBBBBB
BBBBBBB		AA		BBBBBBB
BBBBBBB		BB		BBBBBBB
BBBBBBB		AA		BBBBBBB
BBBBBBB		AA		BBBBBBB
BBBBBBB		AA		BBBBBBB
BBBBBBB		AA		BBBBBBB
BBBBBBB		BB		BBBBBBB
BBBBBBB		AA		BBBBBBB
BBBBBBB		AA		BBBBBBB
BBBBBBB		AA		BBBBBBB
BBBBBBB		AA		BBBBBBB
BBBBBBB	B	BB	B	BBBBBBB
BBBBBBB	B	BB	B	BBBBBBB

2 meters

1 m

10 m

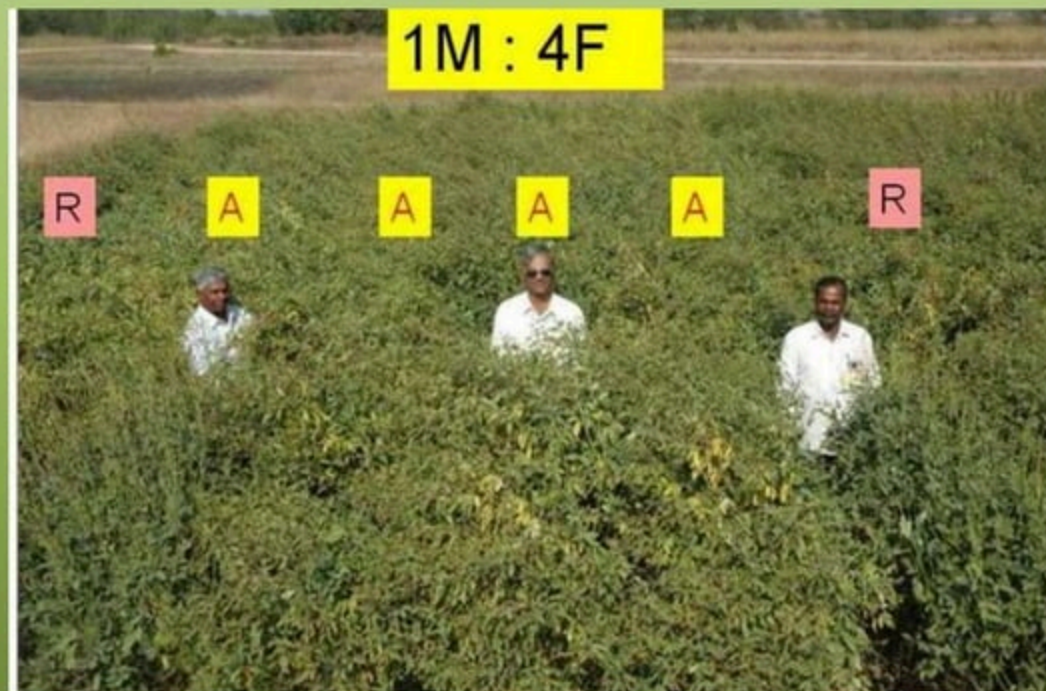
1 m

2 m





# A hybrid seed production plot





**Table 18: Mean attributes of ICPA 2043 as influenced by the direct and interactive effects of row ratio, spacing and irrigation.**

Traits	Year 1			Year 2		
	Factor	Treatment	Mean	Factor	Treatment	Mean
Yield/plant (g)	Irrigation effect	Every 21 days	117.91	Effect of row ratio	4:1	78.02
		Every 14 days	129.72		3:1	56.31
	Effect of spacing	150 x 50	149.07	Effect of spacing	150 x 50	98.61
		150 x 30	140.67		150 x 30	68.72
		75 x 50	101.43		75 x 50	59.23
		75 x 30	104.09		75 x 30	42.09
	Yield/ha (kg)	Effect of spacing	150 x 50	1432.10	Effect of row ratio	4:1
150 x 30			2278.90	3:1		934.33
75 x 50			1903.30			
75 x 30			3254.90			

**Table 19: Effect of Different Planting Ratio's and Insect Attractant Spray on Seed Yield Parameters of Hybrid Pigeonpea Seed Production-ICPH-2671**

Treatments	Seed Yield g/plant *A-line (ICPA- 2043)			Seed Yield kg/plot *A-line (ICPA-2043)			Seed Yield kg/ ha * A-line (ICPA- 2043)		
	T <sub>1</sub>	T <sub>2</sub>	Mean	T <sub>1</sub>	T <sub>2</sub>	Mean	T <sub>1</sub>	T <sub>2</sub>	Mean
<b>P<sub>1</sub>(3:1 Planting Ratio)</b>	<b>52.04</b>	<b>57.1</b>	<b>54.57</b>	<b>2.88</b>	<b>3.25</b>	<b>3.07q</b>	<b>1778</b>	<b>2006</b>	<b>1892</b>
P <sub>2</sub> (4:1 Planting Ratio)	52.96	59.2	56.08	4.04	4.64	4.34	1871	2148	2009
P <sub>3</sub> (5:1 Planting Ratio)	54.16	63.86	59.01	5.15	6.15	5.65	1906	2278	2092
P <sub>4</sub> (3:2 Planting Ratio)	53.11	61.45	57.28	2.99	3.52	3.26	1847	2175	2010
P <sub>5</sub> (4:2 Planting Ratio)	57.36	66.25	61.81	4.44	5.19	4.81	2054	2402	2228
<b>P<sub>6</sub>(5:2 Planting Ratio)</b>	<b>59.21</b>	<b>68.24</b>	<b>63.73</b>	<b>5.7</b>	<b>6.62</b>	<b>6.16</b>	<b>2112</b>	<b>2452</b>	<b>2282</b>
Mean	<b>54.81</b>	62.68	58.74	4.2	4.9	4.54	1928	2243	2085
For comparing means of	S.Em±	CD at 5%		S.E m±	CD at 5%		S.Em ±	CD at 5%	
Insect attractant (T)	1.16	3.4		0.04	0.12		26.27	77.05	
Planting ratio (P)	1.01	3.89		0.07	0.21		45.5	133.45	
P × T	1.84	3.33		0.1	0.3		64.35	188.73	

Note: \* A-line (F<sub>1</sub> hybrid) = A(ICPA-2043) x R(ICPR-2671) line seed production. T<sub>1</sub>: Without spray, T<sub>2</sub>: Insect attractant spray (Bee-Q 12.1g/l).

## Crop management

- ✓ **Field preparation** is an important activity to assure good crop.
- ✓ A basal dose of **100 kg/ha of di-ammonium phosphates** is recommended to provide 18 kg/ha N and 20 kg/ha P.
- ✓ Since genetic purity of the **seed** is of prime importance, the Breeder seed of highest quality should be obtained from a reliable **source**.
- ✓ The **sowing** should be undertaken at the time when the **soil moisture** is adequate for germination.
- ✓ The female parental **seed @ 4-5 kg/ha and that of male parent @ 1-2 kg/ha** should be used.



## Crop management

- ✓ To manage the weeds a pre-emergence herbicide such as **Promytrine or Basaline** be sprayed. For controlling pod borers (*Helicoverpa armigera*) 2-3 spraying of **Dimethoate (30% EC @ 1.0 L /ha)** during reproductive stage gives good results. The most important consideration in spraying is that the insecticide should not kill the pollinating insects; and for this the spraying should be organized either before 9 AM or after 5 PM.
- ✓ Generally four rounds of rouging are recommended to **remove off-type** plants in hybrid seed production.
- ✓ Harvesting should be organized with utmost care. All the **male rows should be harvested first**, removed from field, and kept aside. This should follow the easy harvesting of female rows. Threshing, cleaning, drying, seed treatment, and storage should be done as per the local practices. At every stage enough care should be taken to maintain the purity of seed.

## Seed Quality

- ✓ **Purity of seeds holds the key for the success of hybrids, because any level of genetic contamination will lead to the deterioration in its performance with respect to yield and resistance to various stresses.**
- ✓ **Traditionally, the commercial producers perform Grow-out Tests (GoT) on each seed lot to assess its genetic purity. In this test simply inherited dominant morphological trait present in the male parent is used, and tracked in the hybrid plants to ensure their hybridity.**

## Quality control through molecular markers

Figure 1: The hybrid purity assessment of hybrid ICPH 2438 with the CCB4 marker

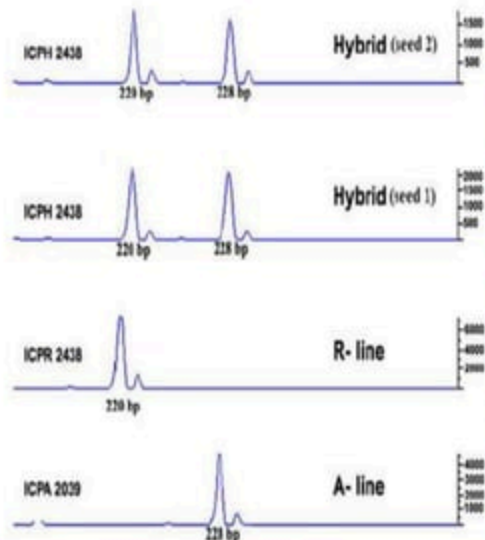


Table 20: A summary of purity assessment of ICPH 2438 hybrid seeds from two sources

Seed source /marker name	Allele size in (bp)			No. of hybrid plants	*Purity index (%)
	ICPA 2039	ICPB 2039	ICPR 2438		
<b>ICRISAT</b>					
CCB4	228	228	220	379	94.2
CCttc006	293	293	290	379	98.7
<b>Mahabeej</b>					
CCB4	228	228	220	91	95.6
CCttc006	293	293	290	91	97.8

\* Purity index = [Number of true hybrids (containing alleles of both the parents) x 100]/Total number of hybrid seeds tested



**Figure 2: SSR based molecular profiles of A-line (PA 163A) and R-line (AK 261322) and hybrid (IPH 09-5)**

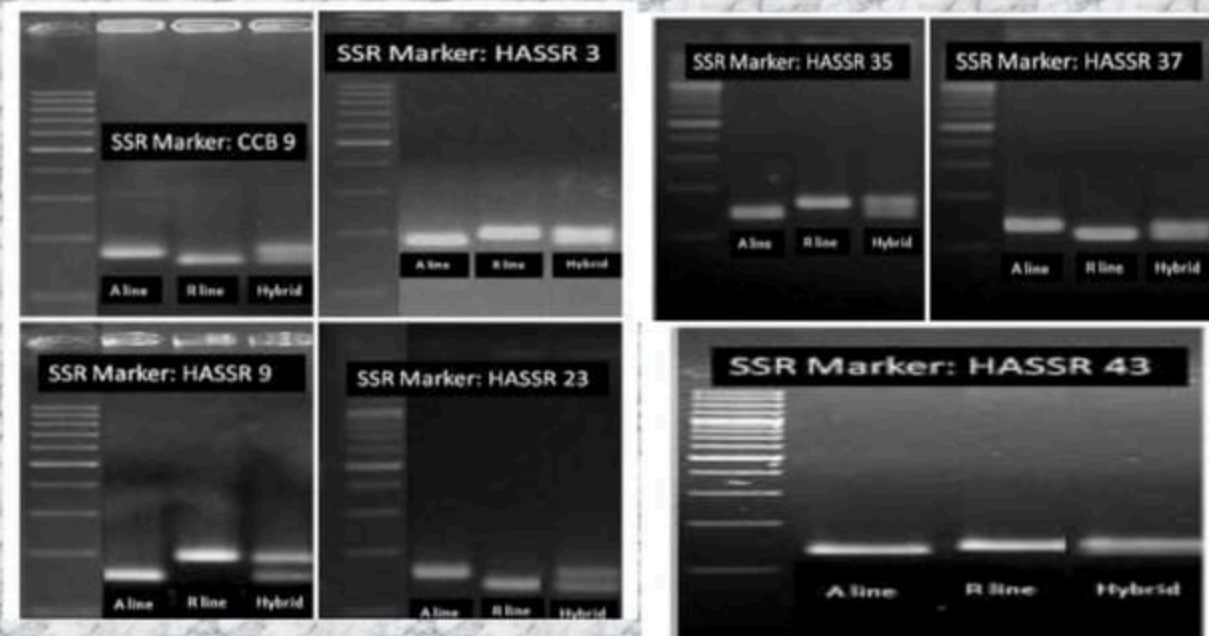
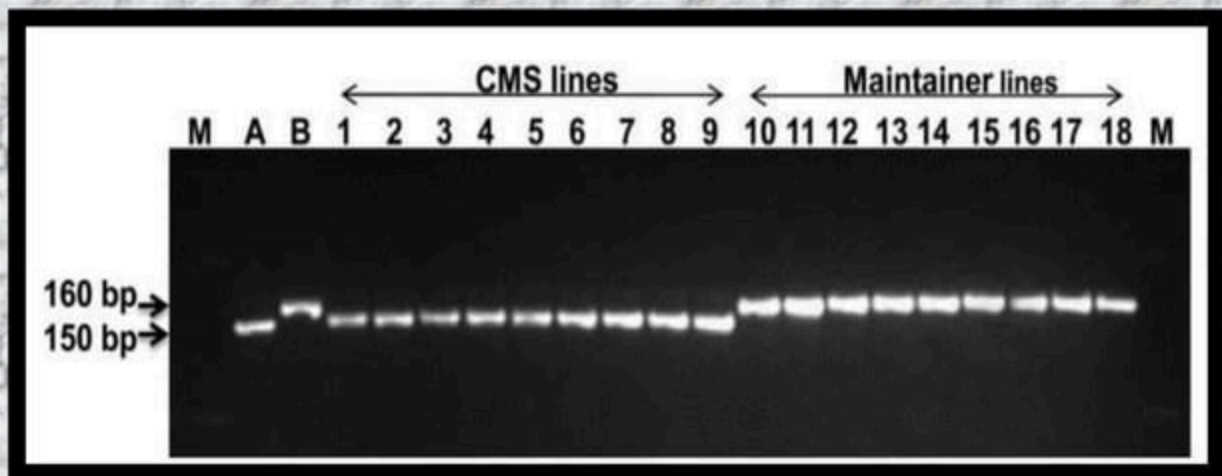




Figure 3. Validation of nad7 gene based marker nad7a\_del in different A4 derived cytoplasmic male sterile (CMS) and its cognate maintainer lines.



**Table 21: GOT of GTH-1**

Sr. No.	Characters	Hybrids / Parents			Maximum time / duration
		GTH-1 (SKNPCH-10)	GT-288-A (Female)	GTR-11 (Male)	
1.	Growth habit	Semi-erect	Erect	Bushy	80 days
2.	Growth type	NDT	NDT	DT	80 days
3.	Flower colour (standard)	Yellow with few red streaks	Yellow with few red streaks	Yellow	85 days
4.	Pod colour (pre-mature)	Green with black basal streaks	Green	Green with black streaks on entire pod	90 days

**Table 22: Naked eye polymorphic (NEP) markers with potential to be used to track purity of pigeonpea hybrids and their corresponding parental lines; their expression time and inheritance**

Trait	Phenotype	Genetic Control	Stage Of Expression	Heritability
Stem Color	Purple Vs. Green	Dominant, Single Gene	6–8 Wk After Sowing	Low
Leaf Shape	Obcordate Leaf Vs. Normal	Recessive, Single Gene	6 Wk After Sowing	High
Leaf Width	Narrow Leaf Vs. Broad Leaf	Recessive, Single Gene	4–5 Wk After Sowing	High
Growth Habit	Determinate Vs. Nondeterminate	Recessive, Single Gene	Flowering	High
Flower Colour	Yellow Vs. Red	Recessive, Oligo-genes	Flowering	Low–moderate
Pod Colour	Green Vs. Purple	Recessive, Oligo-genes	4–5 Wk After Sowing	Low–moderate
Seed Colour	White Vs. Brown	Recessive, Oligo-genes	Maturity	Moderate



Figure 1. Transition of obtuse to obcordate leaflets in ICP 5529. The arrow points to the terminal leaflet transitioning from **obtuse** (A) to **obovate** (B), **truncate** (C), and finally into **obcordate** (D); all of them are clearly different from normal lanceolate leaves.

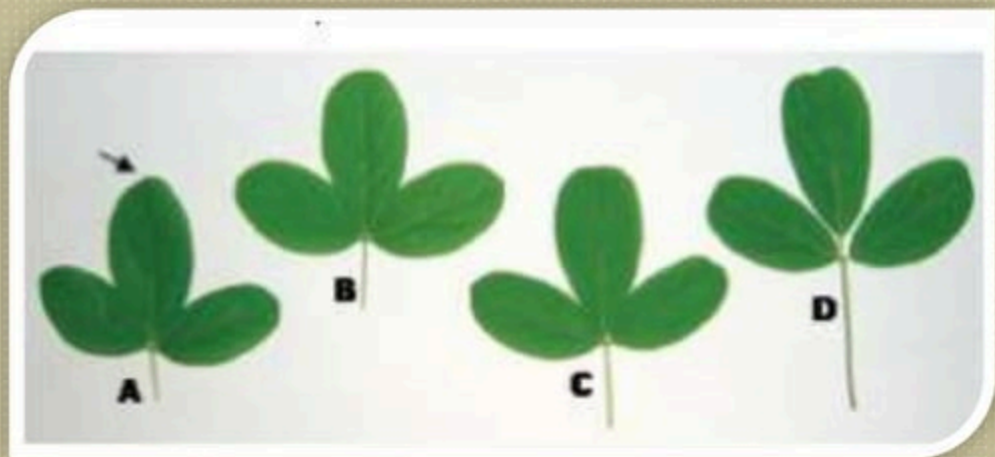


Figure 2. Breeding scheme to introgress the obcordate leaf trait from ICP 5529 to generate A lines (A4/rnrrn) with the obcordate leaves (set I)

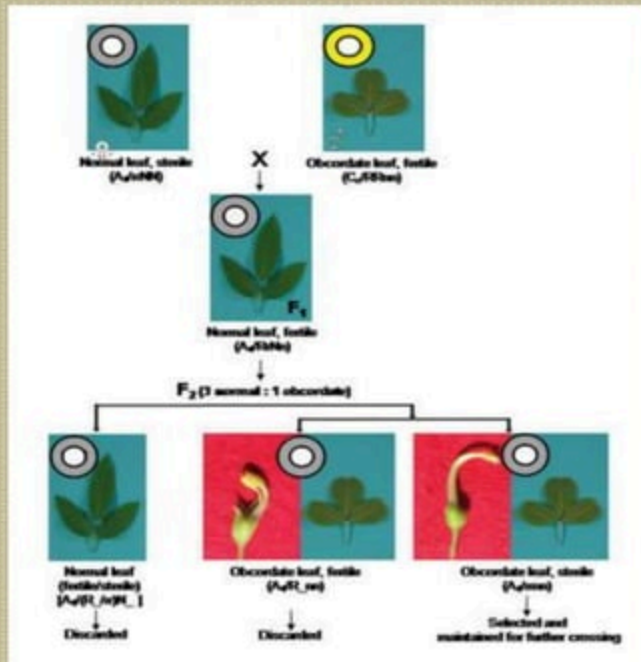
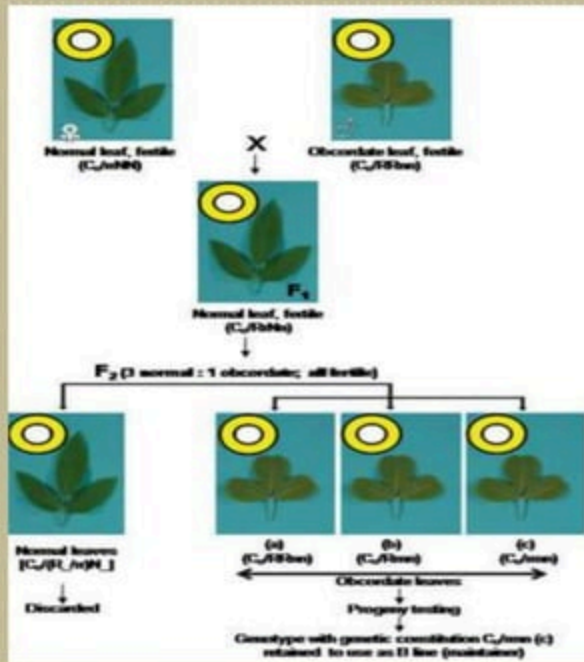


Figure 3. Breeding scheme to introgress the obcordate leaf trait from the ICP 5529 to generate B lines (C<sub>4</sub>/rrrrn) with the obcordate leaf trait (set II)



**Table 23: Seed production of hybrid ICPH 2671 (A x R) in different locations 2007**

State	Village	Area sown (ha)	Seed yield (kg)	Productivity (kg/ha)
Andhra Pradesh	Shadnagar	1.6	1400	875
	Gadivemula, Nandyal	1.6	1000	625
Andhra Pradesh	Alamur, Nandyal	1.6	10000	625
Andhra Pradesh	MK Puram, Nandyal	1.2	1000	833
Andhra Pradesh	Manapur, Ghanapur	1.2	1275	1063
Andhra Pradesh	Yallur	1.0	1000	1000
	Patancheru	0.4	500	1250
Andhra Pradesh	Medchal	0.4	500	1250
Andhra Pradesh	Eluru-1	1.2	750	625
Andhra Pradesh	Eluru-2	1.2	750	625
Andhra Pradesh	Eluru-3	1.6	1146	716



**Table: 23 Conti...**

State	Village	Area sown (ha)	Seed yield (kg)	Productivity (kg/ha)
Andhra Pradesh	Renjal	0.4	700	1750
Andhra Pradesh	Manoharabad	0.68	856	1258
Madhya Pradesh	Indore	0.15	340	2267
Gujarat	Ahmedabad	0.80	850	1063



**Table 24: The pigeonpea ICPH 2671 hybrid (A×R) Seed production record in six Indian states**

State	Locations	Highest yield (kg/ha)	Mean yield (kg/ha)
Andhra Pradesh	34 (6)	1750	998
Gujarat	4 (2)	1669	1179
Karnataka	2 (2)	1900	1138
Madhya Pradesh	9 (3)	3040	1674
Maharashtra	5 (2)	1017	603
Odisha	40 (1)	1040	523
Total/mean	94 (16)	3040	1019

**Table 25: Some hot spots identified Hybrid seed production of ICPH 2671**

Location	Area (ha)	Yield (kg/ha)
<b>Madhya Pradesh</b>		
Tikamgarh	5.0	3040
Seoni	1.0	2500
Indore	0.15	2267
Rewa	1.0	1740
Katni	3.0	1450
Jabalpur	1.5	1333
<b>Andhra Pradesh</b>		
Nizamabad	0.4	1750
Patancheru	0.4	1250
Medchal	1.4	1214
Warangal	1.2	1063
Nalgonda	2.0	1000

## ECONOMICS OF HYBRID SEED PRODUCTION

**Table 26: Profitability and cost of hybrid seed production of pigeonpea hybrid GTH 1**

Sr. No	Particulars	Rates	Cost (Rs.)
1.	Seed cost	Female 18 kg @ Rs.50	900.00
		Male 3kg @ Rs.50	150.00
2.	Cultivation	3 hrs @ Rs.400	1200.00
3.	Sowing	2 hrs @ Rs.400	800.00
4.	Fertilizer	Dose 25:50:00 NPK kg/ha	1000.00
5.	Irrigation (Five)	5 @ Rs.600	3000.00
6.	Insecticides and Pesticides	As required	2000.00
7.	Rouging charges	3 @ Rs.400	1200.00
8.	Harvesting	12 labour @ Rs. 100	1200.00
9.	Thrashing	a. 2 labour @ Rs. 100	200.00
		b. 3 hrs thrasher @ Rs. 400	1200.00
10.	Grading	5 labour @ Rs. 100	500.00
11.	Packing charges	380 bag @Rs 10	3800.00
<b>Total Expenditure per ha.</b>			<b>17150</b>

**Profit (Rs.) :**

$$99085.00 - 17150.00 = 81935.00 \text{ or}$$

**Seed cost of hybrid seed =**

9.09 or Rs 9.00/kg

**Profit /kg of seed = Rs 43.44 or 43.00**



Particulars	Rates (Rs/kg)	Income (Rs.)
Hybrid seed production 1886 kg/ha	50	94300.00
Male seed production 319 kg/ha	15	4785.00
<b>Total Income</b>		<b>99085.00</b>



**Table 27: Profitability and cost of hybrid seed production of pigeonpea hybrid ICPH 2671 at Indore during 2007**

Item	Cost (Rs/ha)
<b>Gross expenditure</b>	
<b>(a) Non-labors inputs</b>	
Field preparation	2,000
Fertilizers & seed treatment	3205
Seed	900
Sub total (a)	6105
<b>(b) Labor input @ Rs 93.50/day</b>	
Sowing (40)	3,740
Weeding & Intercultur (58)	5,423
Roguing (20)	1,870
Spraying (22)	2057
Harvesting (45)	4,208
Threshing (32)	2992
Sub total (b)	20,290

Item	Cost (Rs/ha)
<b>Cost of seed production</b>	
Total expenditure (a+b) (Rs)	26,395
Hybrid yield harvested (kg)	1,400
Cost of producing one kg seed (Rs)	26,395 / 1,400 = 18.85
<b>Gross returns (Rs/ha)</b>	
Income from sale of 1400 kg hybrid seed @ Rs 60/kg	84,000
Income from sale of 800 kg R-line seed @ Rs 15/kg	12,000
Income from sale of total fuel wood	400
Total	96,400
Net Profit (Rs / ha)	96,400 - 26,395 = 70,005

**Pigeonpea hybrid technology is now established with on-farm hybrid advantage of 30-50 per cent. The large-scale hybrid seed production is no more an issue. Since the cross-pollination primarily depends on insect pollinators, the selection of production sites helps in harbouring the hybrid yields of over 1500 kg/ha repeatedly harvested. Seed quality control is another key issue and this has been addressed by incorporating a naked eye polymorphic trait (obcordate leaf) in A- / B- lines. In the alternative approach, genomic science and GOT is being helped to determine the genetic purity of F<sub>1</sub> hybrids and their parents. Overall, the pigeonpea hybrid technology has reached a stage when it can be adopted easily. The statistics of hybrid pigeonpea with respect to on-farm heterosis, hybrid yields and profitability are comparable with other hybrid field crops.**

## **SEED PRODUCTION IN SUNFLOWER**

Sunflower is a common oilseed of India with wider utility. It is used as a source of edible oil, and as raw material for agri -based industry. Botanically it is known as *Helianthus annuus* and belongs to the family asteraceae. It is a cross pollinated crop, insects (honey bees) are the pollinating agents. The crop has got two types of flowers viz. ray and disc florets. Seeds set in disc florets which are bisexual but exhibit self incompatibility due to protoandrous nature of the flower.

### **Botany of flower**

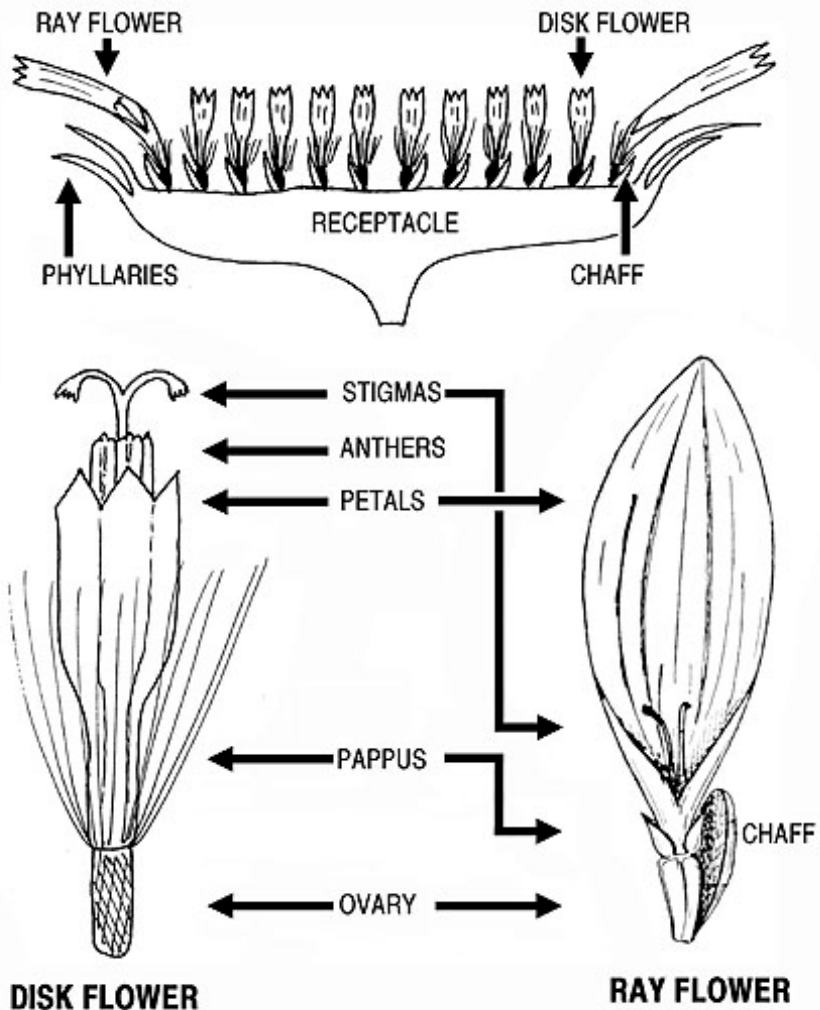
Inflorescence is a head, consisting of pistillate or sterile ray florets at the periphery and central hermaphrodite, disc florets. The involucre is bract. The pappus is calyx or calyx is modified into two papus scales. The five petals are united to form corolla tube. Stamens are free and attached to the base of corolla. Five anthers unite to form anther tube and style is inside the anther tube and stigma bilobed.

### **Anthesis and pollination**

The disc florets are protandrous. Flower opening starts from outer whorl and proceeds towards centre of head. The head bloom within 5-10 days. The pollen grains are viable for 12 hours. Anthesis take place at 5-8 a.m. Self incompatibility operates leading to cross pollination.



## FLOWER HEAD OF SUNFLOWER FAMILY



### Varietal seed production technique

Open pollination under isolation is the common method of varietal seed production.

### Varieties

CO 1, CO 2, Morden, K1, K 2, EC 68414, EC 68415

### Stages of seed multiplication

In sunflower seed is multiplied adopting three generation system, as breeder seed, foundation seed and certified seed as the crop is often cross pollinated crop where the chances for genetic contamination is high.

### **Varietal renovation method (Pustovit model)**

- ❖ In open pollinated variety, selection of superior plants are made based on the quality characters viz., plant yield, 100 seed weight and oil content.
- ❖ The selected plants are harvested separately
- ❖ Then they are raised in rows individually
- ❖ Seeds from promising plants are collected and this form the super-elite seeds

### **Causes for ill filled seed**

#### **a) Pollination**

It is a cross pollinated crop, normally the insect activity is less. For increasing the insect activity bee hives should be kept in the seed production plot in adequate quantities. The insect activity depends on the pollution and insecticides application. If insect activity is less that leads to poor seed setting and formation of ill filled seeds.

#### **b) Development of axillary flowers**

Normally the axillary flowering takes place during the summer because of the high intensity of light. So these type of axillary buds receive the nutrients and assimilate whereas the main head does not get the required quantity of assimilates for seed set there by ill fillings occurs.

#### **d) Self incompatibility**

Presence of self incompatibility in sunflower also leads to poor seed set and ill filled seeds.

### **Technology for increased seed set**

- a. Pollination behavior: Sunflower is a cross-pollinated crop. Two types of flowers are available. They are ray and disc flowers. Ray flowers are unisexual while disc flowers are bisexual.

b. Pollinating agent : Honey bees

### Popular varieties

In Tamil Nadu, Morden, CO1,CO2,CO3, K1, K2 , CO4 are the popular varieties for commercial purpose .

### Season

April to May is highly suitable for irrigated seed crop. The flowering should not coincide either with rain or high RH as it will wash out the pollen and the maturation should coincide with dry weather.

### Land requirement

The land should be fertile and problem soils will lead to low pollen fertility and will adversely affect the quality and the seed set will be poor. The previous crop should not be the same crop to avoid the occurrence of volunteer plants and if to be the same crop it has to be the same variety and should be certified and has to be accepted for certification. The field should not have any volunteer plants.

### Field Standards (Isolation)

General: 1. Sunflower field should be isolated from contaminants as follows

Contaminants	Minimum distance(meters)	
	Foundation stage	Certified stage
Fields of other varieties and the same variety not confirming to varietal purity requirements for certification and wild sunflower	400	200

In sunflower differential blooming dates for modifying the isolation distance is not permitted

### Seed and sowing

- ✓ For production of foundation seed, breeder seed is used as the base material ,while for certified seed, foundation seed should be used as the base material

- ✓ The seed used should be from authenticated source with tag and bill.
- ✓ The required seed rate will be 8-10kg /ha or 3-4kg/ acre. (Morden 80kg/ha)
- ✓ The seeds are sown at a spacing of 30 x10 cm for the variety morden and at a spacing of 60x20 cm for other varieties and are dibbled at a depth of 2-4cm.
- ✓ In the main field seeds are sown either in ridges and furrows or under beds and channels.

### **Presowing seed treatment**

- ✓ The seeds are given with any one of the seed treatment or in combination
- ✓ Fresh seeds of sunflower exhibit physiological dormancy which could be broken by soaking the seeds in 300ppm ethrel for 8h or 0.5% KNO<sub>3</sub> for 16h. Moist hydration of seed with water for 24h followed by dry dressing with thiram @2g kg<sup>-1</sup> of seed improved the productivity of the seed.
- ✓ Seeds are soaked in 2% ZnSO<sub>4</sub> for 12h with a seed to solution ratio of 1:0.06 and are dried back to their original moisture content of 8-9% .This management could be used both for dryland agriculture as well as gardenland.
- ✓ As an ecofriendly treatment seeds are also fortified or hardened with 1% moringa leaf extract for 16h with a seed to solution ratio of 1:0.06 and are dried back to their original moisture content of 8-9%.
- ✓ Seeds are dry dressed with bavistin @2g/kg of seed to protect against seed borne pathogens and soil borne pathogen. Seeds are also treated with azospirillum @50g/kg of seed to fix atmospheric N.
- ✓ Any one of these treatment or combination of treatment is adopted for better productivity. On adoption of sequence of treatment physiological should be followed with physical seed treatment.

### **Nutrient application**

At last ploughing apply 12.5 tonnes of compost per hectare. The fertilizer requirement of seed crop is 80:40:40 kg of NPK, in which 40kg of N and full dose of P and K is applied as basal, while 40kg of N is applied at the time of earthing up i.e. 40-45 days after crop growth..The seed crop is also sprayed with 2% DAP or

20ppm NAA at 30 and 60 days after sowing. In case of deficient soils the crop is sprayed with 0.5% Borax at button formation stage.

### **Micronutrients deficiency**

Zn and Fe composition is very important for the proper seed set in sunflower. Zn is responsible for the production of IAA. Fe deficiency leads to sterility of the pollen.

### **Weeding**

Apply of fluchloralin @ 2l/ha as pre-emergence herbicide to control the growth of weeds up to 20-25 days. One hand weeding is done at the time of button stage to keep the field free of weeds. Weeding after head formation stage is not economical. On organic production, 2 hand weeding at seedling stage and other at boot leaf formation will keep the field weed free.

### **Supplementary pollination**

- ✓ Due to lack of honey bees, seed setting will be poor. Hence critical or additional pollination is given to the crop for effective seed setting by
- ✓ Rubbing the heads of two neighbouring plants with each other.
- ✓ It is done during mid flowering stage (i.e 58-60 days of planting for long duration varieties and 45-48 days for short duration varieties) at alternate days between 7-11 a.m for 2 weeks.
- ✓ Hand pollination: The heads are rubbed with palm or muslin cloth so that pollination can be enhanced.
- ✓ In hybrids, the palm is first gently rubbed on the male parent flowers and then on the female line to transfer the pollen.



**Hand pollination**

- ✓ Keeping of bee hives 5 ha<sup>-1</sup>

### **Foliar application**

At head opening stage 2 % D.A.P and 20 ppm N.A.A. sprayed 2 times on 30<sup>th</sup> and 60<sup>th</sup> day after sowing for effective seed setting.

### **Irrigation**

The crop should be irrigated once in a week for enhanced seed set and formation of bolder grains. The critical stages of irrigation are primordial initiation stage, vegetative stage, milky and maturation stage. If the irrigation is withheld in these stages seed set will be poor and seed size will be reduced.

### **Pest and Disease management**

<b>Common pests and diseases</b>	<b>Management techniques</b>
Cut worm	Chlorpyrifos (20EC) @ 3.75 l/ha
White fly	Imidacloprid @ 0.1ml/lit
Thrips	Phosphomidon 0.03%



Tobacco caterpillar ( <i>Spodoptera litura</i> )	Endosulphan 0.07% or NSKE 5% or Fenitrothion 0.05%
Capitulum borer ( <i>Helicoverpa armigera</i> )	Endosulphan 0.07% or Helicoverpa NPV @ 250 LE/ha.
Alternaria blight and leaf spot	Mancozeb 0.3%
Rust	Zineb 0.2%
Downy mildew	Metalaxyl 25WP
Head rot	Copperoxychloride@0.4% or mancozeb 0.3% combined with endosulfan (0.05%)

## Roguing

Plants rogued from their vegetative phase to harvesting, based on plant, height, head size, branching habit, number of heads and colour of seeds.



## Field standards

Factor	Maximum permitted (%)	
	FS	CS
Off types at and after flowering	0.10	0.20
Objectionable weed	None	None
Plants affected by downy mildew	0.050	0.50

Plants infested with orabanche	None	None
--------------------------------	------	------

### **Seed Certification**

#### **Number of Inspections**

A minimum of three inspections shall be made as follows:

1. The first inspection shall be made before flowering on order to verify isolation, volunteer plants, and other relevant factors,
2. The second inspection shall be made during flowering to check isolation, offtypes and other relevant factors
3. The third inspection shall be made at maturity and prior to harvesting to verify true nature of plant and other relevant factors

#### **Bird scaring**

At the time of maturation birds will create problem due to their feeding habit. Hence, from the time of milky stage of the seed proper protection should be given against birds as it will lead to reduction in seed yield upto 80 per cent.

#### **Harvesting**

Change of thalamus colour from green to yellow is the visual symptom of physiological maturation. Heads are harvested as once over harvest.



#### **Threshing**

The earheads are dried under sun and threshed with flialle stick for extraction of seeds. The moisture content of seed at the time of threshing will be 15-18%. On large scale production sunflower threshers are used, but care should be given to avoid mechanical damage, which in turn will reduce the seed quality and storability.

### **Drying**

The seeds are dried to 8-10 % moisture content either under sun or adopting mechanical driers for long term storage as the seeds is orthodox in nature.

### **Processing**

Mechanical grading can be done with cleaner cum grader, which will remove the undersized immature and chaffy seeds. The middle screen size should be 9/64" round perforated sieves. The size can vary depending on the type of seed. In sunflower the graded seeds also can be upgraded through specific gravity separator for improvement in seed quality characters. Even the quality of seed lots having 5-10% lesser germination than MSCS level can be upgraded through simple specific gravity separation.

### **Seed treatment**

The seeds are infested with several storage pests, to protect against these pests the seeds are given protective treatment with bavistin @2g/kg of seed.

### **Seed packing**

Seeds are packed in gunny bag for short term storage while in HDPE and polylined gunny bag for long term storage.

### **Storage**

The treated seed can be stored up to 10 months provided the seeds are not infected with storage pests. Seed can be stored up to 2 years if the seeds are packed in moisture containers and are stored at low temperature. The godown should be kept clean as the possibility of secondary infestation with *Trifolium* (red flour weevil) is much in these crop.

### **Seed standard**

The processed seed should have the following seed quality characters both for certification and labeling.

### Seed Standard

Factor	Standards for each class	
	FOUNDATION	CERTIFIED
Physical purity (min.) %	98	98
Inert matter (max.) %	2	2
Other crop seed (max.) %	None	None
Germination (min.) %	70	70
Huskless seed (max.) (By number)	2.0%	2.0%
Total weed seeds (max.)	5/kg	10/kg
Objectionable weed seed	None	None
Seed infested with Orabanche (max.)	None	None
Moisture content (%)		
a. Previous container (max.)	9.0	9.0
b. Vapour proof container (max.)	7.0	7.0

### Mid storage correction

The seeds lose their quality during storage due to deterioration and pest infestation, when the germination falls below 5-10 % of the required standard the seeds are imposed with midstorage correction, where the seeds are soaked in double the volume of  $10^{-4}$  M solution of potassium dihydrogen phosphate (3.6mg/lit of water) for 6 hours and the seeds are dried back to original moisture content (8-9%).

## Hybrid seed production in sunflower

- ✓ Hybrids are produced by employing cytoplasmic genetic male sterility.
- ✓ The male sterile female and male parents are raised in BSH 3, 1:6, KBSH 1, 1:4 ratio under 400 m isolation.
- ✓ Seeds are produced by transferring the pollen of male parent to the female parent with the help of honeybees reared at 5 hives / ha.

### Hybrids

BSH -1 = CMS 234 A x RHA 274

KBSH 1 = " x 6 DI

MSFH 1 = MHS 71 x MHR 48

MSFH 8

MSFH -17

TCSH 1 = CMS 234 A x RHA 272

**Season** : June - July, October - November

### Isolation distance

	Foundation seed	Certified seed
Hybrids	600 m	400 m

### Seeds and sowing

Seeds are sown in ridges and furrows

Seed rate : Female 12 kg /ha and Male 4 kg/ha.

### Spacing

60 x 30 cm (hybrids)

Planting ratio : 8:1 or 4:1

Border row : two

### Manures and fertilizers

Compost : 12.5 t/ha  
NPK : 60:45:45 kg /ha

### **Supplementary pollination**

1. As in varieties

In hybrids, the palm is first gently rubbed on the male parent flowers and then on the female line to transfer the pollen.

2. Keeping of bee hives 5 ha<sup>-1</sup>.

### **Roguing**

Plants are rogued based on plant height, head size and colour of seeds during pre-flowering stage upto harvest.

### **Field standards**

	Foundation seeds	Certified seeds
Off types	0.1 %	0.2%

### **Harvesting**

The change of head colour from green to lemon yellow is the indication of physiological maturity. The heads are harvested separately first in male and then in female.

**Drying, processing and others** – as in varieties

### **Seed standards**

The graded seed should possess the following characters for certification and sale as certified/ truthfully labelled seeds

Parameter	FS	CS
Physical purity (min) %	98	98
Inert matter (max) %	2	2
Germination (min)%	60	60
Moisture content (max)%		



(a) Open storage	8	8
(b) Moisture vapour proof Storage	5	5

# GROUNDNUT SEED PRODUCTION

- **Common name-** Groundnut or Peanut or Earth nut or Monkey's nuts or Jack's nut or Manila nuts or Gober peas or Pinder.
- **Scientific name-** *Arachis hypogea*
- **Origin-** South America or Mexico
- **Distribution-** India, Nigeria, USA, Brazil, Senegal
- **Nutrition-** 44 to 56%- edible oil
  - 22 to 30%- edible protein
  - also has P, Ca, K, Mg, Vitamin E, Vitamin K, Vitamin B2
- **Physiology-** short day plant
  - photoinsensitive
  - well drained soil, light and sandy loam soil
  - pH- 5.8 to 6.2



# CLIMATIC REQUIREMENTS

- Groundnut is a tropical plant and requires a long and warm growing season
- It grows in areas receiving 50 to 125cm of well distributed rainfall.
- The optimum temperature for vegetative growth is ranging between 26 to 30°C depending on the cultivar.
- Reproductive growth is maximum at 24-27°C



## SOIL AND LAND REQUIREMENTS

### ❖ SOIL-

- Groundnut prefers well drained, light textured, loose, friable and sandy , sand loam soils.
- Clay or heavy soils are not suitable
- It is sensitive to soil salinity
- Prefers a soil pH of 6.0 to 7.5 with Ca and a moderate amount of organic matter.

### ❖ LAND-

- A field is selected on which groundnut was not raised in the previous two seasons, unless the variety was same and the crops were certified.
- The field should be well drained.



## SELECTION OF VARIETIES

- Only notified varieties recommended for a state/region should be selected.
  - 3 different types of groundnut are-
    - a. Erect/bunch-** shorter in duration. They don't possess seed dormancy.
    - b. Semi erect or semi spreading-** semi erect are between erect and spreading type in duration.
    - c. Spreading-** spreading types are longer in duration.
- The erect and semi erect types are suitable for all seasons.



## LAND PREPARATION

- Although groundnut is a deep rooted crop, deep ploughing should be avoided, because it encourages development of pods in deeper layers of soil which makes harvesting difficult.
- One ploughing and 3-4 harrowing, followed by levelling .
- Apply FYM or compost @ 5T/ha before final land preparation..
- Adopt ridge and furrow method to drain out excess water in rainy season.





# SEED TREATMENT



- Treat 1kg of seeds with 2gm of thiram before sowing.
- Keep the fungicide treated seed for 24hrs and use for sowing.
- Rhizobium culture treatment should be taken up after 7days of seed treatment.
- To break the seed dormancy of spreading type varieties , give the seed treatment of etharel.
- Use repellents like Pinetar and Kerosene to keep the rodents and crows away.
- The seed treatment should be according to the Indian Minimum Seed Certification Standards and should be followed by proper labelling.

# SOWING

- Usually undertaken with the onset of monsoon
- Heavy rain encourages high vegetative growth of plant and delays penetration of pegs.
- Optimum time for sowing for **kharif**- mid June to first week of July
- **Summer**- last week of Jan to 1<sup>st</sup> week of Feb.
- **Rabi**- September to December
- In Odisha it is mainly taken up in rabi season under irrigated condition.



## SEASONS FOR SOWING

In India, groundnut is generally sown in 4 seasons-----

- a. **Kharif**- About 85% of groundnut in india is sown in kharif
- b. **Rabi**- Groundnut is grown in rabi season in a limited area where winter is not severe and temperature do not go below 15°C. This crop is usually cultivated in rice fallow field and utilizes the residual moisture with minimal irrigation.
- c. **Summer**- Generally in the states like Tamil Nadu, Andhra, Karnataka with 9-12 irrigations.
- d. **Spring**- Spring cultivation of groundnut is taken in the states of UP, Punjab, West Bengal etc (March-May)

# SEED RATE AND SPACING

## ❖ SEED RATE

- Seed rate depends on- spacing, type of seeds and germination percentage.
- Spreading type varieties- 80-100kg/ha acc to size of kernels
- Bunch type varieties- 100-125kg/ha acc to size of kernels

## ❖ SPACING

- Spreading varieties- 60cm x 10cm
- Bunch varieties- 45cm X 10cm



# SOWING METHOD

- Seeds should be sown about 5cm deep with the help of a country seed drill or they are sown behind country plough.
- **Broad Bed And Furrow Method Of Sowing In Groundnut-** Under irrigated conditions
  - Advantageous for shallow water table and saline soils.
- **Cross Method Of Sowing-** helps in maintaining optimum plant population
  - Advantageous where groundnut succeeds rice cultivation.



# ISOLATION

- Isolation distances are essential for maintaining genetic purity.
- Groundnut is a largely self pollinated crop.
- Hence an isolation of 3m from other fields of groundnut is sufficient for certified and foundation seed production.
- In self pollinated crops isolation distance avoids mechanical mixture.





## FERTILISER APPLICATION

- Fertiliser influences pod formation and lime application ensures better nodulation.
- Lime @5q/ha
- Fertiliser dose- 20:40:40 NPK Kg/ha
- Gypsum @250kg/ha 20-25 DAS.



# IRRIGATION

- **Critical stages of irrigation-** flowering, peg formation and pod development
- **Rabi groundnut-** 3-4 irrigations
- **Summer groundnut-**9 irrigations
- Irrigation at 10-15 day intervals in kharif season
- Proper drainage is essential.
- Furrow method is the most effective with maximum WUE.



# INTERCULTURAL OPERATIONS

## A) Weeding

- Critical period of weed competition 28 to 42 days after sowing.
- Hand weeding is preferred at 20,45 and 60days of sowing.
- Chemical weed control fluchloralin @0.9 kg a.i./ha as pre emergence

## B) Earthing up

- Done within 2-3 weeks
- Soil is not disturbed after flowering.



## C) Roguing

- Roguing is done for offtypes, disease and pest infested plants and weeds

**D) Field Inspection-** A minimum of 2 inspections shall be made from the time of flowering to harvesting.

**E) Use of hormones-** Application of MH (Maleic hydrazide) near maturity in inducing dormancy in the pods for about 20-30 days .

- Application of growth hormone like planofix or Vardhak at time of flowering reduces excessive vegetative growth.
- Ideal time for hormonal application is 40 to 80days after sowing and ideal concentration is 20ppm.

## MAJOR WEEDS IN GROUNDNUT



*Amaranthus viridis*



*Boerhavia diffusa*



*Celosia argentea*



*Chloris barbata*



*Cynodon dactylon*



*Cyperus rotundus*

# PLANT PROTECTION



## 1. Early leaf spot or Early tikka:

C.O- *Cercospora arachidicola*

### Symptoms:

- Infection starts about a month after sowing.
- Small chlorotic spots appear on leaflets, with time they enlarge and turn brown to black and become sub circular shape on upper leaf surface.
- On lower surface of leaves light brown colouration is seen.
- Yellow halo is seen around the brown spots.
- Lesions also appear on petioles, stems, stipules.
- In severe cases several lesions coalesce and result in premature senescence.

### Management:

- Spray carbendazim@ 500 g/ha or mancozeb@ 1000 g/ha, if necessary 2<sup>nd</sup> round is given after 15 days.
- Spray 10% Calotropis leaf extract

## 2. Late leaf spot or Late tikka:

C.O- *Cercospora personata*

### Symptoms:



- Infection starts around 55-57 days after sowing in Kharif and 42-46 days after sowing in Rabi.
- Black & nearly circular spots appear on the lower surface of the leaflets and darker than early leafspots.
- Lesions are rough in appearance. In extreme cases many lesions coalesce resulting in premature senescence and shedding of the leaflets.

### Management:

- Intercropping pearl millet or sorghum with groundnut (1 : 3) is useful in reducing the intensity of late leafspot.
- Deep burying of crop residues in the soil, removal of volunteer groundnut plants. Spray Carbendazim@ 0.1% or Mancozeb@ 0.2% or Chlorothalonil@ 0.2%.



### 3. Bud necrosis:

C.O- Peanut bud necrosis virus(PBNV)



#### Symptoms:

- Chlorotic spots appear on young leaflets and necrotic rings and streaks are developed.
- As the plant matures it becomes stunted with short internodes and proliferation of auxiliary shoots.
- At last, the chlorotic spots enlarge to form necrotic patch and affect other plant parts.
- The virus is mainly transmitted by thrips.

#### Management:

- Adopt a close spacing of 15 x 15 cm.
- Remove infected plants up to 6 weeks after sowing.
- Spray Monocrotophos 36 WSC 500 ml/ha, 30 days after sowing either alone or in combination with antiviral principles.

## White grub:

S.N- *Holotrichia serrata*



### Symptoms:

- The grubs feed roots and damage pods.
- Grubs also feed on fine rootlets resulting in pale wilted plants.
- In severe condition the plant may die in patches.

### Management:

- Application of carbofuran @ 33kg/ha.
- Application of chloropyriphos 20EC @ 1125ml/ha.

# HARVESTING

- **Maturity indices-**

- Leaves start yellowing
- Spotting of leaves
- Dropping of old leaves.
- Pods develop blackish streaks on the inside of the shell
- Seeds are separated from the shell of the pod



- **Method-**

- Bunch type: by pulling
- Spreading type: by local plough or blade harrow.
- Hard soils are irrigated before harvesting for easy uprooting

## DRYING, CURING AND STORAGE

- Harvested crop kept in small heaps for 2-3 days or until it produces rattling sound.
- Followed by detaching the pods.
- Dried fodder (hulm) can be used for cattle feed.
- Pods must contain moisture less than 9% and kernels 8%. Best stored as pods.



## YIELD

- 1500 to 2000kg/ha (spreading type)
- 1000 to 1500kg/ha (bunch type)
- Ratio of the kernel to pods is 70:30 (kernels and shell)



## INDIAN MINIMUM SEED CERTIFICATION STANDARDS FOR GROUNDNUT

The General Seed Certification Standards are basic and, together with the following specific standards constitute the standards for certification of groundnut seed.

### **I. Land Requirements:**

Not eligible if crops grown within 2 seasons were of same kinds unless they were of same variety and of an equivalent or higher class of certified seed

### **II. Field Inspection:**

A minimum of two inspections shall be made, the first before flowering and the second at flowering and harvesting.

### III. Field Standards

#### A. General requirements

Contaminants	Minimum distance (meters)	
	Foundation	Certified
Field of other varieties	3	3
Fields of same variety not conforming to varietal purity requirements for certification	3	3

#### B. Specific requirements

Factor	Maximum permitted (%) [At the final inspection]	
	Foundation	Certified
Off-types	0.10	0.20



#### IV. Seed Standards

Factor	Standards for each class	
	Foundation	Certified
Pure seed (minimum)	96.0%	96.0%
Inert matter (maximum)	4.0%	4.0%
Other crop seeds (maximum)	none	none
Weed seeds (maximum)	none	none
Germination (kernels hand shelled)	70%	70%
Moisture (maximum)	9.0%	9.0%
For vapour-proof containers (maximum)	5.0%	5.0%

## FIELD WORK ACTIVITIES

Date	Activities
01/03/2021	<ul style="list-style-type: none"><li>• Land preparation was done.</li><li>• Urea and SSP fertilizer were applied at 1:5 ratio per seed.</li><li>• Sowing was done at 30cm × 10cm distance.</li><li>• The rest of sowing was done on the next day.</li></ul>
03/03/2021	Irrigation was given.
05/03/2021	1 <sup>st</sup> germination date was recorded and plant population was counted.
08/03/2021	Irrigation was given.
10/03/2021	<ul style="list-style-type: none"><li>• Irrigation was given.</li><li>• Chloropyriphos@ 1.5 DP was applied.</li></ul>
15/03/2021	Irrigation was given and 2 <sup>nd</sup> reading of plant population was taken.
(16,17,18)/03/2021	Irrigation was given.
22/03/2021	Weeding was done.
24/03/2021	Irrigation was given and 3 <sup>rd</sup> reading of plant population was taken.
25/03/2021	Weeding was done and 1 <sup>st</sup> flowering was observed.
30/03/2021	Irrigation was done and germination of 50% was observed in plot-3.
07/04/2021	Weeding and hoeing was done.

## FIELD WORK ACTIVITIES

### LAND PREPARATION

- ❖ **DATE:** 01.03.2021
- ❖ **MATERIALS REQUIRED:** Phawda, Garden rake, Trench hoe, Leveller.
- ❖ **PROCEDURE:**
  - Weeds were removed, bunds were trimmed.
  - The land was ploughed to a fine tilth.
  - FYM was added and incorporated in the soil.
  - Land was levelled.
  - Then lines were made 30 cm apart from each other with the help of trench hoe.

## FIELD WORK ACTIVITIES

### FERTILISER APPLICATION

- ❖ **DATE:** 01.03.2021
- ❖ 0.081kg urea and 0.601kg SSP was applied to 38.5m<sup>2</sup> area.
- ❖ **PROCEDURE:**
- ❖ The fertilizers were applied in the rows.
- ❖ Fertilizer was properly mixed with the soil with the help of a stick, so that the fertilizer did not come in contact with the seed.

## FERTILIZER DOSE AND SEED RATE CALCULATION

✓ **Fertilizer required:**

N=12.5kg/ha, P=25kg/ha

- Urea required-  $12.5/46 \times 100 = 21.17\text{kg/ha}$

For 38.5 sq.m.-  $21.17/10,000 \times 38.5 = 0.081\text{kg}$

- SSP required-  $25/16 \times 100 = 156.25\text{kg/ha}$

For 38.5 sq. m.-  $156.25/10,000 \times 38.5 = 0.601\text{kg}$

- ✓ **Seed rate**- 100kg/ha, Test wt- 40gm, wt. of 1 seed-  $40/100 = 0.4\text{gm}$

Total no of seeds required-  $1,00,000/0.4 = 250,000$  seeds/ha

**Amount of fertilizers/seed:**

- Urea-  $21170/250000 = 0.084\text{gm/seed}$
- SSP-  $156250/250000 = 0.625\text{gm/seed}$

## FIELD WORK ACTIVITIES

### SOWING

- ❖ Pre treated seeds were sown in lines.
- ❖ **DATE:** 01.03.2021 (TAG-24, SWARAJ-51)  
02.03.2021 (SWARAJ-44)
- ❖ **SEED RATE:** 100 kg seeds / ha for bunchy type
- ❖ **SOWING TYPE:** Line sowing in east-west direction
- ❖ **DEPTH OF SOWING:** 5cm
- ❖ **SPACING:** 30 cm × 10 cm
- ❖ **IMPLEMENTS USED:** Rope , Trench hoe , Scale

## FIELD WORK ACTIVITIES

### IRRIGATION

- Irrigation is not required in chary groundnut as it is sensitive to water.
- Better drainage should be ensured for a healthy crop stand.
- Rabi groundnut irrigation requirement is more.

❖**DATE:** (03,08,10,15,16,17,18,24,30) . 03. 2021

❖As we sow groundnut in zaid season, the water requirement was high. So frequent irrigation was given.

❖At the initial stage, irrigation was done with the help rose cane and pipe using sprinkler method.

❖In later stage before peg initiation furrow method of irrigation was used.

### PLANT POPULATION COUNT

On 5<sup>th</sup>,10<sup>th</sup> and 15<sup>th</sup> march plant population was counted.



## GERMINATION DATA OF GROUNDNUT

### **1<sup>st</sup> germination data: (05/3/21)**

1. Plot-1= 11
2. Plot-2= 09
3. Plot-3= 11

### **2<sup>nd</sup> germination data: (10/3/21)**

1. Plot-1=37
2. Plot-2= 41
3. Plot-3= 165

### **3<sup>rd</sup> germination data: (15/3/21)**

1. Plot-1=132
2. Plot-2=154
3. Plot-3=325

## FIELD WORK ACTIVITIES

### INTERCULTURAL OPERATION

❖ **DATE:** 22.03.2021

❖ **MATERIALS REQUIRED:** Trench hoe.

❖ Hoeing was done between the rows for proper aeration of soil and to control weed.

❖ Hoeing was done in a proper way, so that the groundnut plant was not affected.

## FIELD WORK ACTIVITIES

### PLANT PROTECTION

- ❖ **Chloropyriphos (deadly) 1.5% DP** was applied for protection against major soil pests like termites, ants and white grubs.
- ❖ **Date of application:** 10.03.2021
- ❖ Chloropyriphos was applied carefully, so that seeds and seedlings did not come in direct contact with the pesticide.

### WEED MANAGEMENT

- ❖ Critical stage of crop weed competition is 30-60 days after sowing.
- ❖ Hand weeding was done (20 DAS,40 DAS appox).

## FIELD WORK ACTIVITIES

**Date: 01/03/2021**



**Land Preparation**



**Fertilizer  
Application**



**Sowing**

## FIELD WORK ACTIVITIES

**Date: 03/03/2021**



Irrigation

## FIELD WORK ACTIVITIES

**Date: 05/03/2021**



**Plant Population Count**

## FIELD WORK ACTIVITIES

**Date: 10/03/2021**



**Irrigation**



**Chloropyrifos  
Application**



## FIELD WORK ACTIVITIES

**Date: 15/03/2021**



**Irrigation**

## FIELD WORK ACTIVITIES

**Date: 22/03/2021**



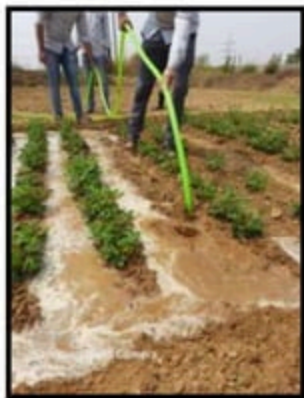
**Weeding**



**Intercultural  
Operation**

## FIELD WORK ACTIVITIES

Date: 24/03/2021



Irrigation

# VARIETAL CHARACTERISTICS

## 1. TAG-24:

- TAG stands for Trombay Akola Groundnut.
- Developed by BARC in 1992.
- Average duration is 110 days.
- Average yield is 25q/ha.
- 2 kernels/pod.
- Resistant to leafspot and bud necrosis.
- Oil content is 51%.

## 2. Swaraj-44:

- Bunchy variety
- 2-3 kernels per pod.
- High shelling percentage i.e. 76%.



- Oil content is 45%-48%.
- Seed rate is 40kg/ha
- Duration is 95-100 days

### 3. Swaraj-51:

- Bunch type.
- High yielding variety.
- Used for domestic purpose.
- Good fodder variety.
- Oil content is 50%-51%.
- Maturity is 90-100 days.



# PROCESS FOR SEED CERTIFICATION

---

**1**

APPLICATION FOR CERTIFICATION

**2**

SCRUTINY OF THE APPLICATION

**3**

INSPECTION OF SEED FIELD

**4**

APPROVE OR RECOMMEND THE FIELD FOR REJECTION

# PROCESS FOR SEED CERTIFICATION

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5

INSPECTION OF SEED PROCESSING

6

SEED SAMPLING BY REPEATED HALVING AND MIXING

7

TAGGING AND SEALING

8

CONTROL PLOT TESTING



# PROCESS FOR SEED CERTIFICATION

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**9**

**CONDITION FOR INTERCROPPING**

**10**

**EXTENSION OF VALIDITY PERIOD OF TAG**

**11**

**REVOCAION OF CERTIFICATE**

**12**

**APPEAL AGAINST CERTIFICATION AGENCY**

## CONCLUSION

- Total cost of cultivation of groundnut for 115 sq m of area= Rs. 414.286
- Average yield/ha= 20 quintal or 23.1kg/115.5 sq m
- Total income=  $50.90 \times 23.1 =$  Rs. 1175.79
- Profit=  $1175.79 - 414.286 =$  Rs 719.768
- BC Ratio=  $719.768 / 414.286 =$  **1.737**
  
- Since the BC ratio is 1.7, it is a profitable enterprise

## REFERENCES

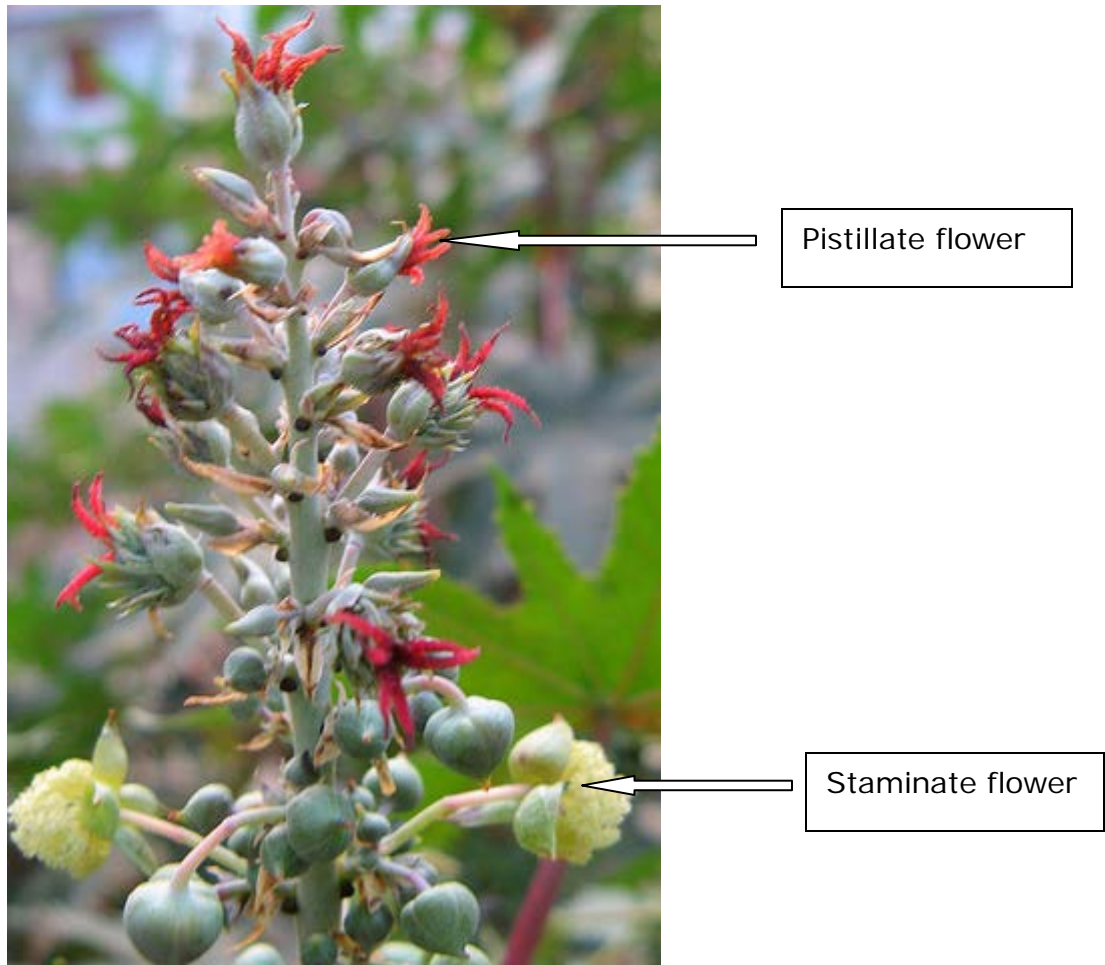
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2. Practical note of seed technology of 3<sup>rd</sup> semester
3. [https://www.google.com/url?sa=t&source=web&rct=j&url=https://kvk.icar.gov.in/API/Content/PPupload/k0447\\_5.pdf&ved=2ahUKEwjws8nMsuLwAhVIU30KHQczCbMQFjAAegQIBBAC&usg=AOvVaw2kQ2LhUkFBgLwCKN4lGhzW&cshid=1621861983351](https://www.google.com/url?sa=t&source=web&rct=j&url=https://kvk.icar.gov.in/API/Content/PPupload/k0447_5.pdf&ved=2ahUKEwjws8nMsuLwAhVIU30KHQczCbMQFjAAegQIBBAC&usg=AOvVaw2kQ2LhUkFBgLwCKN4lGhzW&cshid=1621861983351)

## SEED PRODUCTION IN VARIETIES AND HYBRIDS OF CASTOR

### Castor and its speciality

- Castor is a cross pollinated crop, [protogynous](#) and wind pollinated. Inflorescences are borne terminally on the main and lateral branches.
- The main stem ends in [raceme](#), which is the first or primary raceme. After the first raceme appears, 2 or 3 branches arise at the nodes immediately below it.
- Each of these branches terminates in racemes after 4 or more nodes have formed which are known as secondary racemes.
- Branches arise from the nodes just beneath secondary racemes, ultimately terminating in tertiary racemes. This sequence of development (indeterminate growth habit) continues.
- The racemes of castor are [monoecious](#) with the [pistillate](#) flowers on the upper 30-50% and [staminate](#) flowers on the lower part of the inflorescence.
- The proportion of pistillate and staminate flowers among the racemes varies a great deal both within and among genotypes. It is influenced by the environment of the plant, genotypes and nutrition.
- Female tendency is the highest in winter, while male tendency predominates in summer and rainy seasons.
- Also, the femaleness in young plants with high levels of nutrition is stronger than in old plants with low levels of nutrition.

## Castor raceme



### Pistillate mechanism

In addition to monoecism a sub form of dioecism exists in castor, which has led to the identification of 3 different pistillate mechanisms.

#### 1. N type or conventional mechanism

- ✓ It is governed by a recessive sex switching gene. This can be maintained by sibmating. The progeny from seed produced on pistillate plants segregates in 1: 1 ratio of pistillate and monoecious plants. In the production of F1 hybrid seed using the N pistillate line, the producer is required to rogue out normal

monoecious plants before anthesis to obtain 100% production of pistillate plants in the female rows. This has proved difficult to do for 3 reasons.

- ✓ Uneven emergence
- ✓ Variation in time of flowering and
- ✓ Higher percentage of monoecious plants than expected 50 percent.

## **2. S type or non conventional mechanism**

It is derived from reversals, which start out as female and then revert to normal monoecism any time after the first raceme. Use of this pistillate line is beset with the problems of lack of stability of the expression of pistillate character as large number of revertants as well as monoecious plants was observed in the population. Eg. VP 1. This problem was successfully overcome with the exploitation of the NES system.

## **3. NES system**

This line is normally pistillate under moderate temperature but produces interspersed staminate flowers under high temperature. In crossing fields (hybrid seed production plot) usually one or two roguing of the female line are sufficient to ensure that all flowering plants are pistillate to remove off types that appear.

E.g. The original population of VP 1 was thoroughly screened under high temperature to eliminate the monoecious plants as well as early revertants.

The seed setting in the selected totally pistillated lines is facilitated by the production of interspersed male flowers under the influence of environment sensitive genes.

India is the largest producer of castor in the world. In India, Gujarat is the leading state followed by Andhra Pradesh.

## **Varieties**

SA 1, SA 2, TMV 4, 5, 6, CO 1, Aruna, Bhagya and Sowbaghya

### Speciality with Hybrids in castor

- ✓ The development of N type pistillate line, N 145-4 has led to the exploitation of hybrid vigour in USA in 1950.
- ✓ A 100% pistillate line TSP 10 R (Texas S- pistillate 10) was released in 1962 in USA.
- ✓ Another stable pistillate line (NES 1) based on environmentally sensitive staminate flower character in combination with recessive sex switching gene released at Davis, California in 1964, is now used.
- ✓ In India, Gujarat first started hybrid seed production in mid sixties.
- ✓ First hybrid in India was released in 1968 in Gujarat as GCH3 (Gujarat castor hybrid) using TSP 10 R x JI 15.
- ✓ Indigenous pistillate line VP 1 was developed at Vijapur and using this GAUCH was released in 1973. But it is susceptible to wilt and root rot diseases.
- ✓ Hence another hybrid GCH 2 was released in 1985.
- ✓ Another hybrid GCH 4 was released in 1986 and is in cultivation.

<b>Hybrids</b>	<b>Female</b>	<b>Male</b>
GCH 3	TSP 10 R	JI 15
GAUCH 1	VP 1	V 19
GCH 2	VP 1	JI 35
GCH 4	VP 1	48-1
TMVCH 1	LRES 17	TMV 5



## Land requirement

Well drained fertile soil should be selected. The crop cannot tolerate alkalinity and salinity. It performs well with medium to deep sandy loam and heavy loam soils are highly suited for seed production.

## Isolation distance

	Foundation seed	Certified seed
Varieties and Hybrids	600 m	300 m

## Season

Rabi / Winter - Hybrid seed production. Summer and [kharif](#) provide ideal male promoting environment for undertaking seed production of the variety, male and female parents of hybrids. [Kharif](#) and summer encourages good expression of less productive plant which could be easily eliminated through timely roguing.

Female parents when raised in male promoting environment produce environmentally sensitive staminate flowers, which are very essential for self-production of the female parents.

## Seed and sowing

Seed rate : 10 kg / ha (varieties)  
2 kg / ha male and 5 kg/ ha female for hybrids.

## Spacing

Varieties : 90 x 20 to 90 x 60 cm  
Hybrids : 90 x 40 to 90 x 60 cm

## Planting ratio

3:1 or 4 - 6:1

**Fertilizer** : Basal 40:60: 40 NPK / ha

Top: 1<sup>st</sup> 20 kg N/ha (40-50 DAS) , 20 kg N/ha. (After 1<sup>st</sup> picking)

**Bloom:** Presence of white waxy coating which protects from chilling and jassid attack.

4 types of bloom:

- ✓ No bloom
- ✓ Single bloom - Bloom only on stem
- ✓ Double bloom- On stem, petioles, and lower sides of leaves
- ✓ Triple bloom - On all parts.

### **Stages of inspection**

- ✓ 10 days prior to flowering -Stem colour, inter-node length.
- ✓ During flowering - No. of nodes upto primary raceme
- ✓ Before 1<sup>st</sup> picking (Spike and capsule character, reversion to monoecious in second order raceme)
- ✓ After 1<sup>st</sup> picking - Reversion to monoecious or flower initiation in third order raceme.

### **Irrigation**

Critical stages are primordial initiation and flowering stage in differential segmental order branches. Moisture stress in sensitive crop growth stages may lead to production of more male flowers in monoecious varieties.

### **Harvesting**

Castor produces 4 or 5 sequential order spikes, which can be harvested in 3-4 pickings starting from 90-120 days at 25-30 days interval.



Premature harvesting leads to reduced seed weight, oil content and germination. If shattering is not a problem in a variety, harvesting can be delayed until all capsules are fully dried.

### Grading

The seeds are size graded using round perforated metal sieve of 8/64".



### Field standards

	Foundation seeds	Certified seeds
Off types (Varieties)	0.1	0.2%
Off types (Hybrids)	0.5	1.0%

### Seed storage

Seed treatment with Thiram @ 2 g / kg

Storability in Pervious container - 1 year

Storability in Moisture vapour proof container - 2

### Seed standards

The graded seed should possess the following characters for certification and sale as certified/ truthfully labelled seeds.

Parameter	Foundation seed	Certified seed
Physical purity (min) %	98	98

Inert matter (max) %	2	2
Other crop seed & Weed Seed (max)	-	-
Other distinguishable variety seeds	5 / kg	10/kg
Germination (min)%	70	70
Moisture content (max)%		
(a) Open storage	8	8
(b) Moisture vapour proof storage	5	5

## Questions

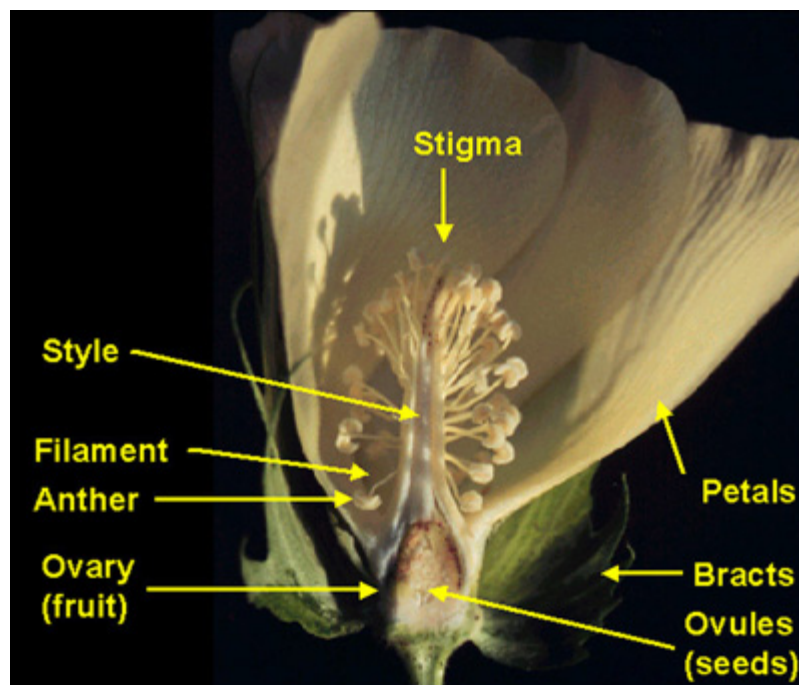
1. Cross-pollination in castor is due to protogynous nature. (**True**/false)
2. The racemes of castor are diecious. (True/**False**)
3. \_\_\_\_\_ is the first castor hybrid released in India
  - a. CH1
  - b. GCH2
  - c. GCH 3**
  - d. CH2
4. The raceme of castor is monoecious (**True**/false)
5. Isolation distance for certified seed production in castor is\_\_\_\_\_
  - a. 600 m
  - b. 300 m**
  - c. 200 m
  - d. 400 m
6. Minimum germination percentage for castor certified seed is
  - a. 85%
  - b. 90%
  - c. 70%**
  - d. 60%
7. Pistillate mechanism which start out as female and then revert to normal monoecism any time after the first raceme is \_\_\_\_\_.
  - a. NES Type
  - b. S Type**
  - c. N Type
  - d. None
8. In which system the line is normally pistillate under moderate temperature but produces interspersed staminate flowers under high temperature.
  - a. N
  - b. S Type
  - c. NES Type
  - d. None
9. \_\_\_\_\_ is the largest producer of castor in the world.
  - a. Indonesia
  - b. China
  - c. Nepal
  - d. India**
10. Critical stage of irrigation in castor is primordial initiation and flowering stage

## SEED PRODUCTION IN COTTON VARIETIES AND HYBRIDS

Cotton botanically as *Gossypium sp.* is a fibre yielding crop. It is known as the queen of fiber crops. It serves as a cash crop to the farmer as the lint serves as the raw material for the textile industry .The seed is used both for multiplication and as animal feed.The success of commercial crop depends on the quality of the basic seed.

### Floral biology

Simple, solitary, terminal, extra axillary, petals yellow to cream in colour, hermaphrodite, bracteoles called as epicalyx, three in number, free and deeply serrated and persistent at the base of the flower. Nectary gland is present on each bracteole. Calyx five, united, cup shaped corolla five, polypetalous, a purple spot is present on the inner side of the claw of the petal (petal spot) in some species. Androecium forming a staminal column (monadelphous) bearing numerous anthers. Ovary superior penta carpellary, style slender, passes through staminal column with three to five lobed stigma, ovules many in axile placentation.



There is much variation in case of flower opening. Asiatic cotton opens between 8 and 10. a.m. American cotton opens much earlier. Temperature affects the flower opening. After flower opening the cream yellow colour of corolla turns pink within a day and later changes to red. The receptivity of the stigma is 8 to 10 a.m.



Cotton is an often cross-pollinated crop where the extend of cross-pollination is > 60%. In cotton 4 different species are in popular usage, viz. *G. arboreum* (eg. K 10) *G. herbaceum* (e.g. Uppam) *G. hirsutum* (e.g. MCU varieties) and *G. barbadense* (e.g. Suvin and Suguna).

### **Method of Seed Production**

**Varieties:** Under isolation, by open pollination, the varieties are multiplied. For nucleus seed production, selfing of flowers is done with cotton (lint) dipped in clay or red earth.

**Hybrids:** In cotton both inter and intraspecific hybrids are available.

Interspecific Hybrid :

Varalakshmi : Lakshmi x SB298 E (*G. hirsutum* x *G. barbadense*)

DCH 32 / Jayalakshmi : DS 28 x SB 425 (*G. hirsutum* x *G. barbadense*)

TCHB213 : TCH 1218 x TCB 209

Intraspecific hybrid : Suguna, Savitha (T7 x M12)

### **Tool employed for hybrid**



The hybrid seed production in cotton is achieved through emasculation and dusting technique, which is the physical removal of male organ (staminal column) from the female parent.

### **1. Emasculation and dusting**

At the time of flower initiation in female line, the flowers that are going to open next day are selected and the petals are removed between 3-6 pm. With the help of nail or needle, the total staminal (pollen + anther + anther tube) column are removed. Then the flowers are covered with a definite colour cover for easy identification of the emasculated flowers. In the morning between 9 am -12 noon, which is the anthesis time, the flowers of selected male parent are plugged and dusted on the stigma of the emasculated flower on opening the cover. It is again covered with different coloured cover to avoid pollination with other pollen and to identify the emasculated and dusted flower from the rest. The pollen from a single flower is enough to dust 4-5 female flowers. The pollen receptivity of the stigma is for 46 hours.

For easy identification of selfed boll from emasculated and dusted boll the bract can be removed while emasculating owing to the little contribution of bract to seed set and seed yield.



*Female flower bud*



*Emasculated flower bud*



*Dusted flower bud covered with white paper bag*



*Hybrid seed production field*



*Emasculated flower bud covered with red paper bag*



*Stigma after dusting*



*Dusting*

**Particulars of varieties/hybrids**

Varieties	Parentage	Season	Irrigated / Rainfed	Seed yield (kg/ha)
<b>Varieties</b>				
MCU 5	Multiple cross	Aug- January	Irrigated	1850
MCU7	X ray irradiation of x L 1143 EE	Jan- Feb. to May - June(summer)	Irrigated (Rice fallows)	1330
MCU 11	MCU 5 x Egyptian hirsutum hybrid derivative	Aug - September	Irrigated	2200
LRA 5166	Laxmi x Reba B.50 x AC 122	Sep-October to Jan - February	Rainfed	725
K10	K9 x 11876 hybrid derivative	Sep-October to Jan - February	Rainfed	726
K11	(0794-1-DX 11876) x (0794-D x 11450) Multiple Hybrid derivative	Oct- March	Rainfed	1100
SVPR 1	MCU 7 x AC 129/2	February - July	Summer - Irrigated	15-16 Qtl. Of kapas /ha
<b>Hybrids</b>				
Suvin	Hybrid derivative from the cross Sujatha x St.Vincent	Aug - February	Irrigated	1020
Jalyalaxmi	Interspecific hybrid of DS 28 <i>G. hirsutum</i> x SB 425 (VF) <i>G. barbadense</i>	Aug-February	Irrigated	2880
TCHB 213	Interspecific hybrid of TCH 1218 <i>G. hirsutum</i> x TCB 209 <i>G. barbadense</i>	Aug-February	Irrigated	2215
Savitha	T7 x M 12 (Intra hirsutum hybrid)	Aug-February	Irrigated	1800
HB 224	It is an interspecific hybrid involving <i>G. hirsutum</i> x <i>G. barbadense</i>	Aug-February	Irrigated	2000

## Steps in hybridizing technique

- ✓ Emasculate and dust as far as possible buds appearing during the first six weeks of reproduction phase to ensure good setting and development of bolls.
- ✓ Restrict your emasculation each day evening from 3 pm to 6 pm and pollination in morning between 9-12 noon to ensure highest purity of hybrid seeds. Emasculation should be complete and perfect.
- ✓ Choose optimum size of bud and avoid young or too old buds for emasculation.
- ✓ Cover the male buds with paper bags, previous evening for their use next day.
- ✓ Emasculated buds may be covered preferably with butter papers.
- ✓ Do not forget to tie a thread to the pedicel of the bud immediately after pollination.
- ✓ Close your crossing programme after 9<sup>th</sup> week (from commencement of crossing) and remove all buds and flowers appearing subsequently to facilitate the development of crossed bolls.
- ✓ Nip the top and side shoots to stop further vertical and horizontal growth.
- ✓ Light irritations should be given as and when required. Excessive or scanty or inadequate irrigations should be avoided especially during crossing and boll development period.
- ✓ Continue irrigation till last picking of the crossed bolls. Frequency of irrigation depends on weather factors like rainfall, temperature and wind velocity.
- ✓ Pick up the ripe and completely opened bolls along with threads and collect in baskets for second sorting. Bolls without threads may be bulk harvested as female seed cotton.
- ✓ Crossed bolls collected in baskets may be sorted out for second time to verify that they are crossed bolls. Then collect the crossed seed cotton and store in gunny bags carefully marked as crossed bolls.
- ✓ Rain touch cotton or hard locks be picked and kept separately to avoid poor germination of hybrid seeds.

- ✓ Store the crossed seed cotton in a cool dry place till it is handed over to processing unit.

### **Use of Genetic male sterility**

Hybrids are also produced by employing genetic male sterility system in cotton, where the female parent will segregate into 50:50 ratio of male sterile and male fertile plants. The male fertile plants are removed and the male sterile plants are crossed with concerned male line.

E.g. Suguna: Gregg x K 3400

### **Land requirement**

The field should be fertile and formed into ridges and furrows. Black cotton soils are highly preferable than other soils. Land should be free from volunteer plants and designated diseases especially the wilt disease.

### **Season**

Winter crop : Aug - Sep

Summer crop : Feb - March

### **Seeds and Sowing**

Seeds should be obtained from an authenticated source with tag and bill.

### **Pre-sowing management**

The seeds can be hardened with 1% prosopis and pungam leaf extract for rainfed/summer sowing to resist water stress problem. Use of delinted seed is better than fuzzy seed to avoid diseased and injured seed.

### **Seed rate**

Varieties : 15 kg/ha (fuzzy seed) 7.5 kg/ha (delinted seed)

Hybrids : 3.75 kg/ha (Jayalakshmi), 1 kg (TCHB 213)

Male : 2 kg /ha and Female 4 kg /ha.

### Seed treatment

Treat the seeds with azospirillum at 3 packets (600 g/ha) and 2 kg of azospirillum / ha mixed with 25 kg of FYM and 25 kg of soil and applied on the seed line. This saves 25 % nitrogen besides increasing yield.

### Spacing – Varieties

1. Long duration : 90 x 30 cm
2. Short duration : 60 x 30 cm

### Hybrids

- ♀ : 120 x 60 cm  
♂ : 90 x 60 cm

### Hybrids - Planting ratio

8:2 but here it is block system where flowers of 2 parts of male is sufficient to dust 8 parts of female parent.

### Isolation (m)

	Foundation seed	Certified seed
Varieties	50	30
Hybrids	50	30

### Manures and fertilizers

- Compost : 12.5 tons/ha  
Total : 100:50:25 NPK kg/ha  
Basal : 50:50:25 NPK kg/ha  
Top dressing: 25:0:0 NPK kg/ha  
(40-45 days after sowing)  
25:0:0 NPK kg/ha (70-75 days after sowing)

### Foliar spray

Spray DAP 2% (for female parents, spray on 60,70,80 and 90<sup>th</sup> days after sowing. (Soak 5 kg of DAP in 25 liters of water over night and supernatant liquid should be taken and mixed with 475 liters of water for spraying 1 hectare).

### Micronutrient application

Mix 12.5 kg of micronutrient mixture formulated by the Department of Agriculture Tamil Nadu with enough sand to make a total quantity of 50 kg for one hectare.

### **NAA application**

Spray 40 ppm of NAA (40 mg of NAA dissolved in 1 liter of water) at 40 / 45th day using high volume spray liquid in 1125 liter /ha. Repeat the same dose after 15 days of first spray.

### **Topping**

Topping arrests terminal growth by nipping the terminal 10-12<sup>th</sup> node for controlling excessive vegetative growth.

### **Rouging**

The crop should be rouged for off types, selfed plants, from vegetative phase to harvest phase depending on plant stature, leaf size, leaf colour, hairiness, stem colour, flower colour, petal spot, pollen colour, number of sympodia, boll size, boll shape, pittedness etc. to maintain genetic purity.

### **Field standards**

	<b>Maximum permitted (%)</b>			
	<b>Foundation seed</b>		<b>Certified seed</b>	
	<b>Varieties</b>	<b>Hybrids</b>	<b>Varieties</b>	<b>Hybrids</b>
Off types	0.1	0.1	0.2	0.5

### **Irrigation management**

Once in 10 days. Critical periods are boll formation to boll maturation stages.

### **Specific problems**

Boll shedding will occur either due to extreme dry climate or lesser frequency of irrigation or physiological disorder.

By spraying 40 ppm of NAA and cycocel at 20ppm, this can be minimized.

### **Harvesting**



- ✓ The seed attains physiological maturation 45 days after anthesis.
- ✓ The initiations of hair line cracks on the dried bolls are the physical symptoms of physiological maturation.
- ✓ At that time, the moisture content will be 30-35%.
- ✓ The bolls are harvested as pickings in cotton.
- ✓ Due to continuous flowering habit once over harvest is not practiced.
- ✓ As and when the bolls burst with hairline cracks the bolls are collected and dried.
- ✓ Normally five to seven pickings can be practiced in a crop.
- ✓ But early 4-5 pickings are recommended for seed purpose.
- ✓ Harvest in the morning hours upto 10 to 11 a.m. only when there is moisture so that dry leaves and bracts do not stick to the kapas and lower the market value.
- ✓ Pick kapas from well burst bolls only.



- ✓ Remove only the kapas from the bolls and leave the bracts on the plants.

- ✓ As kapas is picked, sort out good puffy ones and keep separately.
- ✓ Keep stained, discoloured and insect attacked kapas separately.

### **Kapas sorting**

Kapas is sorted manually to pick good quality seeds. Hard locks are to be removed (Kapas without proper bursting and lint is light yellow in colour), since these kapas mostly result in poor quality seeds, due to boll worm or other insect attack.

Skewed bolls or ill filled or nonviable seeds are formed if stigmatic lobes are not pollinated.

### **Ginning and certification**

- ✓ Gin the crossed kapas in separate gins erected in authorized seed processing units or farm gins under the close supervision of the authorities concerned to ensure purity and avoid seed damage.
- ✓ Sieve the seed in two types of mesh to remove small, shrivelled seeds, broken seeds and clean perfectly from any dirt or dust.
- ✓ After ginning, the seeds should be dried well and cleaned by hand picking. After cleaning, certification agency will take sample for testing germination and genetic purity test. Minimum germination 65% and genetic purity 90% should be maintained.
- ✓ Certified seeds would be bagged in one kg bag, sealed and details regarding its origin, germination, physical purity per cent and genetical purity percent, besides season of production are passed on to sale agencies or respective producers for commercial sale.
- ✓ Uncertified seeds would be procured by the concerned Department or Agency at the market rate for the ordinary cotton seeds for further multiplication. This step is essential to avoid unauthorised sale of substandard uncertified seed.

### **Processing**

The ginned seeds (or) the fuzzy seeds are graded by hand picking and by pressing on wire-mesh sieves to remove the under sized seeds and dust.



### **Acid delinting**

- ✓ Fuzzy seeds will clog with one another. So for easy handling the seeds are delinted using  $H_2SO_4$  @ 100 ml/kg of seed for 2-3 minutes.
- ✓ After acid treatment, the seed should be washed thoroughly for 3 to 4 times with fresh water.
- ✓ From the floaters, mature seeds without any visible damage can be picked and added to the sinkers.

### **Acid delinting machine**



### **Procedure**

Weighed quantity of fuzzy seeds is taken in a plastic container and required quantity of the acid is added. Stir well with wooden rod till a shiny black colour appears (Tar like) wash with more of water (5-6 times) and shade dry the seed to reduce the moisture content to 12% before further handling.

### Processing of delinted seed

The free flowing delinted seeds can be graded using 10/64" round perforated metal sieve, which is recommended as standard sieve in OSAW cleaner cum grader for cotton.

The seed can also be graded by specific gravity method by using floatation technique using water. The seeds will separate into floaters and sinkers. The sinkers are good seeds. From floaters, reddish (immature) and damaged (seed with insect hole) are removed. The brownish seeds which are good seeds are hand picked and used for sowing.

### Seed standards

Characters	Foundation seed	Certified seed
Physical purity % (min)	98	98
Inert Matter % (max)	2.0	2.0
Other crop seeds (max)	5 kg <sup>-1</sup>	10 kg <sup>-1</sup>
Weed seeds (max)	5 kg <sup>-1</sup>	10 kg <sup>-1</sup>
Genetic purity (%)	100	100
Germination (min) % ( variety)	65	65
Germination (min) % ( hybrid)	75	75
Moisture content (max) %		
a. Moisture pervious	10	10
b. Moisture vapour proof	6	6

### Seed storage

The seeds can be stored upto 8-9 months in moisture pervious container and upto 12-15 months in moisture vapour proof containers.

The seed treatment with thiram @  $2.5 \text{ kg}^{-1}$  or chlorine based halogen mixture @  $3 \text{ g kg}^{-1}$  will protect the seed from storage fungi *Aspergillus* spp and preserve the storability.

### **Mid storage correction**

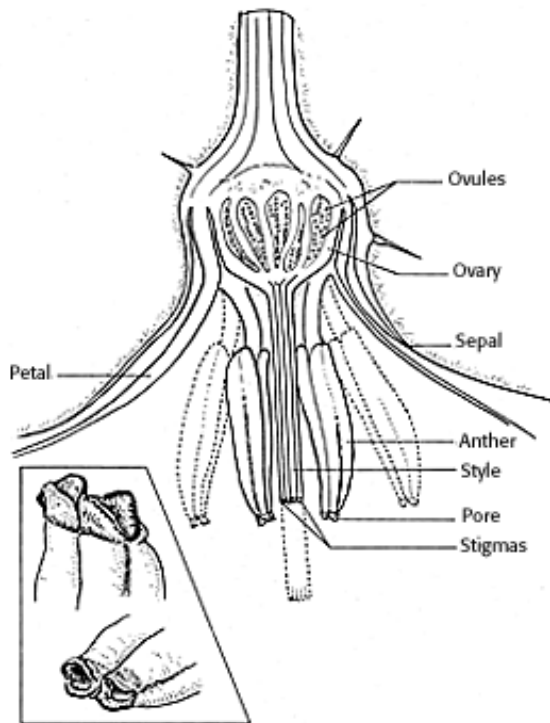
- ✓ The fuzzy and delinted seeds can be soaked in double the volume of  $10^{-4}$  molar solution of  $\text{Na}_2\text{HPO}_4$  for 2 and 1 hr respectively ( 3.59 g / 100 l of water.)
- ✓ Then the seeds are shade and sun dried to bring back to the moisture content of 10-12%. The mid storage correction improves the planting value of old seeds.
- ✓ Dead seeds may be removed by soaking acid delinted cotton seeds in monolayer for 3 h and drying back to original moisture content.
- ✓ The seeds when put into potable water will separate into sinkers and floaters. Dead seeds become buoyant and float.

## **BRINJAL (*Solanum melongena*)**

Brinjal is one of the most important vegetable crops grown extensively in the tropical and subtropical belts of the world. It is grown mainly fresh market and to a little extent for processing. Increased attention is now being bestowed to breeding and production of Brinjal. Production of brinjal can further be increased if improved cultural practices are combined with good quality seeds. The quality seed production techniques of brinjal comprises of the following steps.

### **Botany**

Brinjal is often cross pollinated crop. Brinjal flower opens mainly in morning. A few flower open at 16 hr. Anther dehiscence occurs 15-20 minutes after flowers have opened. The period of receptivity ranges from a day prior to flower opening to 4 days after opening. Brinjal produces 4 types of flowers with different style length. (Long style, short style, medium style and pseudo short style). For seed production and better yield, the long and medium style is desirable. To increase the production of long and medium style application of more nitrogen or spraying of growth regulators during pre-flowering and flowering stages may be followed.



**Method of seed production :** Seed to Seed.

### **Stages of seed production**

Breeder seed → Foundation Seed → Foundation Seed II → Certified Seed.

### **Varieties**

Co.1, Co.2. MDU.1, PKM.1, KKM.1, PLR. 1. AU1, Pusa purple long, Arka nidhi, Pant smart, Arka neelkanth, Arka shrish.

### **Hybrids**

CoBH1, Arka Navneet (IIHR 22-1 x supreme), Pusa H-5, Pusa H-6, MHB 10, MHB 39 (Mahyco), Azad Hybrid.

### **Season**

The brinjal seed production can be taken up in the following 2 seasons. May-June and December- January.

**Land requirement :** The land should be free of volunteer plants.

### **Isolation**



For varieties, 200 M or 100 M of isolation distance is required for foundation and certified seed, respectively. For hybrid seed production minimum of 200 M isolation distance should be maintained.

### **Seed rate**

Varieties - 400 - 500 g/ha

Hybrids - 200 g/ha (Female) - 50 g/ha (Male)

### **Nursery**

Sow the seeds in raised nursery bed of 20 cm height, in rows of 5 cm gap and covered with sand. Eight and ten nursery beds will be sufficient to transplant one acre. Apply 2 kg of OAP 10days before pulling out of seedling.

### **Transplanting**

Seedlings are transplanted when they are 30-35 days old (12-15 cm height) preferably in the evening time. Spacing of 75 x 60 cm (non spreading) and 90 x 60 cm (spreading) varieties, 90 x 60 cm for female parent and 60 x 45 cm for male parent of hybrids.

### **Manuring**

The field should be thoroughly ploughed for fine filth and apply 25 tons of FYM/ha. The other fertilizer requirement for brinjal variety and hybrid are same as followed for tomato seed production.

### **Roguing**

The roguing should be done based on the plant characters, leaf, branching and spreading characters and also based on fruit size, shape and color. The plants affected by [Phomopsis blight](#), [leaf spot](#) and [little leaf virus disease](#) should be removed from the seed production field.

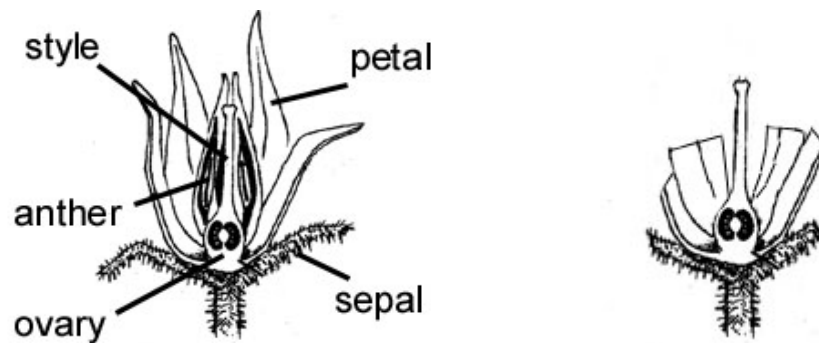
### **Pest and disease management**

The pests like fruit borer, shoot borer, beetles, aphids, mealy bug and jassids can be controlled by spraying Nuvacron or Methyl parathion. The red spider mite can be controlled by spraying in Kelthane. The important diseases are

damping off and little leaf which can be controlled by spraying fungicide and systemic insecticides, respectively. Powdery mildew, leaf spot and anthracnose diseases can be controlled by spraying Benlate.

### Hybrid seed production

The planting ratio of female and male parents adopted for hybrid seed production is normally 5:1 or 6:1. For production of hybrid seeds, crossing programme is done using emasculation and dusting methods as followed in tomato.



### Harvesting and processing

Harvesting is done when fruits are fully ripe (when the fruits turn into yellow colour) i.e., 405 days after flowering. The harvested fruits are to be graded for true to type and off type and fruit borer infested fruits are discarded. The graded fruits are cut in 2-3 pieces or whole fruits will be put in a cement tank with water and crushed manually and then allow it for fermentation for 1-2 days. Then the floating pulp portions are to be removed, the seeds settled at the bottom should be collected and washed with water and then the seeds with equal volume of water is treated with commercial Hydrochloric acid @ 3-5 ml/kg of seed. The mixture is kept for 10-15 minutes with frequent stirring. Then the treated seeds are to be washed with water for 3-4 times. Afterwards seeds are dried under shade for 2-3 days over a tarpaulin and followed by sun drying for 1-2 days to reduce the seed moisture content to 8 per cent. Then the seeds are cleaned and graded with BSS 12 sieve. The processed seeds are treated with fungicides or Halogen mixture @ 5g/kg of seed.



### **Storage**

The seeds dried to safe moisture content after treating either with captan or thiram @ 2 g/kg can be stored for 15 months in moisture vapour pervious containers, while it can be stored in moisture vapour proof containers for 30 months.

**Seed Yield** : 100-200 Kg/ha

### **Seed Certification**

#### **Number of Inspections**

1. The first inspection shall be made before flowering on order to verify isolation, volunteer plants, and other relevant factors,
2. The second inspection shall be made during flowering to check isolation, off types and other relevant factors
3. The third inspection shall be made at maturity and prior to harvesting to verify true nature of plant and other relevant factors

#### **Specific standards**

<b>Factors</b>	<b>Foundation</b>	<b>Certified</b>
Off types – Variety	0.1%	0.25
Hybrid	0.1%	0.05%
Designated diseased plant	0.1%	0.5%



- c. 12/64" d. 15/64"
6. In tomato the hybrid seed production is normally done by\_\_\_\_\_.
- a. Cytoplasmic Male Sterility b. Genic male sterility  
**c. Emasculation and Hand Pollination** d. Detasseling
7. In tomato \_\_\_\_\_ is used as chemical hybridizing agents.
- a. Gibberelic acid b. Colchisin  
c. Etheral **d. Malic hydraside**
8. Minimum germination percentage for tomato is \_\_\_\_\_.
- a. 90% b. 50%  
**c. 70%** d. 90%
9. Brinjal is self pollinated crop. (True/**False**)
10. In Brinjal for seed production and better yield\_\_\_\_\_ flower is suitable.
- a. Long style b. pseudo short style  
c. short style **d. medium style**
11. The planting ratio of female and male parents adopted for hybrid seed production is normally
- a. 5:1** b. 8:1  
c. 12:1 d. 10:1
12. \_\_\_\_\_ is the designated diseases in brinjal
- a. Root rot **b. Little leaf**  
c. Leaf spot d. None
13. Genetic purity of brinjal hybrid is \_\_\_\_\_
- a. 90%** b. 60%  
c. 75% d.50%
14. Pure seed percentage of brinjal is \_\_\_\_\_
- a. 68% **b. 98%**  
c. 90% d. 50%
15. Designated disease allowed during certified seed production is
- a. 1% b. 0.2%  
c. 0.05% **d. 0.5%**



## SEED PRODUCTION TECHNIQUES I IN VEGETABLES

### TOMATO (*Lycopersicon esculentus*)

Tomato is one of the most important vegetable crops grown extensively in the tropical and subtropical belts of the world. It is grown mainly fresh market and to a little extent for processing. Increased attention is now being bestowed to breeding and production of tomato. Production of tomato can further be increased if improved cultural practices are combined with good quality seeds. The quality seed production techniques in tomato comprises of the following steps.

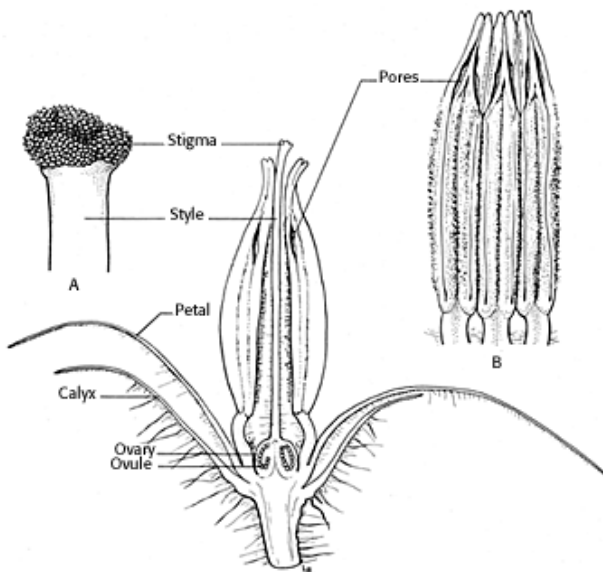


Figure 184. - Longitudinal section of tomato flower, x9. A, Tip of pistil; B, three anthers, greatly enlarged.



### Botany

Tomato is a typical day neutral plant. It requires temperature of 15-20° C for fruit setting. Tomato is self pollinated crop. Self fertilization is favoured by the position of receptive [stigma](#) within the cone anthers and the normal pendant position of the flower.

**Method of seed production :** Seed to Seed.

### Stages of seed production

Breeder seed - Foundation Seed I - Foundation Seed II - Certified Seed



## **Varieties :**

### **Indeterminate varieties**

Pusa Ruby, Solan Gola, Yaswant (A-2), Sioux, Marglobe, Naveen, Ptom-9301, Shalimar- 1, Shalimar-2. Angurlata, Solan Bajr, Solan Sagun, Arka Vikas. Arita Saurbh.

### **Determinate varieties**

Roma (EC-13513), Rupali, MTH-15, Ptom-18, VL-1, VL-2, HS 101, HS 102, HS 110, Pusa Early Dwarf, Pusa Sheetal, Floradade, Arka Meghli, Co.1, Co.2, Co.3 (Marutham), PKM.1, Py1,

### **Hybrids**

COTH-1, Pant Hybrid-2, Pant Hybrid-10, Kt-4. Pusa Hybrid-I-4, Arka Shreshta, Arka Vardan, Arka Abhijit, Navell 1 &2 (Sandoz), Rupali, Sonali, MTH 6

**Season :** May - June and November - December

### **Land requirement**

Selection of suitable land for tomato seed production is important where the previous crop should not be the same variety to avoid the contamination due to the volunteer plants.

### **Isolation requirement**

For Seed production of tomato, varieties require minimum of 50 M for foundation seed and 25 M for certified seed. For hybrid seed production, it requires minimum of 200 M for foundation (parental line increase) and 100 M for certified hybrid seeds.

### **Seed rate**

For i) Varieties - 300- 400 g/ha ii) For F<sub>1</sub> hybrid - Male parent 25 g/ha; Female parent 100 g/ha.

## **Nursery**

Sow the seeds in raised nursery bed of 20 cm height, in rows of 5 cm gap and covered with sand. Eight and ten nursery beds will be sufficient to transplant one acre. Apply 2 kg of DAP 10days before pulling out of seedling.

## **Transplanting**

Transplanting should be done with the seedlings are 20-25 days old, preferably at evening time. Spacing is 60 x 45 cm (90 x 60 cm for female parent and 60 x 45 cm for male parent of hybrids).

## **Manuring**

After thorough preparation of a field to fine tilth, apply 25 tons of FYM per ha. Apply 100 : 100: 100 Kg of NPK/ha of which, 50% of the N is applied as

## **Roguing**

The roguing should be done based on the plant characters (determinate / indeterminate), leaf, branching and spreading characters and also based on fruit size, shape and color. The plants affected by early blight, leaf spot and mosaic (TMV) diseases should be removed from the seed production field.

## **Planting ratio**

For hybrid seed production, the female and male parents are normally planted in the ratio of 12:1 or 12:2.

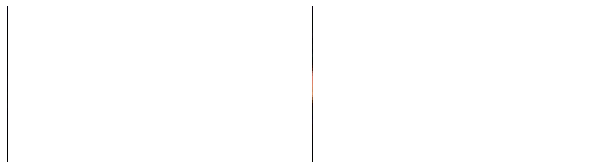
## **Pest and disease management**

The major pests attacking tomato crop are leaf eating caterpillars and fruit borers, which can be controlled by spraying. The major diseases in tomato are [early blight](#) and [mosaic virus](#). The early blight rot can be controlled by spraying Benlate or Dithane M-45.

## **Harvesting seed extraction and processing**

The fruits are harvested after full maturity of the fruit when turn in to red color fruits from first and last one or two harvests should not be used for seed extraction.

Stages of maturation: Mature green, Breaker, Turning, Pink, Red, Dark red / over ripe



The fruits from in between 6-7 harvest should be used for seed extraction. The seed viability is depends on the method on which the seeds were extracted and hence, it is more important to choose proper methods of seed extraction. Before seed extraction, the fruits are to be graded for true to type and selection of medium to large size fruits for getting higher recovery of quality seeds.

The acid method of seed extraction is the best method for tomato seed extraction. In this method, the fruits are to be crushed into pulp and taken in a plastic containers (or) cement tank. And then add 30 ml of commercial Hydrochloric acid per kg of pulp, stir well and allow it for ½ hour. In between this duration the pulp may be stirred well for one or two times. This facilitates the separation of seed and pulp. After ½ hour, the seeds will settle down at the bottom and then the floating fraction is to be removed. The collected seeds should be washed with water for three or four times.

- ✓ While following acid method we must use only plastic or stainless steel containers or cement tank.
- ✓ Care must be taken to avoid the usage of iron or zinc containers, which will affect the viability potential of the seeds and as well damage to the containers due to chemical reaction with acid.
- ✓ For large scale seed extraction we can use the tomato seed extractor developed by Tamil Nadu Agricultural University.
- ✓ The seeds extracted by this machine may again be treated with commercial Hydrochloric acid @ 2-3 ml/kg seed with equal volume of water for 3-5 minutes with constant stirring. And then seed should be washed with water for to four times.

- ✓ It is easy to dry the seeds extracted by acid method and also remove the fungus growth over the seed coat, thus seeds possess golden yellow colour and high vigour.
- ✓ The seed extracted by fermentation method posses poor vigour and off colour due to fungal activity.

### Comparison of different seed extraction methods

	<b>Fermentation</b>	<b>Acid</b>	<b>Alkali</b>
<b>Method</b>	Mix fruit pulp with water - 24 - 48 h	HCl @10ml / Kg of pulp - 20-30 minutes	Washing soda @ 900mg/4 l of water- equal volume – overnight soak
<b>Salient features</b>	<ul style="list-style-type: none"> <li>• Low cost.</li> <li>• Unskilled labour.</li> <li>• More Time taken</li> <li>• Low Seed recovery (0.5 to 0.6 %)</li> <li>• Dull seed colour.</li> <li>• Seed..borne.. pathogens</li> </ul>	<ul style="list-style-type: none"> <li>• Cost is more.</li> <li>• Skilled labour</li> <li>• Lesser Time</li> <li>• High seed recovery (0.8 to 1 %)</li> <li>• Bright colour market value higher.</li> <li>• Seed borne pathogen – removed</li> <li>• Improper washing leads to injury to seeds</li> </ul>	<ul style="list-style-type: none"> <li>• Recovery 0.7 to 0.8 per cent</li> <li>• Luster of the seeds will be lost.</li> <li>• Improper washing leads to injury to seeds</li> </ul>

## Fermentation method



Manual Crushing



Fermentation



Washing



Extracted seed

## Acid seed extraction



Mechanical Crushing



Extracted seed



Acid treatment



Washing of seeds

## Drying and grading

Seeds are to be dried in the shade. It should never be dried in hot sun. the safe moisture content of the seed for grading is 8 to 9 per cent. Seeds can be graded using 6/64" round perforated sieve.

## Storage

The seeds dried to safe moisture content after treating either with captan or thiram @ 2 g/kg can be stored for 15 months in moisture vapour pervious containers, while it can be stored in moisture vapour proof containers for 30 months.



## Hybrid seed production:

In tomato the hybrid seed production is normally done by 'Emasculation and Hand Pollination'. However use of chemical hybridizing agents (MH-1000 ppm) or CMS lines are also practiced

### Emasculation and dusting

1. Emasculation is done before the anthers are mature and the stigma has become receptive to minimize accidental self pollination.



**Selection of flower**

2. Thus emasculation is generally done in the evening, between 4 PM and 6 PM one day before the anthers are expected to dehisce or mature and the stigma is likely to become fully receptive.
3. Emasculate the bud by hand with the help of needle and forceps. Remove the **calyx**, **corolla** and **staminal column** or **anthers**, leaving **gynoecium** i.e., **stigma and style** intact in the flower.



**Removal of anther cone**



**Removal of corolla**

4. Emasculated flowers should be covered immediately with red coloured paper cover to protect against contamination from foreign pollen and also for easy identification of emasculated bud during dusting.



5. Remove the red paper cover of the emasculated bud and dust the pollen gently over the stigmatic surface using cotton or camel brush, etc.,



**Emasculated flower**



**Dusting of pollen**

6. After dusting, the emasculated flowers are again covered with white or other coloured paper cover for two to three days.
7. Pollen collected from one male flower can be used for dusting 5 to 7 emasculated flowers.

### **Pollen collection**



**Male flower**



**Collected flower**



**Drying of flower**



**Collection of pollen I**



**Collection of pollen II**



**Pollen for hybrid crosses**

**Seed Yield** : 100 -120 Kg/ha

**Seed Certification**

**Number of Inspections**

A minimum of three inspections shall be made as follows:

1. The first inspection shall be made before flowering on order to verify isolation, volunteer plants, and other relevant factors,
2. The second inspection shall be made during flowering to check isolation, **offtypes** and other relevant factors
3. The third inspection shall be made at maturity and prior to harvesting to verify true nature of plant and other relevant factors

**Specific requirements**

<b>Factors</b>	<b>Foundation</b>	<b>Certified</b>
Off types - variety	0.1 %	0.2%
Hybrid	0.01%	0.05%
Plants affected by seed borne diseases	0.1 %	0.5%

**Seed standard (variety and hybrid)**

<b>Factors</b>	<b>Foundation</b>	<b>Certified</b>
Pure seed (mini)	98%	98%
Inert matter (maxi)	2%	2%

Other crop seeds (maxi) 5/kg	5/kg	10/kg
Weed seeds (maxi)	None	None
Germination (mini)	70%	70%
Moisture (maxi)	8%	8%
For VP container	6%	6%

## ONION (*Allium cepa*)

Onion is one of the most important commercial vegetable crops in India. Maharashtra, Gujarat, Uttar Pradesh, Orissa and Andhra Pradesh are the major onion growing states. The total annual area is estimated to be about 3 lakhs hectare and production is about 35.37 lakh tonnes. It is grown mainly in rabi season. Three crops viz., Kharif, late Kharif and rabi are taken in Nasik division of Maharashtra whereas

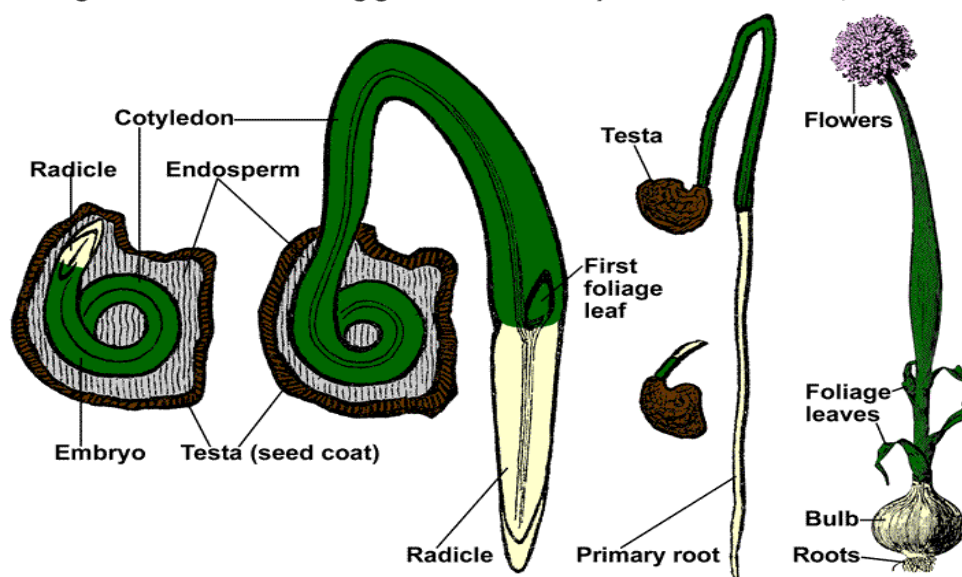


Gujarat, Andhra Pradesh, Rajasthan, Punjab, Haryana, Madhya Pradesh, Karnataka and Tamil Nadu take up two crops that is Kharif and rabi. Kharif onion is a recent introduction in Northern, Eastern and Central India.

### Botany

Onion is the biennial crop and takes two full seasons to produce seeds. In the first year bulbs are formed and in the second year stalks develop and seed are produced. It is [a long-day plant](#). The day length influences bulb onion, but has little effect on induction of seeding. It appears to be [day-neutral](#) for seed production. It requires cool conditions during early development of the bulb crop and again prior to and during early growth of seed stalk. Varieties bolt readily at 10 to 15 degree C. In the early stages of growth, a good supply of moisture is required and temperatures should be fairly cool. During bulbing, harvesting and [curing](#) of seed, fairly high temperatures and low humidity is desirable. Seed production is widely adapted to temperate and sub-tropical regions.

Seed germination and seedling growth of *Allium cepa*



Stages of seed production : BS – FS - CS

### Varieties

<b>A.</b>	<b>RED</b>	
1.	Punjab Selection	PAU, Ludhiana
2.	Pusa Ratna	NBPGR, New Delhi
3.	Pusa Red	IARI, New Delhi
4.	Pusa Madhavi	IARI, New Delhi
5.	N-2-4-1	MPAU, Rahuri
6.	Arka Niketan	IIHR, Bangalore
7.	Arka Kalyan	IIHR, Bangalore
8.	Agrifound Dark Red	NHRDF, Nasik
9.	Agrifound Light Red	NHRDF, Nasik
<b>B.</b>	<b>WHITE</b>	
1.	N-257-9-1	MPAU, Rahuri
2.	Pusa White Round	IARI, New Delhi
3.	Pusa White Flat	IARI, New Delhi
4.	Punjab-48	PAU, Ludhiana
<b>C.</b>	<b>Aggregatum Onion</b>	

1.	CO 5	TNAU, CBE
----	------	-----------

- Bellary Red, Rampur local, and Kalyanpur,

### **Season**

The optimum sowing season is middle of June to Middle of July in the plains.

### **Isolation Requirements**

Onion is largely cross-pollinated crop with up to 93 per cent natural crossing but some self-pollination does occur. It is chiefly pollinated by honey-bees. For pure seed production, the seed fields must be isolated from fields of other varieties of onion and fields of the same variety not conforming to varietal purity requirements for certification atleast by 1000 metres for foundation seed production and 500 metres for certified seed production.

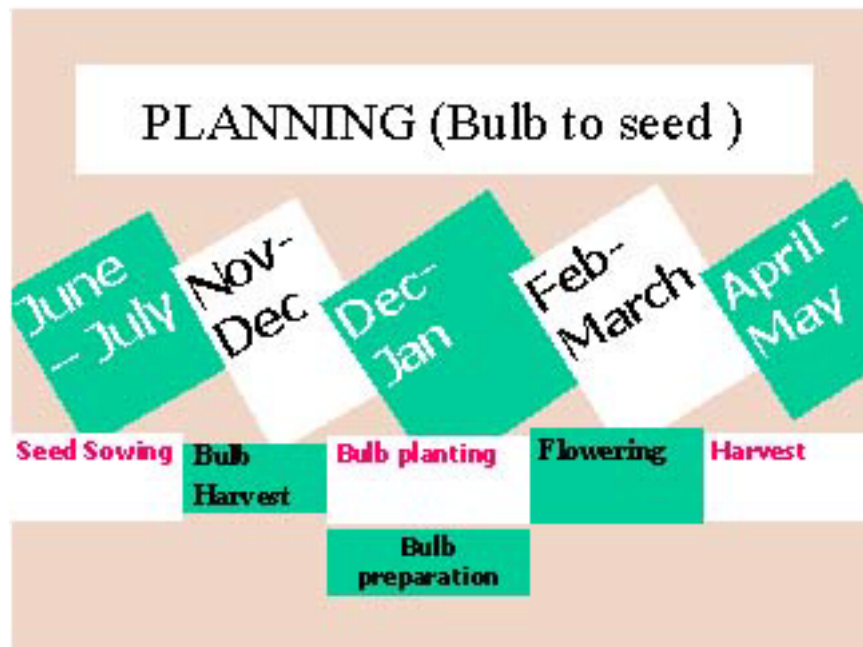
### **Method of Seed Production**

There are two methods of seed production

1. **Seed to seed method:** In this method, the first season bulb crop is left to over-winter in the field so as to produce seed in the following season.
2. **Bulb to seed method:** The bulbs produced in the previous season are lifted, selected, stored and replanted to produce seed in the second year.

Mostly the bulb to seed method is used for seed production because of the following advantages over the seed to seed method.

- a) It permits selections of "true-to-type" and healthy bulbs for seed production.
- b) Seed yields are comparatively very high. The seed to seed method, however, can be practiced for varieties having a poor keeping quality.



## **Bulb to seed method**

### **A. Bulb Production stage**

#### **a) Climatic requirement**

Though it is possible to produce bulbs in different climatic conditions, mild climate is reported to be very good. For better bulb production a temperature of 15.5 to 21°C and about 70% relative humidity required.

#### **b) Land requirement**

Fields in which onion was grown should be selected unless it was of the same variety and was certified. The onion can be grown on various types but it grows best in soils which are able to retain moisture for longer time. Heavy soils do not permit proper bulb development and many times bulbs are misshapen. 6-8 pH range are considered better for onion.

#### **c) Isolation requirement**

Onion is highly cross pollinated crop with upto 93% natural crossing. It is mostly pollinated by honeybees. For pure seed production the seed fields must be isolated from field of other varieties of onion of the same colour at least by 1000



meters for foundation seed and 500 m for certified seed. The isolation distance between colour particularly white and red colour must be much more which needs to be decided.

**d) Seed rate**

8-10 Kg per hectare

**e) Sowing and transplanting time**

Season	Sowing	Transplanting
Kharif	June-July	July-August
Rabi	Oct-Nov	Dec-Jan



In kharif 6-7 weeks old seedling and in rabi 8-9 weeks seedlings should be transplanted. Over aged [nursery](#) should not be planted otherwise premature bolting may be there.

**f) Manures and fertilizers**

FYM	50 tonnes
CAN	400Kg
Or	
Urea	200kg
Super phosphate	300 Kg
Muriate of Potash	100 Kg

Nitrogen should be applied as basal and top dressing in two splits. Top dressing may not be delayed otherwise thick necks may be a problem.

**g) Spacing**

15 x 10 cm. More spacing between plants results in thick necked plants.

**h) Irrigation**

Irrigation should be given at fortnightly interval or weekly interval as the case may be. Field should not be left dry for long otherwise splitting problem is more.

### **i) Weeding**

2-3 weeding and hoeings are done. Stomp @ 3.51 / ha may be applied 3 days after transplanting to manage the weeds economically. One weeding by hand is, however, necessary.

### **j) Plant protection**

Malathion @ 0.1% along with tritone against thrips. 4-5 spraying may be necessary. Indofil M45 @ 0.25% along with tritone against purple blotch and stemphylium blight, 5-6 sprayings may be done.

### **k) Roguing**

Remove off type plants on difference in colour of leaves or plant type. Remove resprouted plants or premature bolters.

### **l) Harvesting**

Harvesting the crops one week after 50% of tops falling and keep in windrow upto 3-5 days for field curing. After that bulbs are cured in shade to remove fields heat before keeping in store. In kharif bulbs are ready for harvesting within 90-100 days after transplanting while tops are still erect. Bulbs are allowed for field curing upto 3-5 days then again cured were in shade or in field depending upon the temperature for 12-15 days. Tops are cut leaving 2.5 cm neck.



## **B. Seed Production Stage**

### **a) Selection of bulb**

True to type bulbs are selected based on colour, size and shape kept in ventilated storage in rabi crop and in kharif crop bulbs are planted after curing for 15 days. 4-6 cm size bulbs are selected for getting good crop.



### **b) Climate**

Conditioning of plants / bulbs is necessary for seed stalks formation. Temperature of 4.5<sup>o</sup>c to 14<sup>o</sup>C are favourable for this conditioning. Longer this prevails, more stalks each plant will produce and more flowers will be in each umbel. Low humidity gives good seed development. While plants are in flowering clear bright sunny days are necessary for good insect activity.

### **c) Bulb rate**

25 quintal / ha

### **d) Spacing**

45 x 30 cm

### **e) Fertilizer and manures**

200 kg urea / ha.50% as basal and rest as top dressing

300 Kg super phosphate (single) / ha

100 Kg muriate of potash / ha



### f) Irrigation

Irrigation at an interval of 15 days in winter and 7-10 days in summer is necessary for proper seed development. Fields should not be kept saturated for long as this facilitates development of diseases.

### g) Rouging

Remove plants based on foliage, colour inflorescence and flower characters.

### h) Plant protection

- 1) Spray Indofil M45 @ 0.25% against purple blotch and **stemphylium** blight.
- 2) Endosulfan @ 0.20% against thrips and head borer.

### i) Harvesting and curing

When capsules become brown and seeds inside become black the umbels are then cured and dried.



**j) Threshing and cleaning**

Threshing is done manually. Pre-cleaning is done by brushing machine and scalper. Cleaning and grading are done by Air screen cleaner by using 1/14x1/2 as grading screen and then upgrading is done by gravity separators.



**k) Drying and Packing**

Seeds are dried upto 6-8% moisture depending upon packaging requirements. If seeds are required to be packed in Aluminium foil and other moisture proof containers, seed are dried upto 6% otherwise upto 8%.

## I) Seed yield

5-7 q / ha

## Certification Standards

### I. Field Standards

#### A. General requirements

##### 1. Isolation

Onion seed fields shall be isolated from the contaminants shown in column 1 of the Table below by the distance specified in columns 2,3,4 and 5 of the said Table:

Contaminants	Minimum distance (meters)			
	Mother bulb production stage		Seed Production stage	
	Foundation	Certified	Foundation	Certified
	2	3	4	5
Fields of other varieties	5	5	1000	500
Fields of the same variety not conforming to varietal purity requirement for certification	5	5	1000	500

#### B. Specific requirements

Factors		Maximum permitted	
		Foundation	Certified
*	Bulbs not conforming to the varietal characteristics	0.10% (by number)	0.20% (by number)
*	Off types	0.10%	0.20%

*			
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\* Maximum permitted at second inspection at mother bulb production stage.

\*\* Maximum permitted at and after flowering at seed production stage.

## II. Seed Standards

Factors	Standards for each class	
	Foundation	Certified
Pure seed (minimum)	98.0%	98.0%
Inert Matter (maximum)	2.0%	2.0%
Other crop seed (maximum)	5 / Kg	10 / Kg
Weed seeds (maximum)	5 / Kg	10 / Kg
Germination (minimum)	70%	70%
Moisture (maximum)	8.0%	8.0%
For vapour-proof containers (maximum)	6.0%	6.0%

### Problems and Prospects of certification in onion seed production

Following are the problems and remedial measures in certification of onion seed:

#### a. Unawareness about the notified varieties by the farmers

Many improved and notified varieties have not been demonstrated fully with the farmers as such farmers still prefer old varieties. The extension agencies in the state may therefore take up demonstration so as to allow farmers to know about the new improved varieties.

#### b. Unawareness about the advantage of certified seed over truthful seed

In cereals and some other seeds the seed production and distribution programme are properly organized. Farmers have been demonstrated with the advantage of using certified seed. In vegetables particularly in small seed such demonstrations or extension education programmes have not been carried out.



Farmers thus are not aware about the benefits of using certified seed in onion. Extension agencies should arrange state level demonstrations on use of certified seed in onion to make the farmer fully aware of advantages of the certified seed.

**c. No maintenance breeding for improved varieties**

Since varieties when developed by the Universities / institutes do not pass through maintenance breeding later, the varieties do not behave in different characters in the same way as these were at the time of development. The application of certification standards particularly for genetics purity therefore becomes impossible. The Universities / Institutes should continue maintenance breeding of their varieties for maintaining distinctiveness, uniformity and stability.

**d. Most of the parameters of the varieties are influenced by agro climatic conditions**

In onion there are many characters like colour, shape, bolting, neck thickness or doubles which are affected adversely by agro climatic conditions like soil, temperature, rainfall, cultural practices etc. Practical application of certification standards required to be seen at the time of certification where staff cannot have proper judgment. The staff should, therefore, know the details of characters and how and to what extent, they are influenced by adverse weather conditions. Based on that the staff should assess the situation and apply their mind in certifying a crop.

**e. Staff with certification agencies are neither adequate nor they have proper knowledge about the crop.**

Onion is highly cross-pollinated crop and it requires through inspection or check at different stages. If one stage is left it becomes difficult to meet the requirements. For example if inspection is not managed at the time of bulb selection, Similarly if isolation is not checked at the time of **bolting** it becomes a futile exercise later as roughing has no meaning at the time of flowering. This is possible only when sufficient staff having good knowledge about onion is provided.

**f. Unawareness of farmers about pre harvest and post harvest practices of onion seed production.**

The extension agencies as also staff certification agencies are supposed to properly guide for production and post harvest practices for certified seed production initially. Certification staffs presently do not guide. Presently since staff themselves are not aware about pre harvest practices as also post harvest practices, programmes many times fail as such farmers hesitate in going for certified seed production. It is, therefore, necessary for certification staff to guide the farmers initially.

**g. Inadequate infrastructural facilities for storage of bulbs, cleaning, grading and drying**

Bulbs of rabi onion are required to be stored in ventilated godowns which are not available. Seed requires is must which is mostly not available. Similarly for enabling the seed producers to pack the seed in moisture proof containers for long term storage, seeds are required to be dried to 6% moisture where dehumidified driers are required. Such facilities are lacking at any places.

**h. Certification standards are not realistic**

Presently standards which have been fixed are not realistic. The standards need to be fixed based on the type of material being developed by the institutes. The effects of agro climatic conditions on different parameters need to be considered. Isolation distances are not adequate particularly between white and red varieties.

**i. Non availability of adequate quality breeder / foundation seed of a variety**

Even if everyone is ready for taking up certified seed production, adequate quality breeder seed foundation seed with the concerned institute is not available. Because of this problem in fact many good varieties in onion have been lost before going to farmers. The seed production programme, therefore, should be properly planned right from production of breeder seed to certified seed so as to make available quality seed in adequate quantities for improving production and quality.

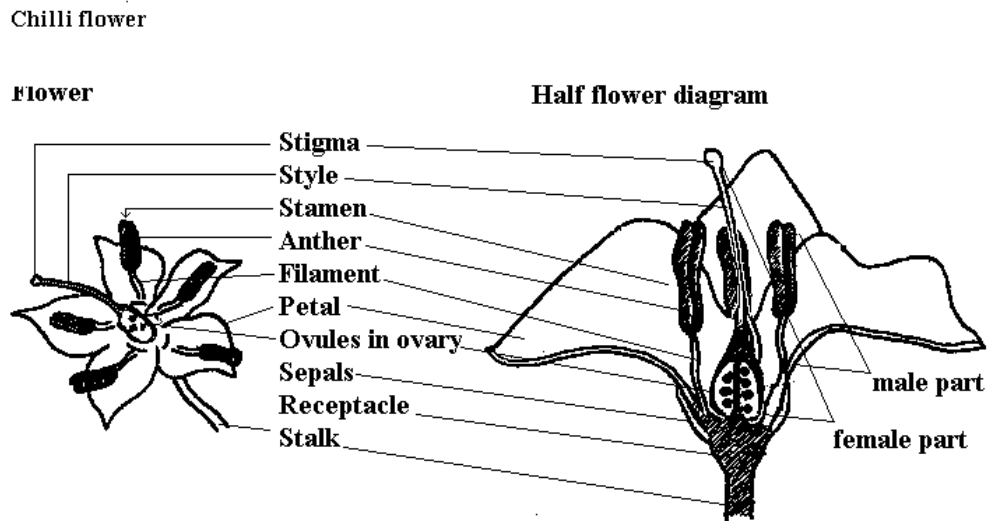
**j. Low price of seed available in the market**

Many times onion seed price in the market are very low compared to quality seed / certified seed. This is mainly because farmers collect seed from premature bolters / takes up *in situ* method where though quality is poor quality is in abundance, Govt. should, therefore give some.

## CHILLI (*Capsicum frutescense*)

Chillies widely used as vegetable and spice is an often cross pollinated crop, where the extend of cross pollination is upto 7 to 36 per cent. It belongs to the family solanaceae. It is also known as hot pepper and botanically it is known as *capsicum annuum*. The quality seed production techniques of chillies comprises of the following steps.

**Botany:** Often Cross pollinated vegetable. The flower is protogynous. Anther dehisces only half to 5 ½ hr after stigma becomes receptive. Anthesis in chilli occurs between 6.00 and 9.00 hr. Flower remains open for 2 to 3 days, receptivity of stigma was the highest at the day of flower anthesis.



**Method of seed production :** Seed to seed

**Stages of seed production :** Breeder seed → Foundation seed → Certified seed.

**Varieties:** K.1, K.2, K.3, Co.1, Co.2, PKM.1, MDU.1, Bagyalakshmi.

**Hybrids:** KT.1, (Pusa Deepti), Solar Hybrid 1, Solar Hybrid 2. Early Bounty, Indira, Lario, Hira, Bharat.

**Season :** June-July, February-March, September- October.

**Land requirement :** There are no land requirement as of previous crops, but the land should be free from volunteer plants. Generally areas affected by wilt or root rot may be avoided. Crop rotation must be followed to avoid endemic Solanaceous pests.

**Isolation requirement :** Minimum isolation distance of 400 M for foundation and hybrid seed and 200 M for certified seed production are necessary.

**Seed rate :** Seed required for one hectare is 500 g to 1 kg for variety; for hybrids - Female = 200 g and male = 50 g

**Nursery :** Sow the seeds in raised nursery bed of 20 cm height, in rows of 5 cm gap and covered with sand. Eight and ten nursery beds will be sufficient to transplant one acre. Apply 2 kg of DAP 10 days before pulling out of seedling.

**Transplanting:** The seedlings of 30-35 days old are ready for transplanting. Transplanting may be done on the ridges in the evening.

**Foliar spray:** To arrest the flower drop, NAA (Planofix) can be sprayed @ 4ml/L. Very light irrigation is also done arrest the flower drop.

**Manuring :** Apply 50 tones of FYM/ha for irrigated crop. Basal 0:70:70 kg of NPK and 50 kg of N at 15 days after transplanting and 50 kg N at 45<sup>th</sup> days after transplanting.

**Roguing:** Field inspection and roughing should be done both for varieties and hybrid at different stages based on the plant height and its stature, flower colour and pod characters. The plants affected with leaf blight, anthracnose and viral diseases should be removed from the seed field.

**Pest and disease management:** The important pest attacking chilli and capsicum are thrips, aphids, pod or fruit borer and mites. The thrips and aphids can be controlled by spraying Dimecron (systemic pesticide), pod borer can be controlled by spraying Nuvacron and the mites can be controlled by spraying Kelthane. The major diseases affecting the plants are die back or fruit rot, powdery mildew and bacterial leaf spot. Spray Dithane M-45 for control of die back, Karathane for powdery mildew and Agromycin for leaf spot disease control.

**Hybrid seed production:** The crossing operation can be performed as per the methods outlined for tomato and brinjal hybrid seed production. However, hand emasculating and pollination is somewhat difficult since the flowers are minute. Hence use of male sterile lines can also be employed for hybrid seed production.

**Harvesting and processing:** Harvesting should be done in different pickings. First and last one or two pickings can be harvested for vegetable purpose. The well ripened fruits with deep, red colour alone should be collected in each picking. After harvest, fruit rot infected fruits are to be discarded. The harvested pods are to be dried



under shade for one (or) two days and then under sun for another 2 or 3 days. Before drying pods are to be selected for true to type and graded for seed extraction. The seeds are extracted from graded dried pods. The pods are taken in gunny bag and beaten with pliable bamboo sticks. The seeds are cleaned by winnowing and dried to 10% moisture content over tarpaulin. Then seeds are processed with BSS 8 wiremesh screens. For large scale seed extraction, the TNAU model chilli seed extractor may be used.

**Seed Yield :** 50-80 Kg/ha

**Seed Certification**

**Number of Inspections**

A minimum of three inspections shall be made as follows:

1. The first inspection shall be made before flowering on order to verify isolation, volunteer plants, and other relevant factors,
2. The second inspection shall be made during flowering to check isolation, offtypes and other relevant factors
3. The third inspection shall be made at maturity and prior to harvesting to verify true nature of plant and other relevant factors

**Specific standards:**

<b>Factors</b>	<b>Foundation</b>	<b>Certified</b>
Off types	0.1%	0.2%
Designated diseased plant	0.1%	0.5%

The designated diseases are caused by *Collertotictum capsici* and leaf blight caused by *Alternaria solari*.

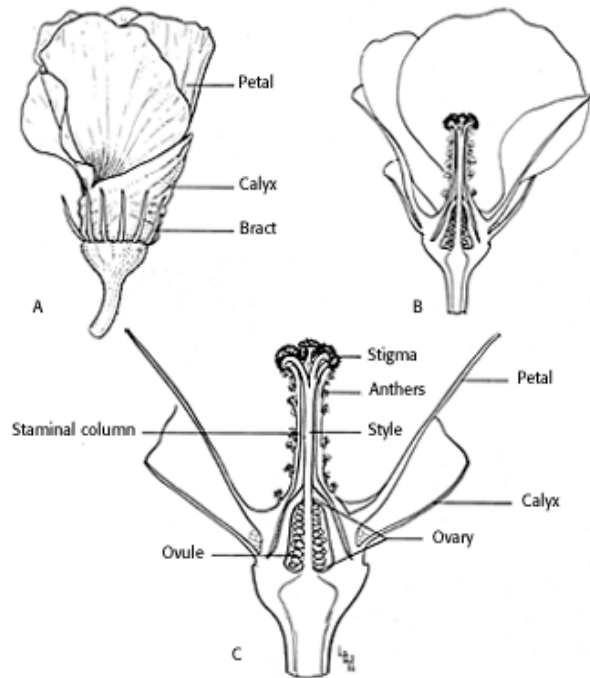
**Seed standards (Variety & Hybrid)**

<b>Factors</b>	<b>Foundation</b>	<b>Certified</b>
Pure seed	98%	98%
Inert matter	2%	2%
Other crop seeds	5/kg	10/kg
Weed seeds	5/kg	10/kg
Germination	60%	60%
Moisture content	8%	8%
For VP Container	6%	6%



## **BHENDI (*Abelmoschus esculentus*)**

**Botany:** Anthesis is between 9 and 10 hr and is preceded by maximum anther dehiscence between 8 and 9 hr. The stigma remains receptive on the day of anthesis. Bhendi is an often cross pollinated crop. Cross pollination to an extent of 12 per cent is due to [protogynous](#).



**Method of seed production :** Seed to seed

**Stages of seed production :** Breeder seed → Foundation seed → Certified seed.

**Varieties :** Co.1, MDU.1, Parbhani Kranti, Arka Anamika, Pusa A-4, Pusa Sawani

**Hybrids:**CO2,CO 3, Mahyco hybrid, Shoba

**Season :** June-July, September- October and February- March

**Land requirement :** Select field on which bhendi crop was not grown in the previous season, unless the crop was of the same variety and certified. Field should be free from wild bhendi (*Abelmoschus sp.*)

**Isolation requirement:** Seed field must be isolated from other varieties at least by 400 M for foundation and hybrid seed production and 200 M for certified seed production.

**Seed rate :** Varieties : 8-10 kg/ha

Hybrids : 4 kg/ha (Female); 1 kg/ha (Male)

**Manuring:** Apply 12.5 tons of FYM/ha before ploughing. Apply 150:75:75 kg NPK/ha, of which 50% of the N should be applied as top dressing in two split doses at flowering and 10 days later.

**Planting ratio:** For hybrid seed production, female and male parents are normally planted in the ratio of 4:1.

**Roguing:** Minimum of three inspections for varieties and 4 inspections for hybrids, one at vegetative, two at flowering and one at fruit maturity stages. The roguing should be based on the plant characters, hairiness, fruit character like fruit colour, number of ridges, fruit length etc., and the off type and mosaic attacked plants should be removed from the seed field. Wild bhendi if present should be removed before flowering.

**Pest and disease management:** The major pest attacking bhendi are jassids, aphids and white fly, which can be controlled by spraying Rogar or Dimecron or Endosulphon. The pod borer and red spider mites can be controlled by spraying Endosulphon and Kelthane, respectively. The diseases such as yellow vein mosaic and powdery mildew can be controlled by spraying systemic insecticides and Karathane, respectively.

**Hybrid seed production:** In bhendi, since the flowers are large in size, hand emasculation and pollination is the best suitable method for seed production. The emasculation and dusting can be done as per the methods outlined in tomato. The male and female parents are raised in blocks at the ratio of 9:1 (Female: Male).

**Harvesting:** Fruits should be harvested when they have dried (30-35 days after crossing). The pods which expose hairline crack and turn to brown colour on drying alone are cut using sickle manually.



### **Threshing:**

The pods are dried and threshed using pliable sticks. Separated seeds are winnowed to remove plant debris and dried over a tarpaulin to 10% moisture content. Dried seeds are subject to water floatation in which, good seeds sink while poor seeds float. The floaters are removed, while sinkers are dried under shade followed by sun drying. Then the seed are cleaned, dried and treated with Captan/Thiram.



**Processing:** Seeds are to be processed with BSS 7 wiremesh sieve.

**Seed Yield:** 1000-1200 Kg/ha

**Specific standards:**

<b>Factors</b>	<b>Foundation</b>	<b>Certified</b>
Off types	0.1%	0.2%
Objectionable weed	None	None
Disease affected plants	0.1%	0.5%

**Objectionable weed:** wild *Abelmoschus sp.*

***A. moschatus***



***A. manihot***



**Designated diseases:** Yellow Vein Clearing Mosaic (Hybiscus virus-1)



## Seed standards

Factors	Foundation	Certified
Pure seed	99%	99%
Inert matter	1%	1%
Other crop seed	None	5/kg
Total weed seed	None	None
Objectionable weed	None	None
Other Distinguishable Varieties (ODV)	10/kg	20/kg
Germination	65%	65%
Moisture	10%	10%
For VP Container	8%	8%

## Questions

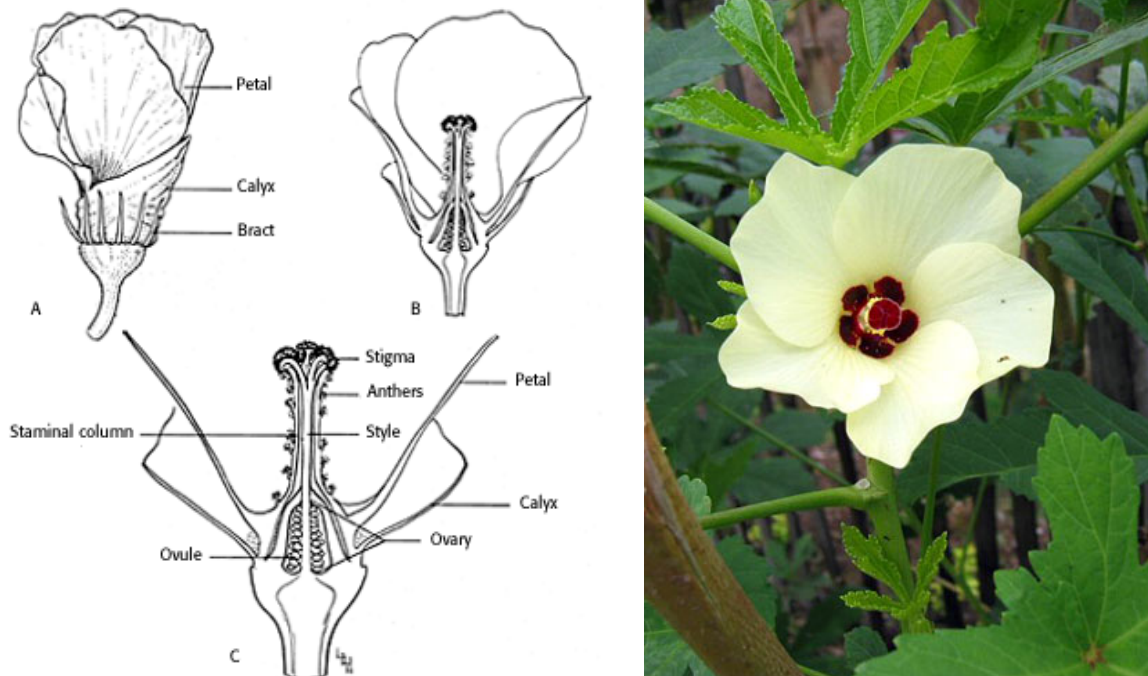
1. Chilli is an often Cross pollinated vegetable. (**True**/False)
2. The flower of chilli is
  - a. Protandry
  - b. Terminal
  - c. Axillary
  - d. Protogyny**
3. \_\_\_\_\_ arrests flower drop in chilli.
  - a. NAA**
  - b. GA3
  - c. MH
  - d. Ethrel
4. Off type allowed during certified seed production in chilli is \_\_\_\_\_
  - a. 0.5%
  - b. 0.02%
  - c. 0.2%**
  - d. 2%
5. Isolation requirement for foundation and certified seed production in chilli is \_\_\_\_\_
  - a. 400 & 200 M**
  - b. 100 & 200 M
  - c. 600 & 200 M
  - d. 600 & 400 M
6. Bhendi is an often cross pollinated crop. (**True**/False)





## BHENDI (*Abelmoschus esculentus*)

**Botany:** Anthesis is between 9 and 10 hr and is preceded by maximum anther dehiscence between 8 and 9 hr. The stigma remains receptive on the day of anthesis. Bhendi is an often cross pollinated crop. Cross pollination to an extent of 12 per cent is due to protogynous.



**Method of seed production :** Seed to seed

**Stages of seed production :** Breeder seed → Foundation seed → Certified seed.

**Varieties :** Co.1, MDU.1, Parbhani Kranti, Arka Anamika, Pusa A-4, Pusa Sawani

**Hybrids:**CO2,CO 3, Mahyco hybrid, Shoba

**Season :** June-July, September- October and February- March

**Land requirement :** Select field on which bhendi crop was not grown in the previous season, unless the crop was of the same variety and certified. Field should be free from wild bhendi (*Abelmoschus sp.*)



**Isolation requirement:** Seed field must be isolated from other varieties at least by 400 M for foundation and hybrid seed production and 200 M for certified seed production.

**Seed rate :** Varieties : 8-10 kg/ha

Hybrids : 4 kg/ha (Female); 1 kg/ha (Male)

**Manuring:** Apply 12.5 tons of FYM/ha before ploughing. Apply 150:75:75 kg NPK/ha, of which 50% of the N should be applied as top dressing in two split doses at flowering and 10 days later.

**Planting ratio:** For hybrid seed production, female and male parents are normally planted in the ratio of 4:1.

**Roguing:** Minimum of three inspections for varieties and 4 inspections for hybrids, one at vegetative, two at flowering and one at fruit maturity stages. The roguing should be based on the plant characters, hairiness, fruit character like fruit colour, number of ridges, fruit length etc., and the off type and mosaic attacked plants should be removed from the seed field. Wild bhendi if present should be removed before flowering.

**Pest and disease management:** The major pest attacking bhendi are jassids, aphids and white fly, which can be controlled by spraying Rogar or Dimecron or Endosulphon. The pod borer and red spider mites can be controlled by spraying Endosulphon and Kelthane, respectively. The diseases such as yellow vein mosaic and powdery mildew can be controlled by spraying systemic insecticides and Karathane, respectively.

**Hybrid seed production:** In bhendi, since the flowers are large in size, hand emasculation and pollination is the best suitable method for seed production. The emasculation and dusting can be done as per the methods outlined in tomato. The male and female parents are raised in blocks at the ratio of 9:1 (Female: Male).

**Harvesting:** Fruits should be harvested when they have dried (30-35 days after crossing). The pods which expose hairline crack and turn to brown colour on drying alone are cut using sickle manually.



### **Threshing:**

The pods are dried and threshed using pliable sticks. Separated seeds are winnowed to remove plant debris and dried over a tarpaulin to 10% moisture content. Dried seeds are subject to water floatation in which, good seeds sink while poor seeds float. The floaters are removed, while sinkers are dried under shade followed by sun drying. Then the seed are cleaned, dried and treated with Captan/Thiram.



**Processing:** Seeds are to be processed with BSS 7 wiremesh sieve.

**Seed Yield:** 1000-1200 Kg/ha

**Specific standards:**

<b>Factors</b>	<b>Foundation</b>	<b>Certified</b>
Off types	0.1%	0.2%
Objectionable weed	None	None
Disease affected plants	0.1%	0.5%

**Objectionable weed:** wild *Abelmoschus sp.*

***A. moschatus***



***A. manihot***



**Designated diseases:** Yellow Vein Clearing Mosaic (Hybiscus virus-1)



## Seed standards

Factors	Foundation	Certified
Pure seed	99%	99%
Inert matter	1%	1%
Other crop seed	None	5/kg
Total weed seed	None	None
Objectionable weed	None	None
Other Distinguishable Varieties (ODV)	10/kg	20/kg
Germination	65%	65%
Moisture	10%	10%
For VP Container	8%	8%

## Questions

- Chilli is an often Cross pollinated vegetable. (**True**/False)
- The flower of chilli is
  - Protandry
  - Terminal
  - Axillary
  - Protogyny**
- \_\_\_\_\_ arrests flower drop in chilli.
  - NAA**
  - GA3
  - MH
  - Ethrel
- Off type allowed during certified seed production in chilli is \_\_\_\_\_
  - 0.5%
  - 0.02%
  - 0.2%**
  - 2%
- Isolation requirement for foundation and certified seed production in chilli is \_\_\_\_\_
  - 400 & 200 M**
  - 100 & 200 M
  - 600 & 200 M
  - 600 & 400 M
- Bhendi is an often cross pollinated crop. (**True**/False)



## SEED PRODUCTION OF CUCURBITACEOUS VEGETABLES

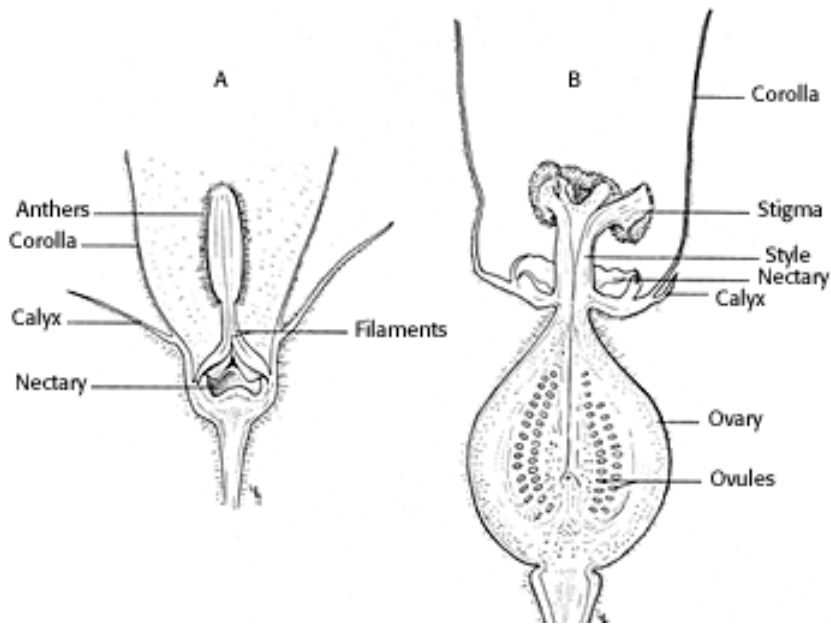
**Land Requirements:** There are no land requirements as to previous crop, but the land should be free of volunteer plants. Generally the soil should be well drained and aerated.

**Isolation Requirements:** Most of the cucurbits are monoecious in character and a few are dioecious. A number of [hermaphrodite](#) and [andromonoecious](#) cultivars are also available in some crops. Pollination is largely done by insects. For pure seed production and isolation distance all around seed field is necessary to separate it from fields of other varieties, fields of the same variety not conforming to varietal purity requirements for certification, from wild cucurbit species, and to separate musk melon from long melon and vice versa, and pumpkin from summer and winter squashes and vice versa as follows

Class	Minimum distance (meters)
Foundation	1000
Certified	500

### Flower structure in cucurbits





### GENETIC PURITY AND SEED HEALTH STANDARDS FOR CUCURBITS

Factors	Minimum permitted level(%)	
	FS	CS
<b>Open pollinated variety</b>		
Off-type	0.10	0.2
Objectional weed plant	None	None
<b>Hybrids</b>		
Off-type in seed parent	0.01	0.05
Off-type in pollen parent	None	0.05
Pollen shedders in seed parent	-	0.10
Seed borne diseases ***		
Muskmelon *	0.1	0.20
Summer squash **	0.1	0.5

Cucumber mosaic virus ,\*\* Cucumber mosaic virus, watermelon mosaic virus



## SEED CERTIFICATION STANDARDS IN INDIA FOR CUCURBITS

Factors	Minimum permitted level (%)	
	Foundation seed	Certified seed
Pure seed (minimum)	98	95
Inert matter (maximum)	2	5
other crop seed (maximum)	None	None
Weed seed (maximum)	None	None
Other objectional varieties (only for hybrids)	5/kg	10/kg
Germination (minimum)	60	60
Moisture for ordinary pack (maximum)	7.0	7.0
Moisture for vapour proof pack (maximum)	6.0	6.0

### Seed production details in Cucurbitaceous vegetables

Particulars	Bittergourd	Snakegourd	Ribbedgourd	Ashgourd / Pumpkin
<b>Isolation</b>	Foundation seed 1000 m and certified seed 500 m			
<b>Season</b>	June - July and Feb – March			

<b>Varieties</b>	CO1, MDU1, Coimbatore long green & long white	CO1, CO2, PKM1, MDU1	CO1, CO2, PKM 1	CO1, CO2
<b>Seed rate / ha</b>	2.5	2.5	2.5	2.5 / 1.0
<b>female flower increased by</b>	Spraying of Ethrel 200 - 250 ppm at two true leaf stage and after a week of 1 <sup>st</sup> spray			
<b>Spacing (cm)</b>	Take pits of size 45x45x45 cm at 2.5x2.0 m distance			
<b>Fertilizers / (NPK g/pit)</b>	6:12:6	12:24:12	9:15:9	6:12:6
<b>Physiological maturity</b>	Change of fruit colour in any part or 1/3 of fruit tip to yellow to red		Complete drying of fruits	Change of fruit colour to orange brown in pumpkin and ashy coating and metallic sound in ashgourd
<b>Processing</b>	Hand picking	Hand picking	BSS 4 wire mesh sieve	16/64 round perforated sieve
<b>Fruit to seed recovery (%)</b>	30	15-16	13-14	1.0-1.3
<b>Seed yield (kg/ha)</b>	120-150	220-250	200-250	120-150

## Techniques of Hybrid Seed Production in cucurbits

### **i. Hand emasculating and hand pollination**

This technique is frequently used for melon seed production. In this species, andromonoecious lines are common and they must be emasculated and hand pollinated if used as the female parent for producing hybrid seed. This method has also been used for some watermelon and cucumber hybrids. This technique is applicable for limited scale production, since a lot of trained labour is required in pinching, pollen collection and hand pollination.



### **ii. Hand emasculating and pollination by insect**

The male flowers from female lines are pinched off a day before anthesis regularly, which honeybees and other insects (voluntary) use as a pollinating agent. The male and female are grown in alternate rows. The fruit set on female lines are of hybrid and harvested for seed extraction. The planting ratio varies within the crops e.g. summer squash 3:1 and 4:1 in muskmelon and cucumber but depends upon the population of bees in the plot. This technique is also used in bottle gourd, pumpkin, muskmelon, cucumber, summer squash and bitter melon for hybrid seed production.

### **iii. Use of genetic male sterility system**

Genetic male sterility system has been utilized for commercial hybrid production in muskmelon. The genetic male sterility in muskmelon is controlled by

single recessive gene (msms). For hybrid seed production, the male sterile line is used as female parent. Since genetic male sterile line is maintained in heterozygous forms, 50% fertile plants are to be removed at flowering. The other 50% having non-dehiscent empty anther are retained in female rows. The female and male are grown in 4:1 ratio. However, to maintain the good plant population in female rows it is suggested that seed parent should be sown with double seed rate. It is also advised that female line seedling should be raised in polythene bags and transplanted at flower appearance in order to avoid the fertile plants in female rows. The pollination is done by honey bees and 1 to 2 medium sizes hives are good enough to ensure the good pollination and fruit set at female row.

The male sterile line is maintained in heterozygous form by crossing with maintainer line under adequate isolation distance or under cover.

#### **iv. Use of gynoecious sex form**

The gynoecious sex form has been commercially exploited in hybrid seed production of cucumber. For hybrid seed production female and male rows are planted in 4:1 ratio. The female (seed parent) bear only female flowers and pollination is done by insect (honeybee). To ensure the good fruit and seed recovery, the sufficient population of honeybee 1 to 1½ colony of medium size has to be kept at the boundary of seed production plot to boost the amount of crossing. The parental lines i.e. male parent maintained by selfing (mixed pollination) and rogue out undesirable plants before contamination take place. The female lines i.e. gynoecious lines maintained by inducing the staminate flower through the sprays of silver nitrate 200 ppm at two to four true leaf stage and then selfing is carried out. It was observed that 10-11 male flowers appear per 100 nodes.

The performance of gynoecious lines is unstable under high temperature and long photo period conditions because of their thermo-specific responses for gynoecious stability. That is why the gynoecious cucumber did not receive much attention in the tropical countries. However, few true breeding tropical gynoecious lines in cucumber and muskmelon have been developed at IARI. As a result of development of true breeding line, muskmelon hybrid Pusa Rasraj was developed.

These homozygous gynoecious lines are maintained by using GA<sub>3</sub>, 1500ppm or silver nitrate 200-300 ppm or sodium thio sulphate 400 ppm to induce staminate flowers at two and four true leaf stage. Homozygous lines are planted in strict field isolation. The gynoecious lines are crossed with monoecious male parent to produce F1 hybrid.

#### **v. Hybrid seed production through chemical sex expression**

The hybrid seed can also be produce in cucurbits by the application of chemicals for attaining the sex of cucurbits. Specific chemicals are known to induce femaleness and maleness as desired. The spraying of ethrel (2-choloro-ethyl-phosphonic acid) 200-300 ppm at two and four true leaf stage and another at flowering is useful for inducing the pistilate flower successively in first few nodes on the female in bottle gourd, pumpkin and squash for F1 seed production. The row of male parent is grown side by the side of female and natural cross pollination is allowed. In the absence of insect, hand pollination is possible when two sexes are separate. Four to five fruit set at initial nodes are sufficient for hybrid seed. The complete suppression of male flowers in squash can be achieved by applying ethrel at higher concentration (400-500 ppm) twice.

The other chemicals like GA<sub>3</sub>, (10-25 ppm) in cucumber, MH-(100 ppm), ethephon (600 ppm) in squash induces female flowers.

# **SEED CERTIFICATION**

***By***

**Dr. Aninda Chakraborty**  
**Dept. of Seed Science and Technology**

# INTRODUCTION

- Seed Certification is a legally sanctioned system for quality control of seed multiplication and production

## **OBJECTIVES:**

- ✓ Identification of new superior varieties
- ✓ Provision of supply of quality seeds by careful maintenance
- ✓ Seed certification procedures and designed to ensure physical and genetic purity
- ✓ Freedom from weed seeds and diseases with good germinability of the certified seed



# Concept of Seed Certification

- 1) The integrity of certified seed growers must be recognized.
- 2) Field inspection must be made by seed inspectors.
- 3) Verification trials to establish identification of varieties must be conducted.
- 4) Maintenance of proper records to establish satisfactory pedigree of seed stocks.
- 5) There should be standards established for purity and germination.
- 6) Sealing seeds to protect both grower and purchaser must be approved.
- 7) Species of farm weeds which would be included within the meaning of noxious weeds, must be defined

# Organization of Certification

Establishment and operation of a seed certification agency

Establishment of minimum seed certification standards

Establishment of procedures for field inspection, seed processing, seed sampling and issuance of seed certification tags

# SEED CERTIFICATION AGENCIES

CSC	Central Seed Committee
CSCB	Central Seed Certification Board
FIS	Federation of International Seed Trade
HSS	Herbage Seed Scheme
ISST	Indian Society of Seed Technology
NSC	National Seeds Corporation
NSDC	National Seeds Development Council.
NSP	National Seeds Programme
NSSL	National Seed Storage Laboratory
SCST	Society of Commercial Seed Technologists
SIDP	Seed Improvement and Development Programme
SRT	Seed Review Team
SSC	State Seed Corporation
SSCA	State Seed Certification Agency
SSCB	State Seed Certification Board
UPS & TDC	Uttar Pradesh Seeds and Tarai Development Corporation



- **Seed certification is done by the Seed Certification Agency (SSCA) of the concerned state or by NSC where such an agency does not exist**

# FUNCTIONS OF NSC

1. Production and supply of foundation & certified seed.
2. To maintain improved seed stocks of improved varieties
3. Export and import of seed
4. Planning the production of breeder seed in consultation with ICAR
5. Providing technical assistance to seeds corporations and private agencies
6. Coordinating market research and sales promotion efforts
7. Providing training facilities for the staff participating in seed industry development
8. Providing certification services to states lacking established and independent seed certification agencies

# REQUIREMENTS OF SEED CERTIFICATION

## General requirements

- ❖ Should be a notified variety under Section-5 of the Indian Seed Act, 1966.
- ❖ Should be in the production chain and its pedigree should be traceable.

## Field standards

- ❖ selection of site, isolation requirements, spacing, planting ratio, border rows etc.

## Specific requirements

- ❖ Presence of off-types in any seed crop, pollen-shedders in Sorghum, Bajra, Sunflower *etc.*, Shedding tassels in maize crosses, disease affected plants, objectionable weed plants *etc.*, should be within the maximum permissible levels for certification.

## Seed standards

- ❖ Minimum seed certification standards have been evolved crop-wise



# PHASES OF SEED CERTIFICATION







Nevada Department of Agriculture
405 S. 21st St.
Sparks, NV 89431

Application for Seed Certification

[Redacted box]

Applicant: [Redacted]
Mailing Address: [Redacted]
Phone: [Redacted]

Grower: [Redacted]
Mailing Address: [Redacted]
Phone: [Redacted]

Crop: [Redacted] Variety Name: [Redacted]
Date Planted: [Redacted] Code Name: [Redacted]
Acres: [Redacted] Experimental Name: [Redacted]
Grower Field Number: [Redacted]
Class of Seed Planted: [Redacted]
Breeder [Redacted]
Foundation [Redacted]
Registered [Redacted]
Class of Seed to be Produced: [Redacted]
Foundation [Redacted]
Registered [Redacted]
Certified [Redacted]

Table with 2 columns: Year, Crop Grown. Multiple rows for data entry.

Seed Purchased From: [Redacted]
Address: [Redacted]

Amount Purchased: [Redacted] Amount Planted: [Redacted]
Lot Number: [Redacted] Certification Number: [Redacted] Grown In: [Redacted]

Location of Field (describe location and include a map to detail the area)
[Redacted]

I agree to abide by all laws and regulations governing the production of certified seed in the State of Nevada and assume responsibility for maintaining the genetic identity and purity at all stages of certification including seeding, harvesting, transporting, processing and labeling.

Signature: [Redacted]

Date: [Redacted]



Seed Program
Official Form

Phone: 775.353.3711

Fax: 775.353.3638

Email: rwillhelm@agri.nv.gov

# PROCEDURE OF SEED CERTIFICATION

1. Establishing Source of Seed
2. Field Area for Certification
3. Unit of Certification
4. Use of Chemical Hybridizing Agents (CHA's)
5. Field Inspection & Re-inspection
6. Harvesting, Threshing and Transportation
7. Seed Lot and Lot size specifications
8. Seed Processing and Seed Treatment
9. Sampling of seeds and Seed Analysis Report
10. Recleaning, Resampling and Retesting
11. Downgrading of Seed Class
12. Packing, Tagging, Sealing-and issuance of the Certificate
13. Refusal for Certification
14. Validity Period of the Certificate
15. Revocation of Certificate
16. Retention of Certification Records

### SAMPLE FORM OF SOWING REPORT

Name and address of the Producer :

Name and address of the grower :

Location of the seed farm :

a. Revenue village :

b. Block :

c. Taluk :

Crop / Variety / Acreage :

Class of seed to be produced :

Quantity of Seeds used (kg/acre) :

Source of seed :

a. Tag number :

b. Purchase Bill No. and date :

Date of sowing :

Signature of the grower :

Signature of the producer

#### Enclosures:

1. Tag for source of seed
2. Purchase bill of the grower

#### FOR OFFICE USE ONLY

Fee remitted :

Bill number and date :

Seed Certification No. :

Seed Certification Officer allotted :

Due dates for field Inspections :

Signature of Assistant Director of  
Seed Certification

## UNIT OF CERTIFICATION

- (a) it is all under one variety and does not exceed 10 hectares
- (c) Not divided into fields separated by more than 50 m between them
- (d) it is planted with seed belonging to the same class and stage in the generation chain
- (e) the crop over the entire area is more or less of the same stage of growth so raised strictly as a single crop
- (j) not grown as inter, companion or ratoon crop

## USE OF CHA's

In hybrid seed production, the seed producer can use proper Chemical Hybridising Agents ('CHAs') on female line in order to induce male sterility and subjected to grow-out test

# FIELD INSPECTION & RE-INSPECTION

- The inspection of standing seed crops is an essential step in verifying conformity of seed crops to prescribed certification standards.
- To collect information on cropping history of the field to verify whether the seed field meets the prescribed land requirements.
- The Certification Agency may at its discretion, also perform one or more re-inspections over and above the minimum number of inspections prescribed, if considered necessary

## SEED PROCESSING

- Seed processing means cleaning, drying, treating, grading and other operations which will improve the quality of seeds

## SAMPLE APPLICATION FORM FOR PROCESSING REPORT

Processor Name / Address :

Producer Name / Address :

Crop / Variety :

Certification Stage :

Seed Certification No. :

Sowing date :

**Seed farm situated in**

Block :

Village :

Acreage of the seed farm :

Date of harvest :

Yield estimated by SCO during field inspection :

The above mentioned seed lot was inspected by me on the date..... This seed lot is properly stored without any contamination of the seeds of other varieties. Kindly request you to provide the processing order to take the seed lots to the processing unit No. .... for processing.

**Signature of the grower**

**Signature of the Producer/representatives**

Name :

Name :

Designation :

Designation:

Date:

Date:

To

Assistant Director of Seed Certification

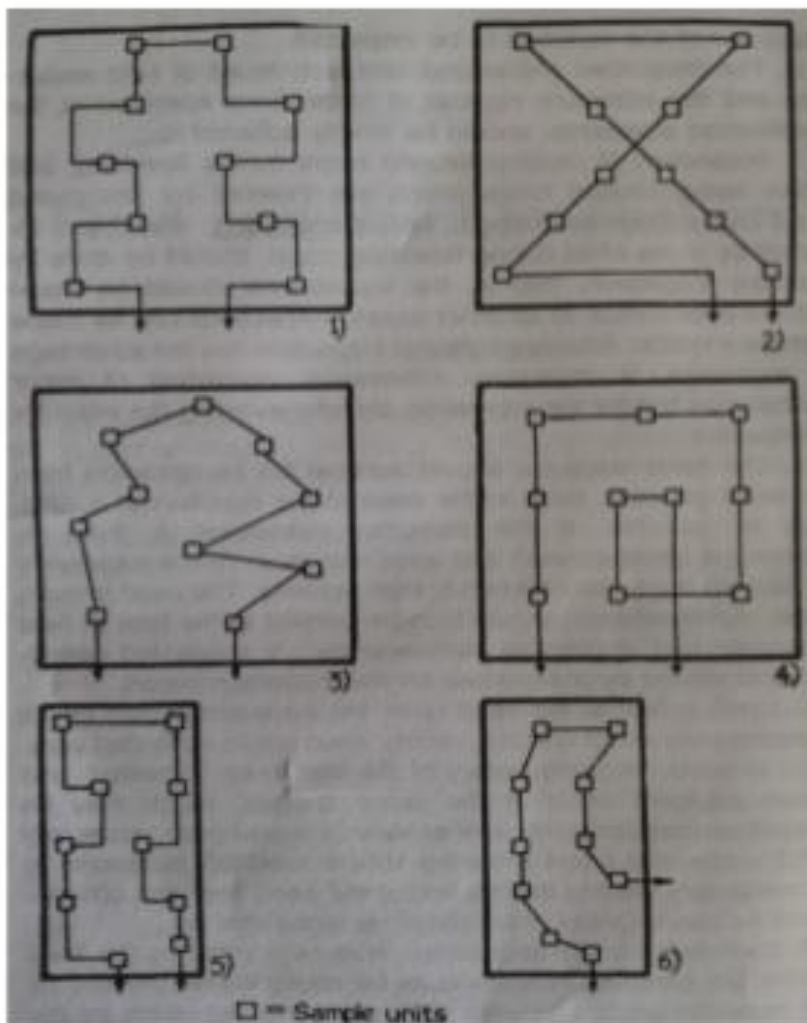
Copy to : Seed Certification Officer

# SEED LOT SIZE

- A seed lot is a physically identifiable quantity of seed which is homogeneous.

<b>Seed Size</b>	<b>Maximum quantity per lot</b>
Paddy, Wheat, Pulses, Cotton, Castor, Sunflower, Groundnut, Cucurbits	20,000 kg
Sorghum, Bajra, Millets, Rapeseed, Mustard, Sesamum, Jute, Cole crops, Brinjal, Chilli, Bhendi, Tomato, Onion	10,000 kg
Maize	40,000 kg





1- observation of 75% of the field

2- observation of 60 to 70% of the field

3- at random

4- clockwise travel pattern

5- observation of 85% of the field

6- observation of 60% of the field

**Fig :- Walking patterns for field inspection**

# UNDERSTANDING A SEED TAG

**GERMINATION RATE**  
Germination percentage by seed variety

**VARIETY AND KIND**  
Variety and kinds of grass contained in the product

**PURE SEED**  
Percentage by weight of each grass variety and kind

**OTHER CROP SEED**  
Other seeds that comprises of 5% or less of the product

**INERT MATTER**  
Non seed materials such as mulch or fertilizer

**WEED SEED**  
Percentage of weed seed contained in the product identified by state

**NOXIOUS WEEDS**  
Number of noxious weed seeds contained per pound. Noxious weeds are regulated and may be restricted by state.

**GUARANTEED ANALYSIS**  
Guaranteed analysis for fertilizer containing products

**LOT NUMBER**  
Production lot identification number

**TEST DATE**  
Germination test date

**SELL BY DATE**  
Sell by date variable by state

**OneStep Complete Seeding Mixture**

For Sun and Shade Areas .6 - 0 - 0    MAT: 100520281  
Sun and Shade Mixture                    NET WT: 5 POUND

---

PURE SEED	VARIETY	KIND	GERMINATION	ORIGIN
4.00%	REBEL XTREME TALL FESCUE		85%	OR
1.80%	PENNINGTON ATF1376 TALL FESCUE		85%	OR
1.70%	VIRTUE II TALL FESCUE		85%	OR
1.00%	BLUE BONNET KENTUCKY BLUEGRASS		80%	WA
0.80%	PENNINGTON ASC295 RED FESCUE		85%	OR
0.70%	SURVIVOR CHEWINGS FESCUE		80%	OR

0.09% OTHER CROP SEED  
89.90% INERT MATTER\*  
0.01% WEED SEED

\*(CONSISTS OF 84.50% MULCH, 5.00% FERTILIZER, 0.40% INERT FROM SEED)

NOXIOUS WEED: NONE FOUND PER POUND

---

**GUARANTEED ANALYSIS: .6 - 0 - 0**

Total Nitrogen (N)..... 0.60%  
0.60% Urea Nitrogen  
Derived From: Urea

**SOIL AMENDING GUARANTEED ANALYSIS**

Active Ingredients:  
84.50% Mulch  
Soil Amendment Inert Ingredients:  
10.50% Seed  
5.00% Fertilizer

INFORMATION REGARDING THE CONTENTS AND LEVELS OF METALS IN THE PRODUCT IS AVAILABLE ON THE INTERNET AT:  
<http://www.aapfco.org/metals.htm>

---

LOT# MH14WWS001

---

TEST DATE 12-14

In AK, AZ, CA, CO, CT, DE, ID, IL, MD, MN  
NC, ND, NE, NH, NJ, NV, NY, OH, OR, PA, SC  
UT, VA, VT and WA SELL BY: ..... 03/31/2016  
In MA, MT, SD, WI and WY SELL BY: ..... 12/31/2015  
In FL SELL BY: ..... 07/31/2015  
In all other states SELL BY: ..... 09/30/2015

GUARANTEED BY:  
Pennington Seed, Inc. P.O. Box 338 Greenfield, MO 65661



# Packing, Tagging, Sealing and Issuance of the Certificate

**Tamil Nadu Agricultural University**  
Coimbatore

**P 0238**

Crop	: Paddy
Variety	: ADT-38
Class of Seed	: BREEDER SEED
Lot No.	: FEB-02-20-EXT-00-01
Date of Test	: 18.6.2003
Pure Seed (Minimum)	: 99.8 %
Inert Matter (Maximum)	: 0.2 %
Germination (Minimum)	: 83.0 %
Genetic Purity (Minimum)	: 100.0 %
Net Weight	: 30kg
Producing Institution	: PROFESSOR (PE & G)

Agricultural Research Station  
Pattukkottai - 641002.

Agricultural Research Station  
PATTUKKOTTAI - 614 602

POISON TREATED

The lot number will have four parts

- Month, Year code
- Production Location Code
- Processing Plant Code
- Seed Produce Code

- Certification Agency shall ensure packing, tagging and sealing and issuance of certificate.
- An authorized official of the Certification Agency shall endorse the signature on the reverse of each certification tag and shall affix stamp indicating the official's name and designation.

# Lot number

OCT-16-18-227-07G 12251

Month

Year

State code

Plant code

Zonal code  
(Balangir)

Lot number



**ANAND AGRICULTURAL UNIVERSITY**  
BREEDER SEED      Label No. 773

Crop Muga      Variety Meha      Lot No. 2020  
Date of Test 13/04      Pure Seed % 94.5      Inert matter % 1.5  
Germination % 85      Genetic Purity % 94.5      Quantity Kg 500  
Production Year 2017

Producing Institute Anand Agril. Uni.  
Inspected & Supervised by [Signature]      Approved by [Signature]  
Asst./Asso. Res. Scientist      Research Scientist  
Regional Research Station  
Anand Agricultural University, Anand

GA-15C      NO 222043      **CERTIFIED SEED**  
CLASS      CERTIFIED  
KIND      PIGEONPEA  
VARIETY      VAISHALI URGMR-853 2KG  
LOT NO.      FEB-14-16-17 2015-0573  
Date & Test      07-04-2016  
Valid up to      06-04-2017

Producer's Name NAVSARI AGRIL UNIVERSITY  
& Full Address NAVSARI  
(Provided Seed is stored under cool and dry environment)

CERTIFIED BY  
**GUJARAT STATE SEED CERTIFICATION AGENCY**  
AHMEDABAD

Certificate No & Date  
H. J. SARDAR  
A.S.C.C. 312  
G.S.S.C.A.  
SURAT

"Use of the seed after expiry of the validity period by any person is entirely at his risk and the holder of the certificate shall not be responsible for any damage to the buyer of seed. No one should purchase the seed if seal or the certification tag has been tampered with"

**SEED TREATMENT WITH THIURAM POISON**  
OR  
**FOR SEED TREATMENT THIURAM POISON PACKET KEPT INSIDE**  
(DO NOT USE FOR FOOD, FEED OR OIL PURPOSE)

No. 4877      Kind MOONG      Germination (Min) 75 %  
Variety MEHA      Pure Seed (Min) 95 %  
Class Foundation      Inert Matter (Max) 2 %  
Date of Test 02/07/13      Moisture (Max) 8 %  
Valid up to 01/03/14      Weed Seed (Max No.) 50/Kg  
Packing Month/Year JANUARY      Other Crop Seeds (Max No.) 50/Kg  
Net Content 5 Kg

Lot No Key 134-1850 (15) 002888

PRODUCED & MARKETING BY NAVSARI AGRICULTURAL UNIVERSITY  
NAVSARI      Navsari Agricultural University  
Navsari-396459

GA-11-      **CERTIFIED SEED**  
CLASS      NO 792158      Certificate No & Date  
KIND      FOUNDATION  
VARIETY      MOONG      5kg  
LOT NO.      MEHA  
Date of Test : MAY-13-05-10 20150028888  
Valid upto : 02/07/13

Producer's Name NAVSARI AGRICULTURE  
& Full Address NAVSARI  
(Provided Seed is stored under cool and dry environment)

CERTIFIED BY  
**GUJARAT STATE SEED CERTIFICATION AGENCY**  
AHMEDABAD

"Use of the seed after expiry of the validity period by any person is entirely at his risk and the holder of the certificate shall not be responsible for any damage to the buyer of seed. No one should purchase the seed if seal or the certification tag has been tampered with"

B. V. MOYANKA  
ASCC-288  
G.S.S.C.A.  
SURAT.

# Truthfully labelled seeds

Max. Retail Price Rs 180/ (Incl. of all taxes)  
Unit Sales Price Rs 400/- Per kg

TABLE	"MAHALAXMI" SEEDS
Kind-COTTON	Germination (min) 66%
Variety-MLCH-22	Pure seed (min) 98%
Lot No.	Inert matter (max) 2%
Date of Test	Other corp seeds (max) 10/kg
Valid up to	Weed seeds (max) 10/kg
Packed	Moisture (max) 10%
	Net wt- 450 gms.

**POISON**  
DO NOT USE FOR FOOD, FEED  
AND OIL PURPOSES



Treated with Carbandazim  
Produced & Marketed by  
**Mahendra Hybrid Seeds Co. Pvt. Ltd;**  
Post Box No, 52, JALNA-431 203.

**TRUTHFUL LABEL**

KIND : HYBRID TOMATO  
VARIETY : US-1350  
LOT NO : 14510840002  
GERMINATION : (MIN) 70%  
PHYSICAL PURITY : (MIN) 98%  
GENETIC PURITY : (MIN) 98%  
MOISTURE : (MAX) 10%  
NO OF SEED : 2000 SEEDS

NET WEIGHT : 450 gms  
RECOMMENDATION : ALL STATES OF INDIA  
SEASON : KHARIF/RABI  
LABEL NUMBER : 1452951001285

DATE TESTED : 15-09-2016  
DATE PACKED : 08-11-2016  
VAL TO EXP TO : 12-06-2018  
MRP (INCLUSIVE OF ALL TAXES) RS. 485/-

"TREATED WITH METALFOSYL & DELTAMETHRIN"

**CAUTION: TREATED WITH POISON**  
DO NOT USE FOR FOOD, FEED OR OIL PURPOSE

The seeds in this package conform to the minimum limits of germination and purity prescribed under the Seeds Act, 1966. Purchase seed only if seal is intact. Store seed in dry and cool place.

Produced, packed and marketed by:  
**Nunhems India Pvt.Ltd.**, S.No.-196 &197, Kandlakol Village,  
Medchal, R.R District, Telangana, India. - 501 403.

Executive, Customer Support Services,  
Phone: 0124 - 3051423  
Email: nunhems.customerservice.in@bayer.com

**Bayer**

# REGISTERED SEED



KIND  
VARIETY  
CERT. NO.

## UTAH REGISTERED SEED

The seed in this container, with label properly affixed thereto, was produced in compliance with the Seed Certification Requirements and Standards established by the Utah Crop Improvement Association for the Registered class of certified seed. Compliance (and any warranty, expressed or implied) is based on and limited to the identification of seed source, and the results of representative field inspections and seed sample analysis.

This tag must be accompanied by a seed analysis label to comply with state and federal seed laws.

**IMPORTANT: SAVE THIS TAG FOR PROOF OF SEED ORIGIN.**

UTAH CROP IMPROVEMENT ASSOCIATION, Utah Agricultural Experiment Station, Logan, Utah 84322-4855

**MEMBER OF ASSOCIATION OF OFFICIAL SEED CERTIFYING AGENCIES**

**Colour: Opal Green**  
**Tag size: 15 cm x 10 cm**



**Label No.**

Crop:  
 Variety:  
 Class of seed: **Breeder Seed**  
 Lot No.  
 Date of test:  
 • Pure seed:                   %      Inert matter:                   %  
 • Germination:               %      Genetic purity:               %

Producing Institution: **Indian Grassland and Fodder Research Institute  
 Jhansi (284003) India**

Based on actuals                   Signature & Designation of breeder

**FOUNDATION SEED**

**TAG No.**

Kind:..... UTTAR PRADESH  
STATE SEED  
CERTIFICATION AGENCY  
LUCKNOW

Variety:.....

Lot No:.....

Use of seed after expiry of the validity period is entirely at users risk and the holder of the certificate shall not be responsible for any damage to the user. No one should purchase the seed if seal or the certificate tag has been tampered with.

Name and Address of the seed producer:.....

Class of seed:.....  
 Certificate No.:.....  
 Date of issue of certificate:.....  
 Date of test:.....  
 Certificate valid upto:.....  
(provided seed is stored under dry and cool environment)

Seed Certification Officer  
(Name & Place)

Validity of certificate  
 Further extended upto:.....

Seed Certification Officer  
(Name & Place)

**TAG No.**

**CERTIFIED SEED**

Kind:..... UTTAR PRADESH  
STATE SEED  
CERTIFICATION AGENCY  
LUCKNOW

Variety:.....

Lot No:.....

Use of seed after expiry of the validity period is entirely at users risk and the holder of the certificate shall not be responsible for any damage to the user. No one should purchase the seed if seal or the certificate tag has been tampered with.

Name and Address of the seed producer:.....

Class of seed:.....  
 Certificate No.:.....  
 Date of issue of certificate:.....  
 Date of test:.....  
 Certificate valid upto:.....  
(provided seed is stored under dry and cool environment)

Seed Certification Officer  
(Name & Place)

Validity of certificate  
 Further extended upto:.....

Seed Certification Officer  
(Name & Place)

**BUNDEL BEEJ**





ICAR-Indian Grassland and Fodder Research Institute (IGFRI)  
 Gwalior Road, Jhansi-284003

Processing and Packing attended by

Treated Seed not for Consumption

Label No. :  
 Crop :  
 Variety :  
 Lot No. :  
 Class of Seed : TFL Seed  
 Date of Test :  
 Net Weight (kg) :  
 Pure Seed (Min.) :  
 Inert Matter (Max.) :  
 Germination (Min.) :

Figure 2. Breeder, foundation, certified and truthfully labelled seed tags



Certified seed	Truthful labelled seed
Certification is voluntary	Truthful labelling is compulsory for notified kind of varieties
Applicable to notified kinds only	Applicable to both notified and released varieties
It should satisfy both minimum field and seed standards	Tested for physical purity and germination
Seed certification officer, seed inspectors can take samples for inspection	Seed inspectors alone can take samples for checking the seed quality.

# SEED ANALYSIS REPORT

- The Seed Testing Laboratory shall analysis the seed samples in accordance with the prescribed procedure and deliver the Seed Analysis Report to the Certification Agency from 30 days of the date of receipt of the samples

## Recleaning, Resampling and Retesting

- When a seed lot does not meet the prescribed seed standards, the Certification Agency on the request of seed producer may permit recleaning, resampling and retesting. It shall be permitted only once.

## Downgrading of seed calss

- If a seed field or a seed lot is not found meeting prescribed standards for the class for which it has been registered, the Certification Agency will certify to the immediate lower class.

## Report of Seed Analysis

Completed by a Registered Member of the Society of Commercial Seed Technologists

Name and Address:

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

### Sender's Information\*

Kind: **Carrot**  
 Variety: **Danvers 126**  
 Genus/Species: ***Daucus carota***  
 Lot Number: **532**  
 Size of Lot: **100 lb**  
 Other Information:

Date Sample Received:

Date Testing Completed:

Test No.: **97-020**

\*The information provided here is that of the sender and not of the laboratory

Purity Analysis:	# Grams Analyzed 3 g
Pure Seed Component (s)	<b><i>Daucus carota</i> 99.7 %</b>
Other Crop Seed	<b>0.0 %</b>
Inert Matter	<b>0.2 %</b>
Weed Seeds	<b>0.1 %</b>
Other Crop Seed	<b>None</b>
Weed Seeds:	
Smartweed ( <i>Polygonum spp.</i> )	3 / 30 g
Barnyard grass ( <i>Echinochloa crus-galli</i> )	2 / 30 g

### Viability Analysis:

Germination	Dormant Seeds	Hard Seeds	Total Viable	No. Seeds (Germ)	Days Tested	Fluorescent	Non-Fluorescent	TZ
89.5%	%	%	%			%	%	%

Comments:

All states (**Except Hawaii**) Noxious Weed Seeds 30 g analyzed

This sample has \_\_\_ or has not \_\_\_ been examined for the presence of noxious weed seeds.

**None of the following found in 30 g:** Canadian Prohibited Noxious  
 Canadian Primary Noxious  
 Canadian Secondary Noxious

Other Determinations: \_\_\_\_\_

Test Code and Fees: \_\_\_\_\_

Rules Followed Other than AOSA: **Canadian Methods and Procedures for Testing Seed**

Signature: \_\_\_\_\_

Registered Seed Technologist - Seal No. 051

## ANALYSIS TAG

Kind: \_\_\_\_\_

Variety: \_\_\_\_\_

Origin: \_\_\_\_\_

Net Weight (lbs): \_\_\_\_\_

Pure Seed (%): \_\_\_\_\_

Inert Matter (%): \_\_\_\_\_

Other Crop Seed (%): \_\_\_\_\_

Weed Seed (%): \_\_\_\_\_

Germination (%): \_\_\_\_\_

Hard Seed (%): \_\_\_\_\_

Test date: \_\_\_\_\_

Noxious Weed/lb: \_\_\_\_\_

Lot Number: \_\_\_\_\_

Vendor: \_\_\_\_\_

### XXIII. Seed Standards of Genetic Purity

(a) All certified seed lots shall conform to the following Minimum Standards for genetic purity unless otherwise prescribed:

---

<i>Class</i>	<i>Standards for Minimum Genetic Purity(%)</i>
Foundation	99.00
Certified:	
(i) Varieties, composites, synthetics, multilines	98.00
(ii) Hybrids	95.00

---





SEED TREATMENT WITH THIRAM POWDER  
OR  
FOR SEED TREATMENT THIRAM POWDER PACKET KEPT INSIDE  
(DO NOT USE FOR FOOD, FEED OR OIL PURPOSE)

CEP  
1411  
FOR  
419  
DO  
412

No. 4877  
 Crop: MOONG  
 Variety: M11A  
 Stage: Foundation  
 Date of Issuance: 20/07/20  
 Year of Issue: 20-20  
 Packing Month: JANUARY  
 Lot No: 154-000 (15) 2020



**NAUROJI SEED**

PRODUCED & MARKETING BY  
 (NAUROJI) NAUROJI SEEDS  
 NAVSARI  
 Navsari University  
 Navsari Agricultural University  
 Navsari-392450

SEAL  
INSIDE  
POSE



CROP :  
 1415 :  
 VARIETY :  
 911 :  
 STAGE : Breeder/Foundation  
 20 : Certified/Labelling  
 LOT NO. :  
 912-4 :  
 YEAR : 20 - 20  
 20 : 20 - 20  
 NET WEIGHT : 2 Kgs.  
 911 200 : 2 (30)  
 SALE PRICE : Rs.  
 (INCLUSIVE ALL TAXES)  
 2000 (300) : 30.  
 (1000 2000 3000)



**NAUROJI**



PRODUCED & MARKETING BY  
 (NAUROJI) NAUROJI SEEDS  
 Navsari Agricultural University  
 Navsari-392450 (Gujarat)

# VALIDITY PERIOD OF REPORT

- The validity period shall be nine months from the date of test at the time of initial certification. The validity period could be further extended for six months

## Revocation of certificate

- The holder of the certificate has, without reasonable cause, failed to comply with the conditions subject to which the certificate has been granted or has contravened any of the provisions of the Act or the Rules

## Retention of certification records

- The Certification Agency shall preserve in order all the documents including the guard samples pertaining to certification of each seed lot for two years from the date of grant/ extension of the certificate and four years in respect of rejected seed crops or lots



# Registration for seed production

<http://www.ossopca.nic.in>



## ODISHA STATE SEED & ORGANIC PRODUCTS CERTIFICATION AGENCY

[Home](#) [Seed Grower Registration](#) [Reprint Acknowledgement Form](#) [Requisition For Threshing Certificate](#) [Application Status](#) [Download](#) [FAQ](#)

GENERAL INFORMATION & APPLICANT'S DETAIL

ADDRESS DETAILS & LAND INFORMATION

CROP INFORMATION

PREVIOUS

NEXT

### GENERAL INFORMATION ALL (\*) FIELDS ARE MANDATORY

1 NAME OF SCO UNIT : - -- Select --

2 AGENCY NAME : \* -- Select --

3 AGENCY DETAIL : \* -- Select --

4 CROP SEASON :  KHARIF  RABI

5 NATURE OF CROP VARIETY :  NORMAL  HYBRID

6 SEED GROWER TYPE :  INDIVIDUAL  GROUP

7 NO OF SEED GROWERS INVOLVED : (ENCLOSE THE LIST)

Activate W  
Go to PC settir

# Threshing floor certificate



ODISHA STATE SEED & ORGANIC PRODUCTS CERTIFICATION AGENCY, BHUBANESWAR

## Threshing Certificate

Issuing Date-05/12/2015

SERIAL NO- 14168  
LOT NO - NOW15-18-227-07G12231  
Plant Name-OSSC. / OSSC Ltd  
Block Name-Agalapur  
Agency Name-OSSC / OSSC - OSSC  
Reference No-BOL/07/2015-16/K/22898

This Is To Certify That,the Threshing of the Harvested Seed produce whose details are given below was supervised to the Extent Possible felt necessary

Seed Grower Name :nilambar patel / UPARBAHAL

Crop Name	Variety Name	Class Name
PaddyDhan	MRUNALINI (DR 1898-18) IET 18649	Certified

Total Area of certified seed crop (in Ha):3.00  
Net Area to which this certificate pertains (in Ha):3  
Harvesting Date- 23/11/2015 ,  
No Of Bags- 184  
Quantity in KG Per Bag-70.00  
Total Quantity- 12880.00

Activate Wi  
Go to PC settin  
Signature Of SCA Officer

# Indian Minimum Seed Certification Standards

Select the Crop:

- India:
- Barley
  - Barley Hybrids
  - Paddy
  - Paddy Hybrids
  - Tribhujale**
  - Wheat
  - Wheat Hybrids
  - Barnyard Millet
  - Common Millet
  - Finger Millet
  - Italian Millet
  - Kodo Millet
  - Little Millet
  - Maize Composites,Synthetics,And Open Pollinated Varieties
  - Pearl Millet Composites,Synthetics,And Open Pollinated Varieties
  - Pearl Millet Hybrids
  - Sorghum Open Pollinated Varieties
  - Sorghum Hybrids
  - Maize Foundation Single Crosses
  - Maize Hybrids

submit

Isolation Distance 1(m)						Isolation Distance 2(m)						Isolation Distance 3(m)						Pollen shedds(%)		Objectionable Weed Plants(%)				Designated Disease(%)	
Found		Cert		Found		Cert		Found		Cert		Found		Cert		Found	Cert	Found	Cert	Found	Cert	Found	Cert		
Pure seed (Min)(%)		Inert matter(Max)(%)		Other crop seeds (Max)(%)		ODV (Max)(%)		Total weed seeds (Max)(%)		Objectionable weed seeds(Max)(%)		Germination (Min)(%)		Moisturiser (Max)(%)		Designated Disease(%)		Vapour proof containers (Max)(%)							
Found		Cert		Found		Cert		Found		Cert		Found		Cert		Found		Cert		Found		Cert			

## Indian Minimum Seed Certification Standards

Field Standard for Crop Paddy

Isolation Distance 1(m)		Isolation Distance 2(m)		Isolation Distance 3(m)		Offtypes (%)		Pollen shedds(%)		Objectionable Weed Plants(%)		Designated Diseases(%)		Inseparable Other Plants(%)		Seed Born Diseases(%)			
Found		Cert		Found		Cert		Found		Cert		Found		Cert		Found		Cert	
3	3	3	3			0.05%	0.20%			0.01	0.02								

Seed Standards for Crop Paddy

Pure seed (Min)(%)		Inert matter(Max)(%)		Other Crop seeds (Max)(%)		ODV (Max)(%)		Total Weed seeds (Max)(%)		Objectionable weed seeds(Max)(%)		Germination (Min)(%)		Moisturiser (Max)(%)		Designated Disease(%)		Vapour proof containers (Max)(%)		Ergotted Earheads(%)			
Found		Cert		Found		Cert		Found		Cert		Found		Cert		Found		Cert		Found		Cert	
98.00%	98.00%	2.00%	2.00%	10/kg	20/kg	10/kg	20/kg	10/kg	20/kg	2/kg	5/kg	80%	80%	13.00%	13.00%	0.10%	0.50%	8.00%	8.00%				



# Costs of certification

Registration fee per grower/ location/ crop/ season/unit	25/-
Inspection fee	
a) Foundation class of all crops	350/-
b) Certified class of all crops	300/-
Processing supervision fees (per quintal)	3/-
Packing/ Repacking supervision fees (per quintal)	3/-
Re-processing supervision fees (per quintal)	5/-
Sampling and seed testing fees	80/-
Grow out test fees (per sample)	300/-
Processing plant registration fee	2000/-
Processing plant renewal fee/ year	1000/-
Cost of tag including cost of lead seal	3/-
Seed transfer fee/ qtl (if transferred from site of processing to other places for storage)	10/-



ODISHA STATE SEED & ORGANIC PRODUCTS CERTIFICATION AGENCY,  
BHUBANESWAR

SAMPLING SLIP [ LAB]

Unique Code : E4D263

Generated On :5/28/2016 12:30:28 PM

Crop:PaddyDhan

Variety:MTU-7029(SWARNA)

Class:Certified

Date Of Sampling: 5/30/2016

Test Required: SEED HEALTH  
INSECT DAMAGE  
ODV  
MOISTURE  
PURITY  
GERMINATION

Status Of Lot: PROCESSED  
UN TREATED

Signature Of Sampler

Sample Submitted For: INITIAL TEST  
Signature Of Producer



ODISHA STATE SEED & ORGANIC PRODUCTS CERTIFICATION AGENCY,  
BHUBANESWAR

SAMPLING SLIP [ PRODUCER]

Lot No.:NOV/15-18-227-07G13433 - 1

Generated On :5/28/2016 12:30:28 PM

Crop:PaddyDhan

Variety:MTU-7029(SWARNA)

Class:Certified

Date Of Sampling: 5/30/2016

Processed Quantity :15180

No. Of Bags.:759

Location Of The Lot: ossc, bgr

Test Required: SEED HEALTH  
INSECT DAMAGE  
ODV  
MOISTURE  
PURITY  
GERMINATION

Status Of Lot: PROCESSED  
UN TREATED  
Sample Submitted For: INITIAL TEST

Signature Of Sampler

Signature Of Producer

Sample slip

***THANK YOU***

# **Introduction to Seed Act 1966- An Overview**

***By***

**Dr. Aninda Chakraborty**  
**Dept. of Seed Science and Technology**



## The Seeds Act, 1966

To control the quality of seed during production and marketing , Govt. of India enacted Seed Act in 1966. For effective implementation of the act, major provisions are

- Central Seed Committee
- Power to notify kind or variety of seeds
- Minimum Seed Certification Standards
- Certification voluntary but labeling is compulsory
- Label should contain necessary information
- Central Seed Testing Laboratory
- State Seed Testing Laboratories

- Central Seed Certification Board
- Central Seed Certification Agency
- State Seed Certification Agencies
- Seed Inspectors
- Seed Analysts
- Appellate Authority
- Recognition of Seed Certification Agencies of Foreign Countries

Seeds Act, 1966 consist of 25 clauses

## 1. Short title, extent and commencement

- 1) This Act may be called the **Seeds Act, 1966**.
- 2) It extends to the **whole of India**.
- 3) It shall **come into force on such date** as the Central Government may, by **notification in the Official Gazette**, appoint, and **different dates** may be appointed for different provisions of this Act, and for different States or for different areas thereof.

## 2. Definitions

- “agriculture” includes horticulture;
- “kind” means one or more related species or sub-species of crop plants each individually or collectively **known by one common name** such as cabbage, maize, paddy and wheat
- “notified kind or variety”, in relation to any seed, means any kind or variety thereof **notified under section 5**

➤ seed” means any of the following classes of seeds used for sowing or planting—

- (i) seed of food crops including edible oil seeds and seeds of fruits and vegetables;
- (ii) cotton seeds;
- (iii) seeds of cattle fodder;
- (iv) jute seeds,

and includes seedlings, and tubers, bulbs, rhizomes, roots, cuttings, all types of grafts and other vegetative propagated material, of food crops or cattle fodder;



### 3. Central Seed Committee

To **advise** the Central Government and the State Governments on matters arising out of the administration of this Act and to carry out the other functions assigned to it by or under this Act.

### 4. Central Seed Laboratory and State Seed Laboratory

(1) The Central Government may, by **notification in the Official Gazette**, **establish a Central Seed Laboratory** or declare any seed laboratory as the Central Seed Laboratory to carry out the functions entrusted to the Central Seed Laboratory by or under this Act



MINISTRY OF AGRICULTURE  
(Department of Agriculture and Co-operation)  
NOTIFICATION

New Delhi, the 8th March, 2007

**S.O. 331(E)**---In exercise of the powers conferred by Sub-section (1) of Section 4 of the Seeds Act, 1966 (54 of 1966), and in supersession of the notification of the Government of India, in the then Ministry of Food, Agriculture, Community Development and Co-operation (Department of Agriculture) number S.O. 4435, dated the 29th September, 1969, except as respects things done or omitted to be done before such supersession the Central Government hereby declares the Seed Testing Laboratory, National Seed Research and Training Centre, Varanasi, Department of Agriculture and Co-operation as Central Seed Laboratory to carry out the functions herein before entrusted to the Indian Agricultural Research Institute, New Delhi under the said Notification.

2. This notification comes into force with effect from first day of April, 2007.

[F.No.18-148/2006-SD.IV]

S. L. BHAT, Addl. Secy.

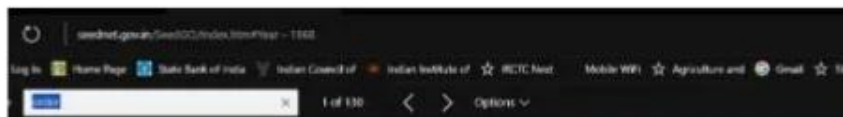
775 (G)/2007

Printed by the Manager, Govt. of India Press, Ring Road, Mayapuri, New Delhi-110064  
and Published by the Controller of Publications, Delhi-110054.



## 5. Power to notify kinds or varieties of seeds

- If the Central Government, after consultation with the Committee, is of opinion that it is necessary or expedient to regulate the quality of seed of any kind or variety to be sold for purposes of agriculture, it may, by notification in the Official Gazette, declare such kind or variety to be a notified kind or variety for the purposes of this Act and different kinds or varieties may be notified for different States or for different areas thereof



Seed Division : Gazette Notifications

Select Year of Notification

2017	2016		
2015	2014	2013	2012
2011	2010	2009	2008
2007	2006	2005	2004
2003	2002	2001	2000
1999	1998	1997	1996
1995	1994	1993	1992
1991	1990	1989	1988
1987	1986	1985	1984
1983	1982	1981	1980
1979	1978	1977	1976
1975	1974	1973	1972
1971	1970	1969	1968

Year - 2017

S. No.	G.O. No.	Statutory Order (S.O.) Number	Date of the Order	Remarks
1	IV	<a href="#">S.O 182 (E)</a>	19/01/2017	Seed Variety Notification
2	IV	<a href="#">S.O 802 (E)</a>	10/03/2017	Seed Variety Notification
3	IV	<a href="#">S.O 1007 (E)</a>	30/03/2017	Seed Variety Notification
4	IV	<a href="#">S.O 1007 (E)</a>	30/03/2017	Notification of crop varieties under section 5 of the Seeds

[Section 3(ii)]

बनस की सूची : अध्यापन

7

MINISTRY OF AGRICULTURE AND FARMERS WELFARE  
(Department of Agriculture, Co-operation and Farmers Welfare)

NOTIFICATION

New Delhi, the 30th March, 2017

S.O. 1007(E).—In exercise of the powers conferred by section 5 of the Seeds Act, 1966 (54 of 1966), the Central Government after consultation with the Central Seed Committee, is of the opinion that it is necessary and expedient to regulate the quality of the seeds of the varieties specified in column (3) of the Table below of the kinds specified in the corresponding entries in column (2) of the said Table, hereby declares that the said varieties of the seeds shall be notified varieties to be sold for the purposes of agriculture for the States mentioned in column (4) of the said Table and shall be the notified varieties for the whole of India for the purposes of the said Act, with effect from the date of publication of this notification in the Official Gazette, namely:-

TABLE

	Crop	Variety	State
✓ 1.	Rice	HRI-183 (Arize Swift Gold)	Haryana, Uttarakhand, Uttar Pradesh and Gujarat.
2.	Rice	HRI-180 (Arize Tej Gold)	Punjab, Haryana and Uttarakhand.
3.	Rice	PA6129 (Arize 6129)	Madhya Pradesh.
4.	Rice	BS129G (Arize 6129 Gold)	Chhattisgarh.
5.	Rice	28P09	Odisha, West Bengal and Uttar Pradesh, Assam, Chhattisgarh, Maharashtra, Gujarat, Tamil Nadu and Andhra Pradesh.
6.	Rice	CO 51	Haryana, Uttarakhand, Odisha, Bihar, West Bengal, Uttar Pradesh, Madhya Pradesh, Maharashtra, Gujarat, Andhra Pradesh, Kerala, Karnataka and Tamil Nadu.
7.	Rice	VL Dhan 158 (VL 8657)	Himachal Pradesh and Uttarakhand.
8.	Rice	Jalkunwari (TTB 202-4)	Assam.
9.	Rice	Jalashree (TTB 202-3)	Assam.
10.	Rice	Kanakhya (TTB 103-1-1)	Assam.
11.	Rice	Gitesh (TTB 283-1-26)	Assam.
12.	Rice	Mahesh Kumar (TTB 103-1-1)	Assam.

<http://www.seednet.gov.in/SeedGO/Index.htm>

## 6. Power to specify minimum limits of germination and purity, etc

The Central Government may, after consultation with the Committee and by notification in the Official Gazette, specify—

- (a) the **minimum limits of germination and purity** with respect to any seed of any notified kind or variety;
- (b) the **mark or label to indicate** that such seed conforms to the minimum limits of germination and purity specified under clause (a) and the particulars which such mark or label may contain.

## 7. Regulation or sale of seeds of notified kinds or varieties.

keeping for sale, offering to sell, bartering or otherwise supplying any seed of **any notified kind or variety**

- is **identifiable** as to its kind or variety
- conforms to the **minimum limits of germination and purity** specified under clause (a) of section 6
- the **container** of such seed bears in the prescribed manner, the **mark or label** containing the correct particulars thereof, specified under clause (b) of section 6



## 8. Certification agency

- The State Government or the Central Government in consultation with the State Government may, by notification in the Official Gazette, establish a certification agency for the State to carry out the functions entrusted to the certification agency by or under this Act.
- The Central Seed Certification Board - to advise the Central Government and the State Governments on all matters relating to certification, and to co-ordinate the functioning of the agencies established under section 8.

## 9. Grant of certificate by certification agency

- (1) Any person selling, keeping for sale, offering to sell, bartering or otherwise supplying any seed of any notified kind or variety may, if he desires to have such seed certified by the certification agency, apply to the certification agency for the grant of a certificate for the purpose.
- (2) Every application under sub-section (1) shall be made in such form, shall contain such particulars and shall be accompanied by such fees as may be prescribed.

(3) On receipt of any such application for the grant of a certificate, the certification agency may, after such enquiry as it thinks fit and after satisfying itself that the seed to which the application relates conforms to the 1[prescribed standards], grant a certificate in such form and on such conditions as may be prescribed:

[Provided that such standards shall not be lower than the minimum limits of germination and purity specified for that seed under clause (a) of section 6.]



## 10. Revocation of certificate.

If the certification agency is satisfied, either on a reference made to it in this behalf or otherwise, that— (a) the certificate granted by it under section 9 has been **obtained by misrepresentation** as to an essential fact; or (b) **the holder** of the certificate has, without reasonable cause, **failed to comply with the conditions** subject to which the certificate has been granted or has **contravened any of the provisions of this Act** or the rules made thereunder, then, without prejudice to any other penalty to which the holder of the certificate may be liable under this Act, the **certification agency may, after giving the holder of the certificate an opportunity of showing cause, revoke the certificate.**

## 11. Appeal

- (1) Any person aggrieved by a decision of a certification agency under section 9 or section 10, may within thirty days from the date on which the decision is communicated to him and on payment of such fees as may be prescribed, prefer an appeal to such authority as may be specified by the State Government in this behalf
- (2) On receipt of an appeal under sub-section (1), the appellate authority shall, after giving the appellate an opportunity of being heard, dispose of the appeal as expeditiously as possible.
- (3) Every order of the appellate authority under this section shall be final.

## 12. Seed Analysts

The State Government may, by notification in the Official Gazette, appoint such persons as it thinks fit, having the prescribed qualifications, to be Seed Analysts and define the areas within which they shall exercise jurisdiction

### 13. Seed Inspectors

- (1) The State Government may, by notification in the Official Gazette, appoint such persons as it thinks fit, having the prescribed qualifications, to be Seed Inspectors and define the areas within which they shall exercise jurisdiction.
- (2) Every Seed Inspector shall be deemed to be a public servant within the meaning of section 21 of the Indian Penal Code (45 of 1860) and shall be officially subordinate to such authority as the State Government may specify in this behalf



## 14. Powers of Seed Inspector

- (1) The Seed Inspector may— (a) **take samples** of any seed in any notified kind or variety from—
- (i) any **person selling** such seed; or
  - (ii) any person who is in the **course of conveying, delivering or preparing to deliver** such seed to a purchaser or a consignee; or
  - (iii) a **purchaser or a consignee** after delivery of such seed to him;

(b) **send** such sample **for analysis** to the Seed Analyst for the area within which such sample has been taken;

(c) **enter and search** at all reasonable times, with such assistance, if any, as he considers necessary, **any place** in which he has reason to believe that an offence under this Act has been or is being committed and **order in writing** the person in possession of any seed in respect of which the offence has been or is being committed, **not to dispose of any stock of such seed for a specific period not exceeding thirty days** or, unless the alleged offence is such that the defect may be removed by the possessor of the seed, **seize the stock of such seed**;

(d) examine any record, register, document or any other material object found in any place mentioned in clause

(c) and seize the same if he has reason to believe that it may furnish evidence of the commission of an offence punishable under this Act; and

(e) exercise such other powers as may be necessary for carrying out the purposes of this Act or any rule made thereunder.



(2) Where any sample of any seed of any notified kind or variety is taken under clause (a) of sub-section (1), its **cost, calculated** at the rate at which such seed is usually sold to the public, **shall be paid on demand** to the person from whom it is taken

(3) The power conferred by this section includes **power to break-open any container** in which any seed of any notified kind or variety may be contained or to **break-open the door** of any premises where any such seed may be kept for sale: Provided that the power to break-open the door shall be exercised only after the owner or any other person in occupation of the premises, if he is present therein, **refuses to open the door** on being called upon to do so.

(4) Where the Seed Inspector takes any action under clause (a) of sub-section (1), he shall, as far as possible, call **not less than two persons to be present** at the time when such action is taken and take their signatures on a memorandum to be prepared in the prescribed form and manner.

(5) **The provisions of the Code of Criminal Procedure, 1898** (5 of 1898), shall, so far as may be, **apply** to any search or seizure under this section as they apply to any search or seizure made under the authority of a warrant issued under section 98 of the said Code

## 15. Procedure to be followed by Seed Inspectors

- (1) Whenever a Seed Inspector intends to take sample of any seed of any notified kind or variety or analysis, he shall—
  - (a) give notice in writing, then and there, of such intention to the person from whom he intends to take sample;
  - (b) except in special cases provided by rules made under this Act, take three representative samples in the prescribed manner and mark and seal or fasten up each sample in such manner as its nature permits.



(2) When samples of any seed of any notified kind or variety are taken under sub-section (1), the Seed Inspector shall— (a) deliver **one sample to the person** from whom it has been taken;

(b) send in the prescribed manner **another sample for analysis** to the Seed Analyst for the area within which such sample has been taken; and

(c) **retain the remaining sample** in the prescribed manner for production in case any legal proceedings are taken or for analysis by the Central Seed Laboratory under sub-section (2) of section 16, as the case may be.

(3) If the person from whom the samples have been taken **refuses to accept one of the samples**, the Seed Inspector shall send **intimation** to the Seed Analyst of such refusal and thereupon **the Seed Analyst receiving the sample** for analysis shall divide it into two parts and shall seal or fasten up one of those parts and shall cause it, either upon receipt of the sample or when he delivers his report, to be **delivered to the Seed Inspector** who shall retain it for production in case legal proceedings are taken.

(4) Where a **Seed Inspector takes any action** under clause (c) of subsection (1) of section 14,—

(a) he shall use all despatch in ascertaining whether or not the seed contravenes any of the provisions of section 7 and if it is ascertained that the **seed does not so contravene, forthwith revoke the order passed** under the said clause or, as the case may be, take such action as may be necessary for the **return of the stock of the seed seized**;

(b) if he **seizes the stock** of the seed, he shall, as soon as may be, **inform a magistrate** and take his orders as to the custody thereof;

(c) without prejudice to the institution of any prosecution, if the alleged offence is such that the defect may be removed by the possessor of the seed, he shall, on being satisfied that the defect has been so removed, forthwith revoke the order passed under the said clause.

(5) Where a Seed Inspector seizes any record, register, document or any other material object under clause (d) of sub-section (1) of section 14, he shall, as soon as may be, inform a magistrate and take his orders as to the custody thereof.



## 16. Report of Seed Analyst

(1) The Seed Analyst shall, as soon as may be after the receipt of the sample under sub-section (2) of section 15, analyse the sample at the State Seed Laboratory and deliver, in such form as may be prescribed, one copy of the report of the result of the analysis to the Seed Inspector and another copy thereof to the person from whom the sample has been taken.

(2) After the institution of a prosecution under this Act, the accused vendor or the complainant may, on payment of the prescribed fee, make an application to the court for sending any of the samples mentioned in clause (a) or clause (c) of sub-section (2) of section 15 to the Central Seed Laboratory for its report and on receipt of the application, the court shall first ascertain that the mark and the seal or fastening as provided in clause (b) of sub-section (1) of section 15 are intact and may then despatch the sample under its own seal to the Central Seed Laboratory which shall thereupon send its report to the court in the prescribed form within one month from the date of receipt of the sample, specifying the result of the analysis.

(3) The report send by the Central Seed Laboratory under sub-section (2) shall supersede the report given by the Seed Analyst under sub-section (1)

(4) Where the report sent by the Central Seed Laboratory under sub-section (2) is produced in any proceedings under section 19, it shall not be necessary in such proceedings to produce any sample or part thereof taken for analysis.

## 17. Restriction on export and import of seeds of notified kinds or varieties

No person shall, for the purpose of sowing or planting by any person (including himself), export or import or cause to be exported or imported any seed of any notified kind or variety, unless—

(a) it conforms to the minimum limits of germination and purity specified for that seed under clause (a) of section 6; and (b) its container bears, in the prescribed manner, the mark or label with the correct particulars thereof specified for that seed under clause (b) of section 6.



## 18. Recognition of seed certification agencies of foreign countries

The Central Government may, on the recommendation of the Committee and by notification in the Official Gazette, recognise any seed certification agency established in any foreign country, for the purposes of this Act.

## 19. Penalty

If any person— (a) **contravenes any provision** of this Act or any rule made thereunder; or (b) **prevents a Seed Inspector from taking sample** under this Act; or (c) prevents a Seed Inspector from **exercising any other power** conferred on him by or under this Act, he shall, on conviction, be punishable— (i) for the **first offence** with fine which may extend to **five hundred rupees**, and (ii) in the event of such person having been previously convicted of an offence under this section, with **imprisonment** for a term which may extend to **six months**, or with **fine** which may extend to one **thousand rupees**, or with both.

## 20. Forfeiture of property

When any person has been convicted under this Act for the contravention of any of the provisions of this Act or the rules made thereunder, the seed in respect of which the contravention has been committed may be forfeited to the Government



## 21. Offences by companies

1) Where an offence under this Act has been committed by a company, every person who at the time the offence was committed was in charge of, and was responsible to, the company for the conduct of the business of the company, as well as the company, shall be deemed to be guilty of the offence and shall be liable to be proceeded against and punished accordingly: Provided that nothing contained in this subsection shall render any such person liable to any punishment under this Act if he proves that the offence was committed without his knowledge and that he exercised all due diligence to prevent the commission of such offence

(2) Notwithstanding anything contained in sub-section (1), where an offence under this Act has been committed by a company and it is proved that the offence has been committed with the consent or connivance of, or is attributable to any neglect on the part of, any director, manager, secretary or other officer of the company, such director, manager, secretary or other officer shall also be deemed to be guilty of that offence and shall be liable to be proceeded against and punished accordingly. Explanation.—For the purposes of this section,— (a) “company” means any body corporate and includes a firm or other association of individuals; and (b) “director”, in relation to a firm, means a partner in the firm.

## 22. Protection of action taken in good faith

Not suit, prosecution or other legal proceeding shall lie against the Government or any officer of the Government for anything which is in good faith done or intended to be done under this Act.

## 23. Power to give directions

The Central Government may give such directions to any State Government as may appear to the Central Government to be necessary for carrying into execution in the State any of the provisions of this Act or of any rule made thereunder.

## 24. Exemption

Nothing in this Act shall apply to any seed of any notified kind or variety grown by a person and sold or delivered by him on his own premises direct to another person for being used by that person for the purpose of sowing or planting.



## 25. Power to make rules

(1) The Central Government may, by notification in the Official Gazette, make rules to carry out the purposes of this Act. (2) In particular and without prejudice to the generality of the foregoing power.

## Lacunae in Seed Act 1966

- The farmers' traditional seed system is left outside the Act.
- Seed marketing is linked neither to plant breeders' rights nor to any established ownership on variety.
- Not prescribe the declaration of pedigree, particularly in the case of TLVs, secrecy on pedigree is used to create a commercial monopoly on seeds.
- In the seed chain involving producers, processors and stockists/traders, license for the transaction is required only for the stockist/trader

- No provision for **transgenic varieties**
- No provision related to Environment and labour standard
- No provision for seed price monitoring
- No encouragement for organic seed production
- No specific provision for **compensation to farmers**
- The **enforcement of the law is weak** and the prescribed penalty is soft.
- **Excludes horticultural nurseries**





**THANK YOU**

# **Seed Control Order, 1983**

*By*

**Dr. Aninda Chakraborty**  
**Dept. of Seed Science and Technology**

# PRELIMINARY


## 1. Short title and extent.

- ✓ This order may be called the seeds (control) order. 1983.
- ✓ It extends to the whole of india.
- ✓ It shall come into force on the 30<sup>th</sup> December of 1983.

## 2. Definitions.

1. **“Act”** means the essential commodity act, 1955 (10 of 1955).
2. **“Controller”** means a person appointed by the controller of seeds by the central government and includes any person empowered by the central government to exercise all or any functions of the controller under this act.

3. **“Dealer”** means a person carrying on the business of selling, exporting, or importing seeds, and includes an agent or a dealer.
4. **“Export”** means to take or cause to be taken out from any place in india to a place outside india.
5. **“Form”** means a form appended in this order.
6. **“Import”** means to bring or cause to be brought to any place in india from outside india.
7. **“Inspector”** means an inspector of seeds appointed under **clause 12.**

8. **“Registering authority”** means a licensing authority appointed under **clause 11**.
  9. **“Seeds”** means the seeds as defined in the act , 1966 (54 of 1966).
  10. **“State government”** in relation to a union territory means the administrator thereof by whatever designation known.
- 



### 3. Dealer to obtain license.

1. No person shall carry on the business of selling , exporting or importing of seeds at any place except under and in accordance with the terms and conditions of license granted to him under this order.
2. Notwithstanding anything contained in **sub –clause (1)**, the state government may, by notification in the official gazette, exempt from the provision of that sub-clause such class of dealers in such **areas and subject** to such conditions as may be specified in the notification.


#### 4. Application for license.

- ✓ Every person desiring to obtain a license for selling, exporting or importing seeds shall make an application in duplicate in **form A** together with a fee of rupees fifty for license to the licensing.



## 5. Grant and refusal of license.

1. The licensing authority may, after making such inquiry as it thinks fit, grant a license in **from B** to any person who applies for it under clause 4, provided that a license shall not be issued to a person;-
  - A. Whose earlier license granted under this order in under **suspension**, during the period of such suspensions.
  - B. Whose earlier license granted under this order has been **cancelled**, within a period of one year from the date of such cancellation.

- c. Who has been **convicted** under the essential commodity act, 1955 (10 of 1955) or any order issued there under within three years proceeding the date of application.
  
  - 2. When the licensing authority refuses to grant a license to a person who applies for it under **clause 4**, he shall **record his reasons** for doing so.
- 

## 6. Period of validity of license.

- ✓ Every license granted under this order, shall unless previously suspended or cancelled, remain valid for **three years** from the date of its issue.

## 7. Renewal of license.

1. In **form C** together with a fee of **twenty rupees** for renewal before expiry of the license.
2. If any application for renewal is not made before the expiry of the license, the license may be renewed on payment of **additional fee of rupees twenty-five**, in addition to the fee for renewal of license.

## **8. Dealers to display stock and price list.**

Every dealer of seeds shall display in his place of business:-

- A. The opening and closing stocks, on daily basis, of different seeds held by him.
- B. A list indicating prices of rates of different seeds.

### **9. Dealers to give memorandum to purchase.**

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

### **10. Power to distribute seeds.**

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



## **Enforcement authority.**

### **11. Appointment of licensing authority.**

The state government may after notification in the official gazette appoint such number of persons as it thinks necessary to the licensing authority and may also define in that notification the area within which each such licensing authority shall exercise his jurisdiction.

## 12. Appointment of inspectors.

The state government may by notification in the official gazette appoint such number of persons as it thinks necessary as the inspector and may in such notification define the local area within which each such inspector shall exercise his jurisdiction.

### 13. Inspection and punishment.

1. An inspector may with a view to securing compliance with this order:-
  - A. Require any dealer to give any information in his possession with respect to purchase, storage and sale of seeds by him;
  - B. Enter upon and search any premises where any seed is stored or exhibited for sale to ensure compliance with the provision of this order.
  - C. Draw sample of seeds meant for sale, export and seeds imported, and send the same in accordance with the procedure laid down in **schedule 1, to a laboratory notified** under the seeds act 1966 (54 of 1966) to ensure that the sample conforms to standards of quality claimed.

- D. Seize or detain any seed in respect of which he has reasons to believe that a contravention of this order has been committed or is being committed.
  - E. Seize books of accounts or documents relating to any seed, provided that the inspector shall give a receipt to the person from whom they have been seized and further they shall be returned to that person.
2. Subject to the provision of paragraph (d) of **sub-clause (1)** the provision, of section 100 of the code of criminal procedure 1973 (2 of 1974) relating to search and seizure shall so far as may be apply to searches and seizures under this clause.

3. Where any seed is seized by an inspector under this clause, he shall forthwith report the fact of such seizure to a magistrate where upon the provisions of sections 457 and 458 of the code of criminal procedure 1973 (2 of 1974) shall, so far as may be applied to the custody and disposal of such seeds.
4. Every person, if so required by an inspector, shall be bound to offer all **necessary facilities** to him for the purpose of enabling him to exercise power under this clause.

#### **14. Time limit for analysis.**

The analysis report has to be sent to the inspector within 60 days from the date of receipt by the laboratory.

#### **15. Dispensation/cancellation of license.**

The licensing authority may suspend or cancel the license on the following grounds:

- A. If the license had been obtained by misinterpretation as to the material particulars, or,
- B. If any of the provisions of this order or any conditions of license has been contravened.



## 16. Appeal.

Any person aggrieved by an order:-

- A. Refusing to grant, amend or renew the license for sale, export and import of seeds;
- B. Suspending or cancelling any license may within sixty days from the date of order, appeal to the authority as the state government may specify in this behalf and the decision of such authority shall be final; provided that an application for appeal shall accompany an appeal fee **of rupees fifty.**

Miscellaneous.

**17. Amendment of license.**

The licensing authority may on receipt of a request in writing together with a fee of ten rupees from a dealer amend the license of such dealer.

**18. Maintenance of records and submission of returns etc.,**

Every dealer should maintain book accounts and records relating to his business as may be directed by state government.

Every dealer shall submit monthly returns relating to his business for the preceding month in the **form D** to the licensing authority by the 5<sup>th</sup> day of every month.

- ▶ **Form A** = form for application to obtain dealer's license.
- ▶ **Form B** = license to carry on the business of a dealer in seeds.
- ▶ **Form C** = application for renewal of license to carry on the business of a dealer in seeds.
- ▶ **Form D** = form to submit monthly returns of dealer's business in seeds.



**FORM 'A'**

(See clause 4)

**FORM OF APPLICATION TO OBTAIN DEALER'S LICENCE**

To

The Registering Authority,  
\_\_\_\_\_ (Place)  
State of/ U.T. of \_\_\_\_\_

1. Full name and address of the applicant:
  - (a) Name and postal address:
  - (b) Place of business (please give exact address):
    - (i) for sale
    - (ii) for storage
2. Is it a proprietary/partnership/Limited Company/Hindu undivided family concern? Give the Name(s) and address(es) of proprietor/partner/Manager/Karta.
3. In what capacity this application is made:
  - (i) Proprietor
  - (ii) Partner
  - (iii) Manager
  - (iv) Karta
4. Was the applicant ever convicted under the Essential Commodities Act, 1955 (10 of 1955), or any order issued thereunder during the last three years preceding the date of application? If so, give details
5. Give the details of seeds to be handled.  
S.No.                      Name of Seed
6. I/we have deposited the licence fee of rupees fifty vide challan No. \_\_\_\_\_ dated \_\_\_\_\_ in treasury/bank \_\_\_\_\_
7. Declaration:
  - (a) I/we declare that the information given above is true to the best of my/our knowledge and belief and no part thereof is false.
  - (b) I/we have carefully read the terms and conditions of the licence given in Form 'B' appended to the Seeds (Control) Order, 1983, and agree to abide by them.

Signature of Applicant

Date: \_\_\_\_\_

Place: \_\_\_\_\_

Note: (1) Where the business of selling/exporting/importing seeds is intended to be carried on at more than one place, a separate licence should be obtained for each such place.

For use in the office of Licensing Authority

Date of receipt \_\_\_\_\_

Name and designation of officer receiving the application



FORM 'B'  
(See clause 5)

**LICENCE TO CARRY ON THE BUSINESS OF A DEALER IN SEEDS**

Licence No. \_\_\_\_\_

Date: \_\_\_\_\_

Subject to the provisions of the Seeds (Control) Order, 1983 and to the terms and conditions of this Licence Shri/M/s \_\_\_\_\_ is hereby granted licence to sell, export, import and store for the said purposes of seeds.

2. The licensee shall carry on the aforesaid business at \_\_\_\_\_  
(Place for storage and place for sale) \_\_\_\_\_ (Tehsil or District)

Date: \_\_\_\_\_

Seal:

Licensing Authority

State of \_\_\_\_\_

**Terms and conditions of licence**

- (i) The licence shall be displayed at a prominent and conspicuous place in a part of the business premises open to the public.
- (ii) The holder of the licence shall comply with the provisions of the Seeds (Control) Order, 1983 and the notifications issued thereunder and for the time being in force.
- (iii) This licence comes into force with immediate effect and shall be valid upto \_\_\_\_\_ unless previously cancelled or suspended.
- (iv) The holder of the licence shall from time to time report to the licensing authority any change in the premises where he carries on his business of sale, export, import or storage for the said purposes of seeds.
- (v) The licensee shall give every facility to the licensing authority or any other officer acting under his Authority for the purpose of inspecting his stock in any shop, depot or godown or other place/places used by him for the purpose of storage, sale or export of seeds.





**FORM 'C'**  
(See clause 7)

**APPLICATION FOR RENEWAL OF LICENCE TO CARRY ON THE BUSINESS OF A  
DEALER IN SEEDS**

To

The Licensing Authority  
\_\_\_\_\_ (Place)  
State of/U.T. of \_\_\_\_\_

I/We hereby apply for renewal of the Licence to carry on the business of dealer in  
seeds under the name and style of Shri/M/s. \_\_\_\_\_  
The licence, desired to be  
renewed, was granted by the Licensing Authority for the State of  
\_\_\_\_\_ and allotted Licence No. \_\_\_\_\_ on the  
\_\_\_\_\_ day of \_\_\_\_\_ 19\_\_\_\_

Signature of applicant(s)

Full name and address of the applicant(s) \_\_\_\_\_

Date and Place: \_\_\_\_\_

Certified that the Licence bearing No. \_\_\_\_\_ granted on  
\_\_\_\_\_ to carry on the business of a dealer in seeds at the premises situated  
\_\_\_\_\_ is hereby renewed upto \_\_\_\_\_  
unless previously cancelled or suspended under the provisions of the Seeds (Control) Order,  
1983.

Date: \_\_\_\_\_

Licensing Authority

Renewal No. \_\_\_\_\_

State of \_\_\_\_\_

Seal:



**FORM 'D'**  
(See clause 18)

1. Month and year:
2. Name and designation of Licensee:

(Quantity in Quintals)

Crop/ Variety	Class of seed	Opening stock on the first day of the month	Quantity purchased during the month	Total quantity imported	Total	Total quantity sold	Total quantity exported	Closing stock on the last day of the month
1	2	3	4	5	6	7	8	9

(3+4+5)

6-(7+8)

Signature of dealer

Name: \_\_\_\_\_  
Address: \_\_\_\_\_  
\_\_\_\_\_

# SCHEDULE I

## (See clause 13) Sealing, Fastening, Despatch and Analysis of Samples


### I. Manner of taking Samples

- ▶ Samples of any seed for the purpose of analysis shall be taken in a clean dry container which shall be closed sufficiently tight to prevent leakage and entrance of moisture and shall be carefully sealed.

## ii) Sampling Intensity

- ▶ Bulk Sampling – When sampling seed lots are stored in bulk (heaps, bins, wagons, etc.), the following sampling intensity should be regarded as a minimum requirement for obtaining the “bulk sample”.
  - upto 500 kilograms – at least 5 individual samples except in case of small lots upto 50 kilograms where a smaller number of samples is sufficient, not less than, 3 samples need be taken.

## Cont.....

- 501 to 3,000 kilograms – one individual sample for each 300 kilograms, but not less than 5 individual samples.
  - 3,001 to 20,000 kilograms – one individual sample for each 500 kilograms but not less than 10 individual samples.
  - ▶ For seed in bulk the individual samples should be distributed at random all over the bulk and the samples drawn from varying depths.
- 

## Cont...

- ▶ Bag sampling – For seed lots in bags or other containers the following sampling intensity should be regarded as a minimum requirement:
  - upto 5 containers – sample each container but always take at least 5 individual samples.
  - from 6 to 30 containers – sample at least one in every three containers but never less than 5.
  - 31 containers or more – sample at least one in every five containers but never less than 10.



### III) Containers to be labelled and addressed

- ▶ All containers containing samples for analysis shall be properly labelled and the parcels shall be properly addressed. The label on any sample of seed sent for analysis shall bear
  - ❖ serial number
  - ❖ name of the sender with official designation, if any;
  - ❖ name of the person from whom the sample has been taken;
  - ❖ date and place of taking the sample;
  - ❖ kind or variety of the seed for analysis;
  - ❖ nature and quantity of preservative, if any, added to the sample.


## IV) Manner of Packing, Fastening and Sealing the Samples

All samples of seeds sent for analysis shall be packed, fastened and sealed in the following manner:

- ▶ The stopper shall first be securely fastened so as to prevent leakage of the containers in transit.
- ▶ The container shall then be completely wrapped in fairly strong thick paper. The ends of the paper shall be neatly folded in and affixed by means of gum or other adhesive.

## Cont....

- ▶ The paper cover shall be further secured by means of strong twine or thread both above and across the container, and the twine or thread shall then be fastened on the paper cover by means of sealing wax on which there shall be at least four distinct and clear impressions of the seal of the sender, of which, one shall be at the top of the packet, one at the bottom and the other two on the body of the packet. The knots of the twine or thread shall be covered by means of sealing wax bearing the impression of the seal of the sender.



Thank You



# **Protection of Plant Varieties and Farmers' Rights Act (PPVFRA)**

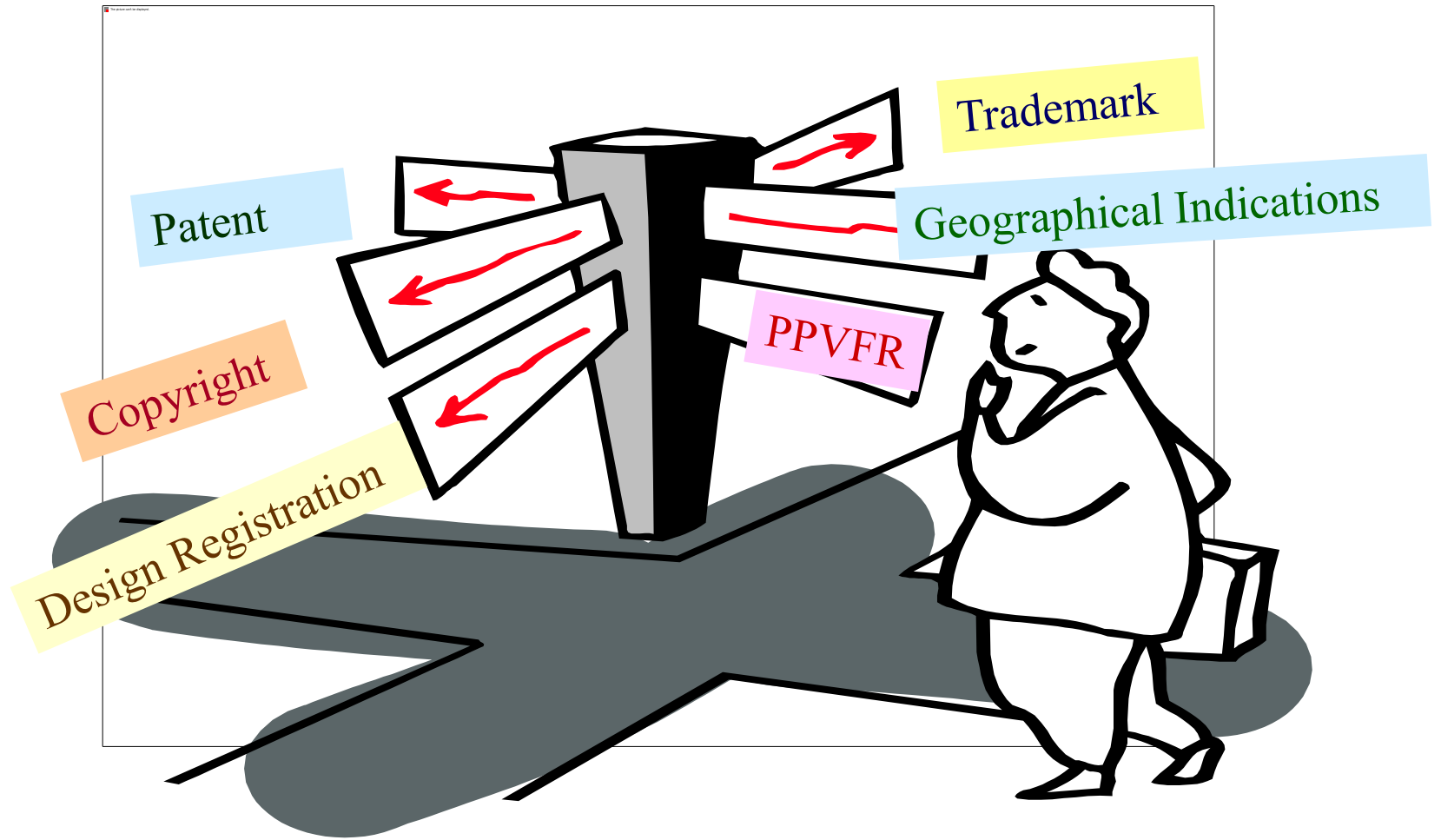


# Intellectual Property

- Intellectual property (IP) refers to creations of the mind: inventions, literary and artistic works, and symbols, names, images, and designs used in commerce.
- **Any new idea, invention, or scholarly work,**
- **if expressed in tangible form, can be protected legally**



**I have an innovation .... How do I protect it in the market ???**



# National Support System for Safeguarding IPs

**Copy Right ACT 1957 : Amended in 2000**

**Patent Act 1970 amended in 2004-05**

**Trademark Act 1999**

**GI Act 1999**

**Design Act 2000**

**PPV&FR Act 2001**

**Biological Diversity Act 2002**

They provide protection from unfair trade practices

# PLANT VARIETY PROTECTION AND THE PURPOSE

- Plant variety protection provides legal protection of a plant variety to a breeder in the form of Plant breeder's rights.
- Plant Breeder's Rights are intellectual property rights that provide exclusive rights to a breeder of the registered variety.

# THE PLANT VARIETY PROTECTION AND FARMERS RIGHTS ACT 2001

- a sui generis system, is an attempt by the Indian Government to recognize and protect the rights of both commercial plant breeders and farmers in respect of their contribution made in conserving, improving and making available plant genetic resources for development of new plant varieties and to encourage the development of new plants varieties.
- Protection of the plant varieties under the Act accelerates agricultural development and stimulates investment for research and development for the development of new plant varieties which in turn facilitates the growth of the seed industry and ensures the availability of high quality seeds and plant in material to the farmers.

# Significance of IPR

## IPR Gives the inventors/authors

- ***Exclusive right and monopoly*** over the invention/ technology developed
- ***Right to exclude*** others from exploiting the same for ***commercial benefits***

## The purpose of Safeguarding IPR

- Make money out of new ideas. It gives the inventor ***monopoly*** on its commercial use
- Better return on investment on R&D

# India and the TRIPs



- India a country of long standing membership and signatory to the WTO related agreements being outcome of protracted negotiations and is to comply with the **Trade Related Intellectual Property Rights (TRIPs)**.
- Protection of Plant Varieties under the *Sui generis* **System** meets India's needs and fulfils the obligations.

**The Presidential ordinance, 1995  
and the PPV&FRA, 2001,  
are meant to meet some of the essentials.**

# *What Should Be Protected ?*

**Article 27(3)(b) of TRIPS *excludes***

**“..... Plants and animals other than micro-organisms, and essentially biological processes for the production of plants or animals other than non-biological and micro-biological processes and plant varieties ....”**

**• TRIPS says that:**

- **New plant varieties have to be protected by an effective “sui-generis” system or by patents or a combination thereof.**
- **Plant varieties produced by traditional methods of breeding and screening techniques of mutation, cross-fertilisation, recombinant techniques will become subject matter of Protection of sui-generis system**



# DEVELOPMENT OF VARIOUS INTELLECTUAL AND OTHER RIGHTS RELATED TO AGRICULTURE.

Forum	Framework	Approaches
FAO 1983	Common Heritage of Mankind	Genetic resources are to be freely used and shared
UPOV 1991	Breeders' Rights	Everything and anything can be owned if it meets certain criterion
CBD 1992	Sovereign Rights of Nation	Genetic resources are no longer viewed as a free resource
<b>TRIPS 1995</b>	<i>Sui Generis System</i>	<b>Constituting a class of its own kind</b>
PPV&FRA 2001 (India)	Breeders Rights and Farmers' Rights	Access and benefit sharing

# What is Variety?

The BDA, 2002 defines:

- ▣ “Cultivar” means a variety of plant that has originated and persisted under cultivation or was specially bred for the purpose of cultivation.
- ▣ “Folk Variety” means a cultivated variety of plant that was developed, grown and exchanged informally among farmers.
- ▣ “Land race” means primitive cultivar that was grown by ancient farmers and their successors.

# Meaning of 'VARIETY'

As per the PPV&FR Act sec. 2(za) “variety” means a plant grouping **except microorganism** within a single botanical taxon of the lowest known rank, which can be -

- i. **defined** by the expression of the characteristics resulting from a given genotype of that plant grouping;
- ii. **distinguished** from any other plant grouping by expression of at least one of the said characteristics; and
- iii. **considered** as a unit with regard to its suitability for being propagated, which remains unchanged after such propagation, **and includes propagating material of such variety, extant variety, transgenic variety, farmers' variety and essentially derived variety.**



**The PPV&FRA 2001, covers all plants including spices, trees and variety of plants.**



# The PPV&FR Act, 2001 (53 of 2001)

THE GAZETTE OF INDIA EXTRAORDINARY

1

REGISTERED NO. DL-33004/2001

*The Gazette of India*

EXTRAORDINARY  
PART II – Section 1

PUBLISHED BY AUTHORITY

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No. 64] New Delhi, TUESDAY, OCTOBER 30, 2001/KARTIKA 8, 1923

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Separate paging is given to this Part in order that it may be filed as a separate compilation

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MINISTRY OF LAW, JUSTICE AND COMPANY AFFAIRS  
(Legislative Department)

*New Delhi, the 30<sup>th</sup> October, 2001/Kartika 8, 1923 (Saka)*

The following Act of Parliament received the assent of the President on the 30<sup>th</sup> October, 2001, and is hereby published for general information :-

THE PROTECTION OF PLANT VARIETIES AND FARMERS'  
RIGHTS ACT, 2001

No. 53 OF 2001

[30<sup>th</sup> October, 2001]

**Act – 2001**

**11 Chapters**

**97 clauses**

**Rules – 2003**

**Regulations**

**– 2006**

**Notifications**

**– from time to time**

**Case Laws**

**– as and when these will  
appear**

**Official Publication: Plant Variety Journal of India 2007**  
**Official Website: <http://plantaauthority.gov.in/>**



# Web Page of PPV&FR Authority

Visit: <<http://www.plantauthority.gov.in>> Or Contact: [plantauthority@gmail.com](mailto:plantauthority@gmail.com)

← → ↻ www.plantauthority.gov.in

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सत्यमेव जयते



PROTECTION OF PLANT VARIETIES & FARMERS' RIGHTS AUTHORITY, INDIA



[Authority](#) [DUS](#) [Center](#) [Publications](#) [Tenders](#) [Vacancy](#) [Application](#) [FAQ's](#) [Draft-Guidelines](#) [\(New Crops\)](#) [RTI](#)

## PPV&FR Authority

In order to provide for the establishment of an effective system for protection of plant varieties, the rights of farmers and plant breeders and to encourage the development of new varieties of plants it has been considered necessary to recognize and protect the rights of the farmers.

[Location Map](#)  
[Google Location Map](#)  
[Read More »](#)

## Members of Authority

[Members of the PPV & FR AUTHORITY](#)  
[Present Members of the AUTHORITY](#)

## NEWS / Forth Coming Activities

National Workshop on Outsourcing Farm Innovation held on  
Date: 4 September 2013 at AP Shinde Symposium Hall, NASC Complex, New Delhi.  
[Click to View Details](#) NEW

## Application Details Announcements

- [Status of the Total Applications recieved Crop Wise upto dated: 25.11.13](#)
- [Status of the Total Applications recieved upto dated: 25.11.2013](#)
- [List of Registered Varieties Certificate issued upto dated: 28.11.2013](#) NEW
- [Details of Registration fees, DUS Test Fees and Annual fees](#) NEW

 e-filing of Application

- [Terms & Conditions for Online Payment](#)

- [Tender related to hiring of vehicles. Last date: 30th December, 2013](#) NEW
- [Disclosure of All Official Tours details\[Under Sec. 4 of the RTI Act 2005\] from 01st July 2013 to 30th Sept. 2013.](#) NEW
- [Disclosure of All Official Tours details\[Under Sec. 4 of the RTI Act 2005\] from 01st April 2013 to 30th June 2013.](#) NEW
- [Inviting Comments on Proposed Amendment In Second Schedule of PPV&FR Rules, 2003.](#) NEW
- [RTI Manual/Disclosure \[Under Sec. 4 of RTI Act 2005\]](#)
- [The judgement on issue of Parental Lines.](#)

## DUS Test Guidelines

 DUS CENTERS more »

## Registration open for 57 Crops

## Citizen's Charter

## Important Orders/Decisions



भारत राजपत्र  
The Gazette of India

## Annual Reports

## Minutes of The Authority Meeting

**Newsletter**

# Milestones in Indian Seed Sector

- 1957 - First All India Coordinated Research Project
- 1963 - National Seed Corporation (NSC) established
- 1965 - Import of 250 tons dwarf wheat seed from CIMMYT
- 1966 - Seed Act passed
- 1968 - Seed Act became operational
- 1969 - State Farms Corporation of India (SFCI) created
- 1971 - Indian Minimum Seed Certification Standards adopted
- 1979-80 - All India Coordinated 'National Seed Project' launched
- 1988 - New Policy on Seed Development (NPSD) implemented
- 1993 - ICAR gave First Draft on PPVFR Bill
- 1994 - Marrakesh Agreement signed; WTO emerged on 1.1.1995
- 2001 - PPVFR Act 2001 passed
- 2007 - Beginning of receipt of Applications under PPVFR Act



# PPVFRA



- **Introduction**

- The Indian Parliament, in November 2001, passed The Protection of Plant Varieties and Farmers' Rights Act (PPVFRA). It is a sui generis law that gives due consideration to farmers rights vis-à-vis plant variety protection.
- In the context of intellectual property rights (IPR) it means a right which is derived from itself, or which is not a part of the patent system.
- The Act introduces interesting approaches to farmers' rights and has adapted some provisions of UPOV to the Indian context.
- The Act proposes to establish an Authority to be known as the Protection of Plant Varieties and Farmers' Rights Authority. It shall, among other things, maintain at its head office a National Register of Plant Varieties.

# REGISTERABLE PLANT VARIETIES IN INDIA

- **New Varieties:** A Variety which is not in public domain in India earlier than one year before the date of filing or outside India, in the case of trees or vines earlier than six years or in any other case earlier than four years.
- **Extant Variety:** A Variety which is notified under Seed Act, 1966 or a variety about which there is common knowledge or a farmer's variety or any other variety which is in public domain is considered as an Extant Variety.

contd...

- **Farmer's Variety:** A Variety which has been traditionally cultivated and evolved by the farmers in their fields or a variety which is a wild relative or land race of a variety about which farmers possess common knowledge.
  - *Examples: Bikaneri Lerma Cotton of Punjab, East Coast Tall Coconut of TN & AP, Nendran Banana of Kerala, Desari Mango of UP, Ganesh Pomegranate of Maharashtra, Ambri Apple of Jammu & Kashmir etc.*
- **Essentially Derived Variety (EDV):**
  - i) Predominantly derived from such initial variety, or from a variety that itself is predominantly derived from such initial variety, while retaining the expression of the essential characteristics that result from the genotype or combination of genotypes of such initial variety.
  - ii) Is clearly distinguishable from such initial variety; and
  - iii) Conforms to such initial variety in the expression of the essential characteristics

# NON-REGISTERABLE PLANT VARIETIES IN INDIA

- All plant varieties cannot get legal protection in India. Certain Plant varieties are excluded from the protection under PPVFR Act 2001.
- Any variety where prevention of commercial exploitation of such variety is necessary to protect public order or public morality or human, animal and plant life and health or to avoid serious prejudice to the environment or any varieties which has terminator technology or any variety belonging to the species or genera which is not listed in the notification issued by the Central Government cannot be registered for the protection under the Act.

# CRITERIA FOR PROTECTING A PLANT VARIETY

The plant variety must be:

**Distinct:** A variety should be clearly distinguishable by at least one essential characteristic from existing or commonly known varieties in any country at the time of filing of the application.

**Uniform:** A Variety must be sufficiently uniform in its essential characteristics.

**Stable:** Essential characteristics of a variety must be stable after repeated propagation or in the case of a particular cycle of propagation at the end of each cycle.

# WHO CAN APPLY FOR THE REGISTRATION OF A PLANT VARIETY?

*Any of the following, claiming to be the breeder of the variety, may make application for PVP to Registrar:-*

**any person (natural person – breeder)**

**successor of the breeder**

**assignee**

**any farmer or group of farmers or community of farmers**

**any authorized person by any of the above person(s)**

**any university or publicly funded agricultural institution**

# WHERE TO FILE THE APPLICATION FOR THE REGISTRATION OF A PLANT VARIETY?

- For the purposes of Protection of Plant Varieties and Framers Right Act, 2001 Protection of Plant Varieties and Farmers Right Authority was established in October 2005 and its **Head Quarters** is located at **NASC Complex, DPS Marg, Opp-Todapur, New Delhi – 110 012.**
- Any information regarding protection, application, fee structure etc can be obtained from the office or at **<http://www.Plantauthority.gov.in/>**



# Making PVP Application

- **Application Form** (Form I for New or Extant Variety or Form II for EDV -- From Regulations)
- **Technical Questionnaire** (in prescribed Format -- from Regulations)
- **Authorization** (Form PV-1 -- From Rules)
- **Proof of right to make application** (Form PV-2 -- From Rules)
- **Other prescribed particulars/ Fees/ Seed Sample/ etc.**

# **DEPOSITION OF SEED OR PROPAGATING MATERIAL BEFORE REGISTRATION**

- Deposition of seeds is necessary for DUS test conducted by PPV & FR authority. The applicant needs to deposit the fixed amount of seed or propagating material with prescribed germination percentage and physical purity along with the seed quality test report to the authority.

# Registration and Term of Protection

- The period of validity of certificate of registration is **nine years** in case of **trees and vines**; and **six years** in case of **other crops**.
- This validity period can **be reviewed and renewed** on payment of the prescribed fees subject to a **maximum period of validity**, which is
  - in case of **tree and vines, eighteen years** from the date of registration of the variety;
  - in the case of **extant varieties, fifteen years** from the date of notification of that variety by the Central Government under Section 5 of the Seeds Act, 1966; and
  - in **other** cases, **fifteen years** from the date of registration of the variety



# Fee for Application Registration

- The fee for registration has been notified by the Central Government in official gazette of India.
- The fees notified for different category of varieties is as under in the box:

<i>Type of variety</i>	<i>Fees for Registration</i>
Essentially Derived Varieties	Individual Rs. 5000/- Educational Rs. 7000/- Commercial Rs. 10000/-
Extant variety notified under section 5 of Seeds Act, 1966	Rs. 1000/-
New Variety	Individual Rs. 5000/- Educational Rs. 7000/- Commercial Rs. 10000/-
Extant variety about which there is common knowledge	Individual Rs. 2000/- Educational Rs. 3000/- Commercial Rs. 5000/-
Farmers' Variety	No fee

# DUS Test Fee

- The applicant has to submit the DUS test fee for conduct of the DUS test of the candidate variety.
- The DUS test fee has been decided by the Authority for different crops and notified in the PVJI.
- The DUS test fee notified for different crops is as under:

<i>Crop species</i>	<i>DUS test fees</i>
Wheat , rice, maize, sorghum, pearl millet, pigeon pea, chickpea, lentil, mungbean, urd bean, field pea, kidney bean	Rs. 20,000/-
Cotton, jute, sugarcane	Rs. 35,000/-
Oilseed crop species	Rs. 20,000/-
Black pepper, small cardamom, ginger, turmeric	Rs. 45,000/-
Tomato, brinjal, okra, cabbage, cauliflower, onion, garlic	Rs. 40,000/-
Potato	Rs. 48,000/-
Rose, chrysanthemum	Rs. 45,000/-
Mango	Rs. 30,000/-

# Annual Fee

- For maintenance of registration the applicant has to pay annual fee which is specified as under:

<i>Type of variety</i>	<i>Annual Fee</i>
New Variety	Rs. 2000/- plus 0.2 per cent of the sales value of the seeds of the registered variety during the previous year plus 1 percent of royalty, if any, received during the previous year from the sale proceed of seeds of a registered variety.
Extant variety notified under Section 5 of the Seeds Act, 1966 (54 of 1966)	Rs. 2000/- only.
Extant variety other than the category specified above	Rs. 2000/- plus 0.1 per cent of the sales value of the seeds of the registered variety during the previous year plus 0.5 percent of royalty, if any, received during the previous year from the sale proceed of seeds of a registered variety.
Annual fee shall be determined on the basis of declaration given by the registered breeder or agent or licensee regarding the sales value of the seeds of the variety registered under the Act during the previous year and royalty, if any, received during the previous year from the sale proceed of seeds of the registered variety and verified by the Authority.	



# Three Streams That Merge To PPV&FRA, 2001

**Researchers'  
right**

**Breeders'  
right**



**Farmers'  
right**



# Plant Breeders' Rights



- **Produce or reproduce the material.**
- **Offer the material for sale**
- **Market the material**
- **Distribute the material**
- **Import the material**
- **Export the material**
- **Stock the material**
- **Transfer the rights**

# RESEARCHERS' RIGHTS



- Can use any of the variety registered under this Act by any person using such variety for conducting experiment or research.
- The use of a variety by any person as an initial source variety for the purpose of creating other varieties.
- Authorization of the breeder of a registered variety is required where repeated use of such variety as parental line is done for commercial production of other new developed variety.

# FARMERS' RIGHTS

- **Right to register farmer's varieties**
- **Benefit sharing for use of biodiversity conserved by farming community**
- **Right to save, use, sow, re-sow, exchange, share or sell farm produce including seed of registered variety**
- **Right to claim compensation for under-performance from the promised level**
- **Requirement to seek consent of farmer(s) when farmer variety is used to develop an EDV**
- **Protection from legal proceedings of an alleged infringement**
- **Exclusion from paying fee in any legal proceedings in Tribunal and Higher Courts**

# List of Crops specified now under PPV&FR: 57

1. Rice
2. Bread wheat
3. Maize
4. Sorghum
5. Pearl Millet
6. Chickpea
7. Mungbean
8. Urdbean
9. Fieldpea
10. Kidney bean
11. Lentil
12. Pigeon pea
13. Indian mustard
14. Karan rai
15. Rapeseed
16. Gobhi sarson
17. Groundnut
18. Soyabean
19. Sunflower
20. Safflower
21. Castor
22. Sesame
23. Linseed
24. Diploid Cotton
25. Diploid Cotton
26. Tetraploid Cotton
27. Tetraploid Cotton
28. Jute
29. Jute
30. Sugarcane
31. Black pepper
32. Small cardamom
33. Turmeric
34. Ginger
35. Tomato
36. Brinjal
37. Okra
38. Cauliflower
39. Cabbage
40. Potato
41. Onion
42. Garlic
43. Rose
44. Crysanthemum
45. Mango
46. Durum wheat
47. Dicoccum wheat
48. Other Triticum species
49. Isabgol
50. Menthol Mint
51. Damask Rose
52. Periwinkle
53. Brahmi
54. Coconut
55. Bamboo Leaf Orchid or Boat Orchid
56. Spray Orchid or Singapore Orchid
57. Vanda or Blue Orchid

# Crop Wise Applications

Status Crop wise (2007-20.11.2013)

Crop	Public	Private	Farmer
Black gram	24	2	6
Black Pepper	4	0	1
Brinjal	17	207	5
Cabbage	1	8	0
Castor	6	9	1
Cauliflower	3	31	0
Chickpea	56	0	6
Chrysanthemum	4	0	0
Coconut	0	0	4
Diploid Cotton	37	22	4
Dicoccum Wheat	1	0	0
Durum Wheat	1	0	0
Field pea	35	1	2
Garlic	0	0	2
Ginger	3	0	3
Green gram	42	3	4
Groundnut	30	1	3
Indian Mustard (Sarso)	46	20	3

Jute	27	0	1
Indian Mustard (Karan Rai)	2	0	1
Kidney bean	11	1	13
Lentil	14	0	2
Linseed	5	0	1
Maize	110	231	12
Mango	0	0	4
Okra	0	62	3
Onion	1	9	1
Orchid	0	0	3
Pearl Millet	59	156	1
Pigeon pea	32	21	16
Potato	18	12	3

Rapeseed (Torja)	6	0	2
Rapeseed (Gobhi Sarso)	4	1	0
Rice	202	210	1607
Rose	0	3	0
Safflower	8	0	1
Sesame	6	0	5
Small Cardamom	3	0	1
Sorghum	105	85	20
Soybean	9	10	0
Sugarcane	54	0	1
Sunflower	9	88	0
Tetraploid cotton	66	842	0
Tomato	12	166	4
Turmeric	6	0	3
Wheat	123	14	13
Total	1202	2215	1762



# Status

- Total PPV&FR Applications since 2007:
  - Public: 1202
  - Private: 2215
  - Farmer: 1762

- Indian Parliament passed the protection of PPVFRA in November 2001.
- It is sui generis law providing due consideration to farmers' rights vis-à-vis plant variety protection.
- The variety is defined by the expression of the characteristics resulting from a genotype of that plant grouping. It should be distinguished from any other plant grouping by expression of at least one of the said characteristics.
- Farmers' variety is one which is traditionally cultivated and evolved in fields by the farmers.
- The criterion for a variety to be registered under the Act is that it should be novel, distinct, uniform and stable.

- Period of validity of certificate of registration is 9 years (extendable up to 18 years) in case of trees and vines, and 6 years (extendable up to 15 years) in case of other crops.
- The registration affords rights to farmers' breeders, researchers & communities.
- The infringement can occur if a variety is sold, exported, imported or produced without the permission of the breeder of the registered variety; or his agent, or deceptive denomination is applied to the goods.
- The penalty for infringement can be an injunction and damages or share of profit at the option of the plaintiff.

# **Varietal Identification through Grow Out Test, Chemical Test and Bio Chemical Test**

*By*

**Dr. Aninda Chakraborty**  
**Dept. of Seed Science and Technology**

# Genetic purity

## Meaning :

- True to type or genuine
- A count is made of the number of seeds, seedlings or plants that are true to this type
- It decides the maximum potential that can be accessed from the variety and also proves the effectiveness of modern agronomic practices
- Plants in a population of a variety are true to the type for which it has been claimed

## Varietal Purity Testing

- To ensure the varietal performance over the generations through maintaining varietal purity during seed multiplication and subsequent handling
- To ensure that the farmers gets the seeds of a variety for which he pays
- Presence of transgene in case of GM crop seeds

Minimum standards for genetic purity for different class of seeds.

SL. No.	CLASS OF SEEDS	PURITY %
1	Breeder Seeds	100%
2	Foundation seeds	99%
3	Certified seeds	98%
4	Hybrids	95%

**Factors affecting genetic purity.**

1. Natural crossing
2. Mechanical admixtures
3. Random drift
4. Mutation
5. Selective influence of pest and diseases.

(Basra, 2002)

# Different methods of genetic purity determination

- ▶ Morphological
- ▶ Chemical
- ▶ Biochemical
- ▶ Molecular



# Different Morphological Methods

- ▶ Seed morphology
- ▶ Examination of seedlings
- ▶ Examination in green houses
- ▶ Grow out test

# Seed morphology testing

- ▶ Characters like size and shape of grain, base of lemma, vertical crease hairs, rachilla hairs, deviation of lateral dorsal nerves wrinkling of lemma and palea etc.
- ▶ The colour characteristics examined under full day light or light of limited spectrum e.g. ultraviolet light.
- ▶ Scanning electron microscope for studying differences in seed coat surface and its inner structure have also been used in some species.



**White**  
**IC201087**



**Creamish white**  
**IC198323**



**Mottled**  
**IC198326**



**Grey**  
**IC5969**



**Creamish brown**  
**IC202868**



**Light brown**  
**IC198361**



**Brown**  
**C-152**



**Dark brown**  
**IC253270**

# Seed shape



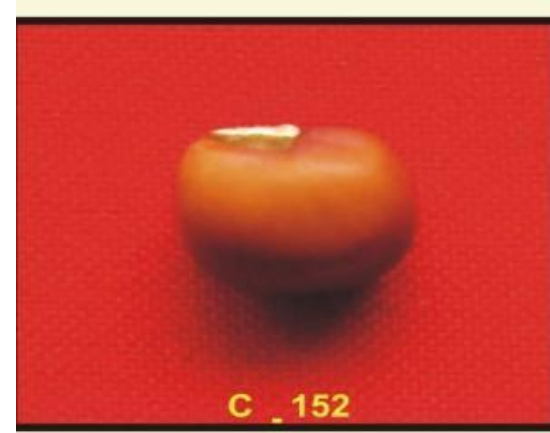
IC253275

Kidney



IC219599

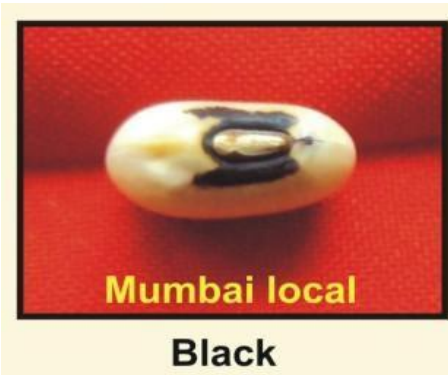
Ovoid



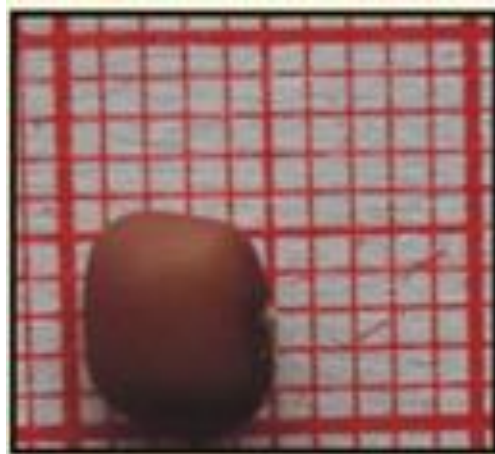
C\_152

Rhomboid

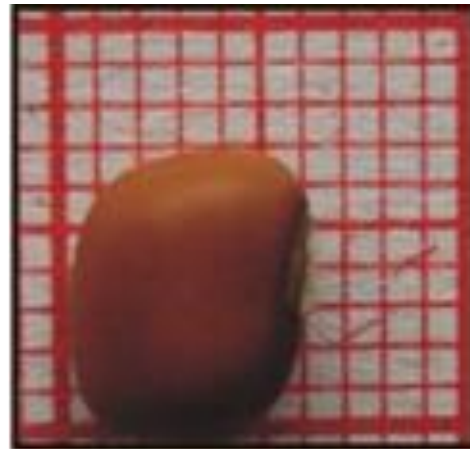
# Hilum colour



# Seed size



**Small**  
IC4506



**Medium**  
IC202867



**Bold**  
IC212872



# Traditional approach to purity testing

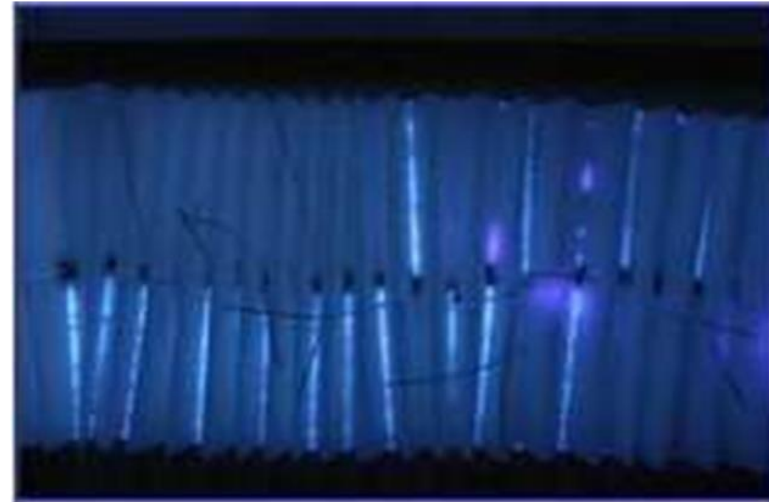
## Morphological traits



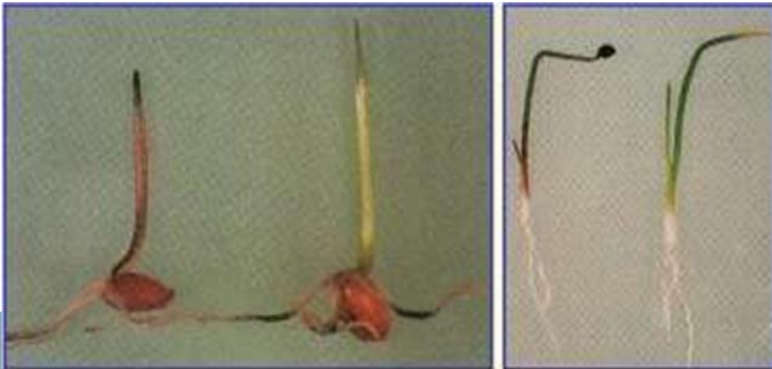
### ON SEED



### ON SEEDLING



### IN LAB OR GREEN HOUSE

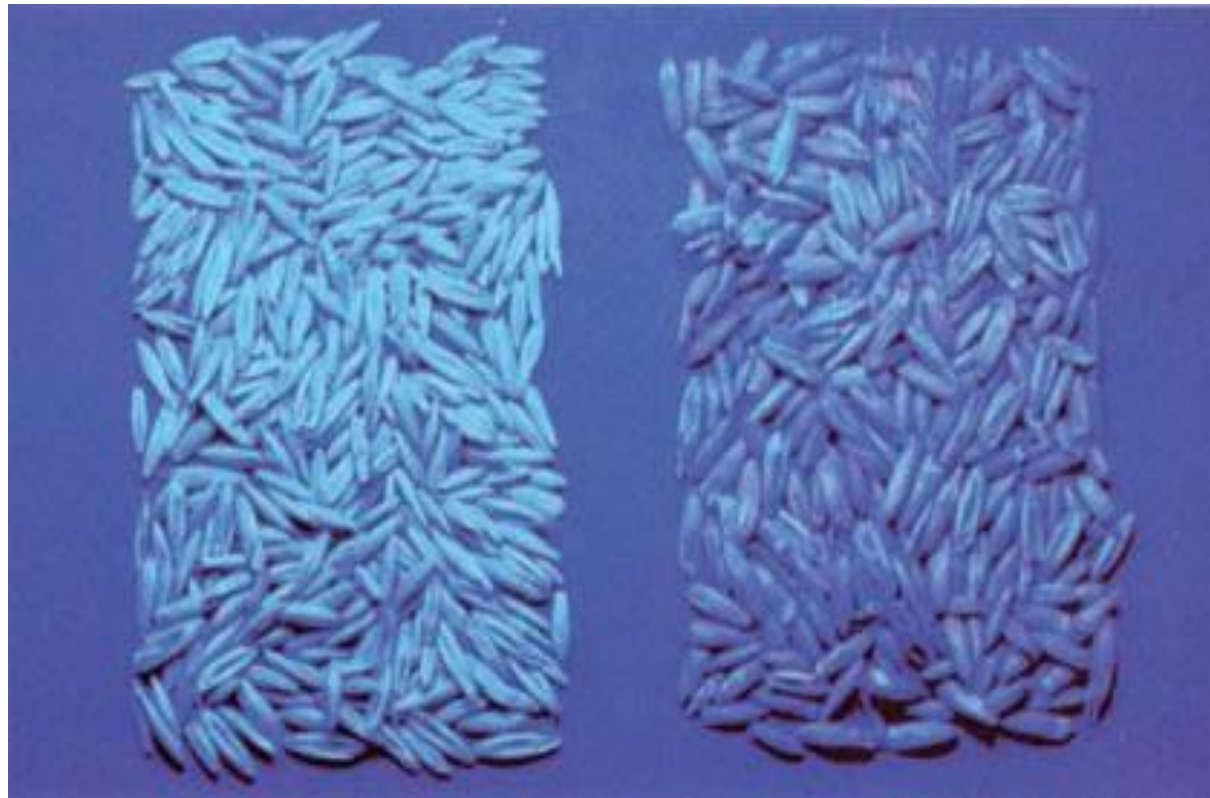


### IN FIELD





# Flourescence (oat)



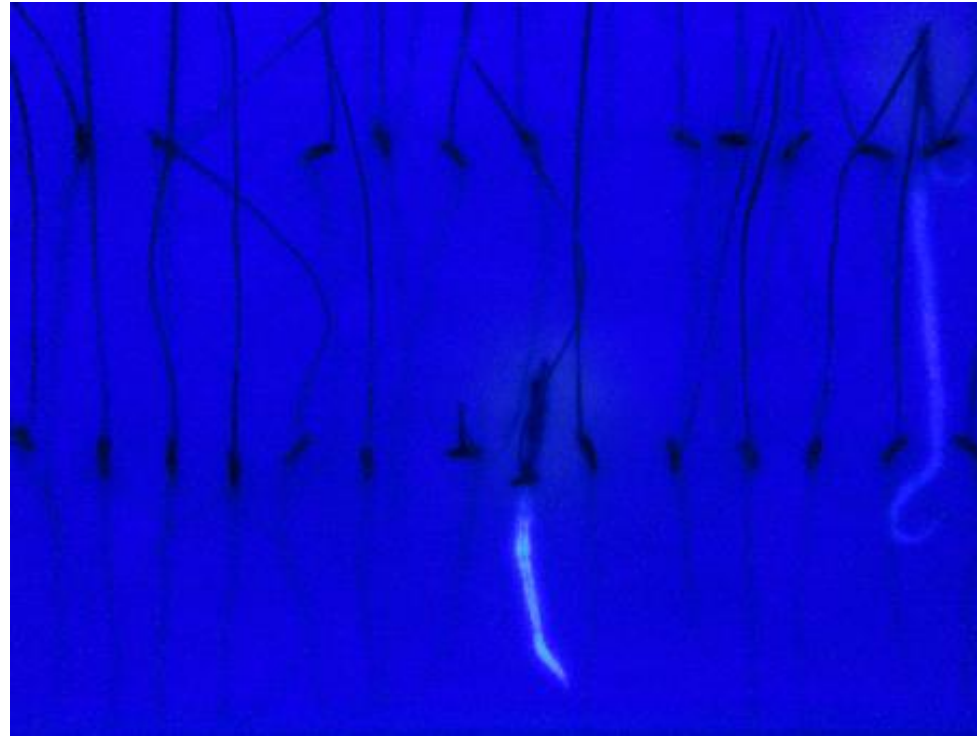
# Fluorescence Test (*Lolium*, *Festuca*)

*Lolium* spp    *L. multiflorum*

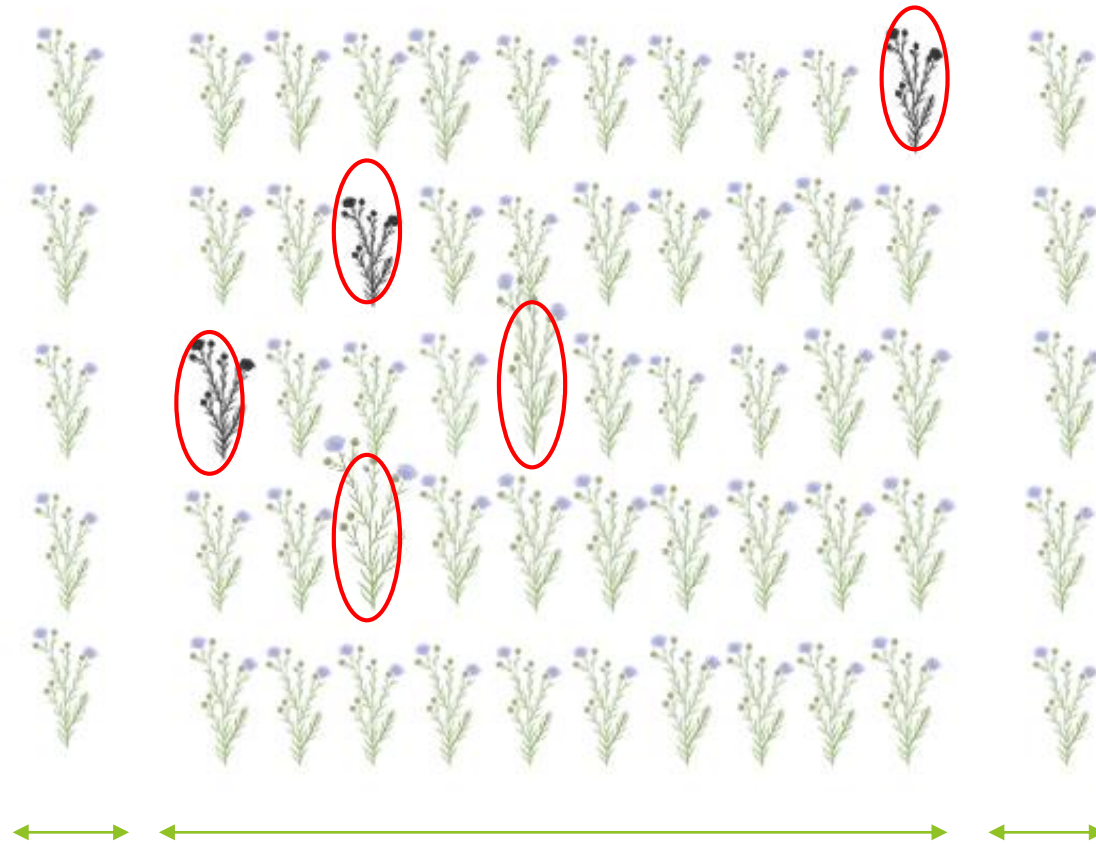
*L. perenne*

*Festuca* spp   *F. rubra*

*F. ovina*



## Grow out test



## Characters

- Highly heritability
  - Stable expression over a range of environments.
  - Easily differentiated by visual observation.
- 
- Sufficient spacing between rows and plants.
  - Various samples of the same cultivar sown in succession and standard samples are sown at suitable interval
  - **Deviation** from control sample counted
  - **Mutual comparison between the samples** to be tested and the standard.
  - **Observations at full growing period.**

# Sample size(lab and field)

1,000 g -	for maize, cotton, groundnut, soyabean and species of other genera with seeds of similar size;
500 g -	For sorghum, wheat, paddy and species of other genera with seeds of similar size;
250 g -	Beta and species of other genera with seeds of similar size;
100 g -	For bajra, jute and species of all other genera;
250 tubers / planting stakes/roots/corms -	Seed potato, sweet potato and other vegetatively propagating crops.



**Basal pigmentation of seedlings in Pearl Millet**



**Seedling pigmentation in Wheat**



Node pubescence



Node pigmentation



Internode pigmentation





# CRITERIA FOR GOT TO DECIDE THE GENUINENESS OF VARIETY

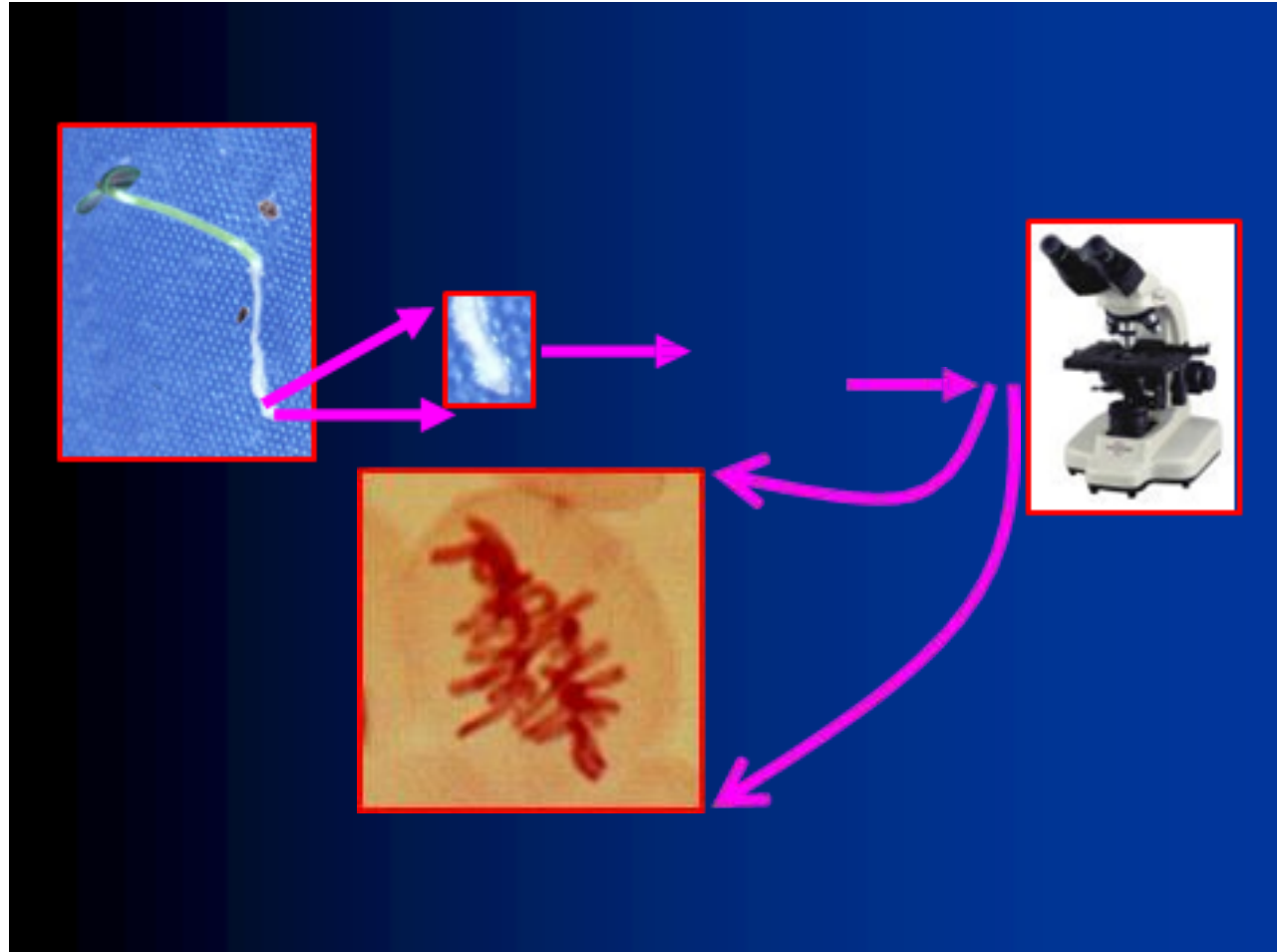
<b>Maximum permissible off types (%)</b>	<b>Minimum genetic purity (%)</b>	<b>Number of plants required/sample for observation</b>
<b>0.10</b>	<b>99.9</b>	<b>4,000</b>
<b>0.20</b>	<b>99.8</b>	<b>2,000</b>
<b>0.30</b>	<b>99.7</b>	<b>1,350</b>
<b>0.50</b>	<b>99.5</b>	<b>800</b>
<b>1.00 and above</b>	<b>99.0 and below</b>	<b>400</b>

## REJECT NUMBER FOR PRESCRIBED STANDARDS AND SAMPLE SIZE

Standard	Reject number for sample size of	
	800	400
99.5(1 in 200)	8	*
99.0(1 in 100)	16	8
95.0(10 in 100)	48	24
90.0(10 in 100)	88	44
85.0(15 in 100)	128	64

\*- indicates that the sample is too small for a valid test.

# Cytological Test (Ploidy Test)



# Drawbacks

- ▶ Time consuming Effect of environment
- ▶ Less number of plant morphological markers
- ▶ Environmental stress conditions often mask specific morphological traits.
- ▶ Large amount of land required.
- ▶ Laborious

# Types of Chemical test

- ▶ IATAAOSA
- ▶ Phenol test for wheat
- ▶ Lugol's test for lupin
- ▶ Electrophoretic technique for wheat, oat, peas, lolium, maize and sunflower
- ▶ Copper sulfate-ammonia test for sweet clover
- ▶ HCl test for oat
- ▶ Peroxidase test for soybean
- ▶ KOH test for rice and sorghum
- ▶ NaOH test for wheat

# Phenol Test in Wheat

- ▶ Principle: The ‘**Tynosinase**’ enzyme present in the seed coat reacts with phenol vapours to No colour change produce melanin, a pigmented product.
- ▶ Based on enzyme activity the quantity of melanin produced varies and depending on which the seed colour varies from **colourless (no melanin production or no enzyme activity)**, **light brown (low enzyme activity)** to **black (high Dark Brown Light brown enzyme activity)**.
- ▶ Since enzyme activity is specific for cultivar, the colour reaction between cultivars will also vary aiding in varietal purity testing.





# Peroxidase Test in Soybean

- ▶ **Principle:** The 'Peroxidase' enzyme present in the seed coat, oxidizes the 'Guaiacol' in the presence of  $H_2O_2$  to impart reddish-brown colour
- ▶ **Drawback:** During reaction, the 'Guaiacol' may be oxidized by other oxidizing enzymes

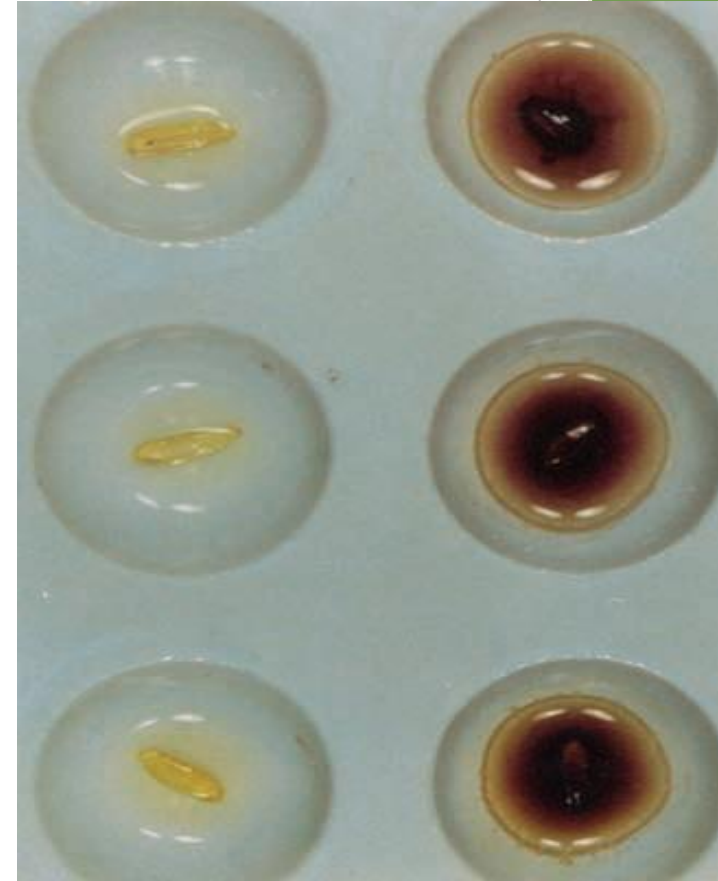


## Copper Sulfate-Ammonia Test for Sweetclover (*Melilotus spp.*)



# Potassium Hydroxide (KOH) Test for red rice (*Oryza sativa*)

- ▶ Due to the variation in emergence and maturity of red rice and the time required for the development of the red coloration on the grain, it is possible for colorless or nearly colorless seeds of red rice to contaminate rice seed lots.
- ▶ A simple KOH soak test for the detection of red rice seed was originally developed by Rosta (1975).



# Sodium Hydroxide (NaOH) Test for Wheat (*Triticum aestivum*)



# Demerits of Chemical Tests

- ▶ Difficult to distinguish the varieties falling in same group

# Electrophoresis test

- ❖ Sodium Dodecyl Sulphate Polyacrylamide Gel Electrophoresis (SDS-PAGE)
- ❖ Acid-page Alkaline-page
- ❖ Starch Gel Electrophoresis (SGE)
- ❖ Ultrathin Layer Isoelectric Focusing (UTLIEF)

# Electrophoretic methods recommended by ISTA (1999) for various crops species

Crop species	Method
<i>Triticum and Hordeum</i>	Acid PAGE of alcohol soluble proteins (Gliadins from <i>Triticum</i> and Hordeins from <i>Hordeum</i> ) using 100 individual seeds
<i>Pisum and Lolium</i>	SDS-PAGE of Tris-HCL soluble proteins using 100 individual seeds are used in <i>Pisum</i> while in <i>Lolium</i> bulked seeds are analysed. In <i>Lolium</i> the method will serve to varify seed lots but will not permit the detection of admixtures.
<i>Zea mays</i>	Alcohol soluble proteins (Zeins) extracted from individual seeds are separated by UTLIEF. Normally 200 single seeds analysed. For reports and issue of ISTA certificate, 400 single seeds are analysed.
<i>Avena sativa</i>	Urea/ethylene glycol-soluble proteins (Avenins) are extracted from seeds and separated by Acid-PGE

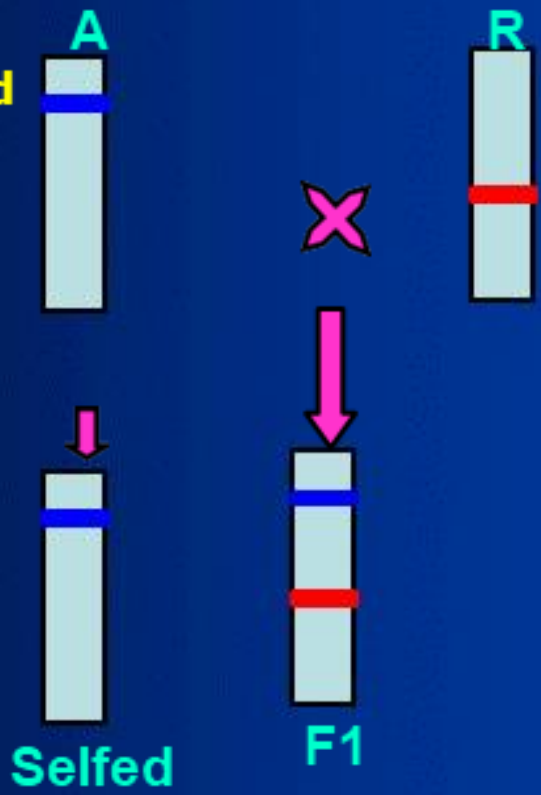


## Evaluation

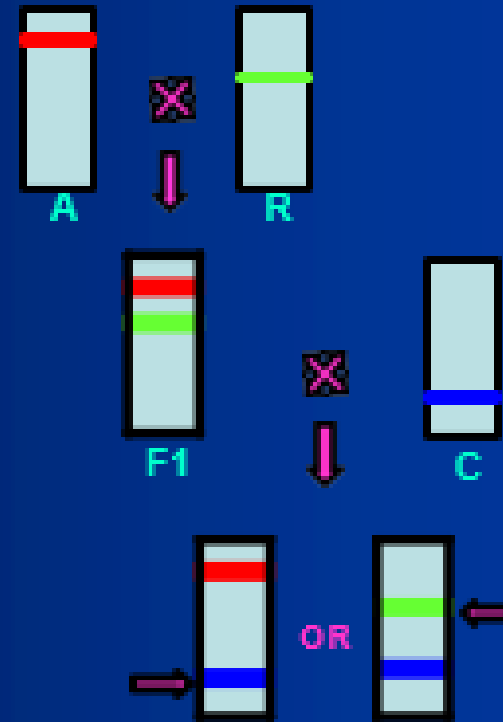
According to ISTA rules, verification of varieties is generally done by comparing the **electrophoretic profiles** of the **sample with that** of the authentic reference Variety with a well- described and established **protein banding pattern**.

In case of Hybrids, the protein patterns of the **hybrid was compared with the female and male parents**. Seeds with protein pattern similar to **female parent** are judged to be self pollinated. **Foreign pollinated seeds show a different pattern**.

Single cross hybrid

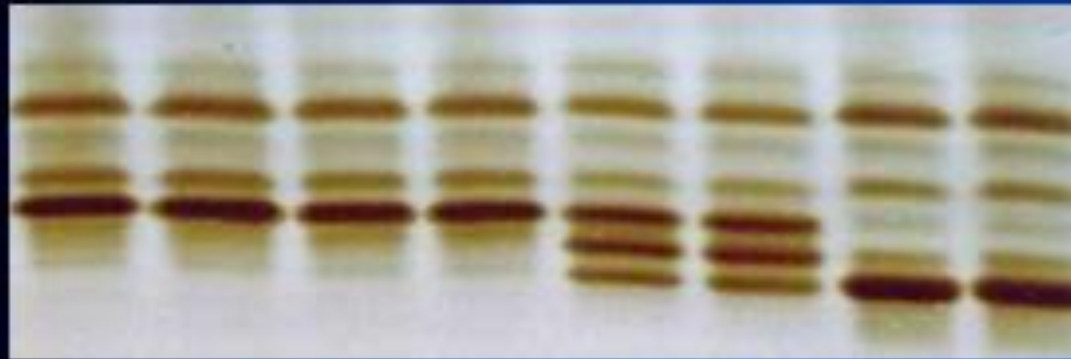


## Three way cross Hybrid



Three way Hybrid

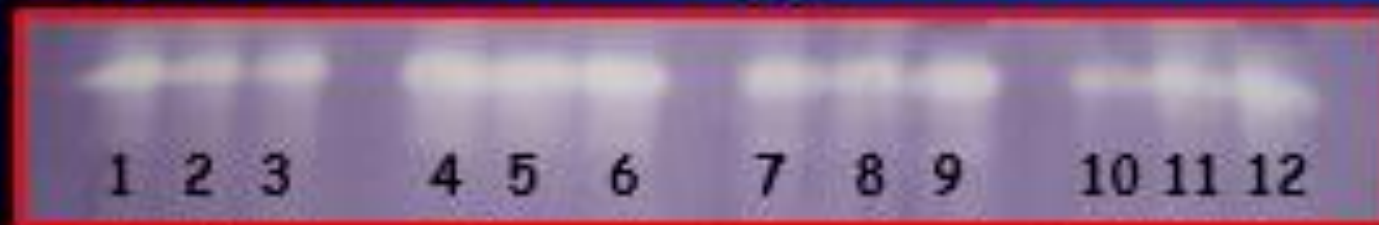
**Electrophoretic profiles of seed esterases of Pearl millet hybrids and parental lines separated on Alkali-PAGE**



## Electrophoretic banding pattern of Seed Esterases



## Electrophoretic banding pattern of SOD



1: ♂ Pusa Hybrid 5    4: ♂ Pusa Hybrid 6    7: ♂ ARBH 786    10: ♂ GBH2  
2: ♀ Pusa Hybrid 5    5: ♀ Pusa Hybrid 6    8: ♀ ARBH786    11: ♀ GBH2  
3: Pusa Hybrid 5    6: Pusa Hybrid 6    9: ARBH 786    12: GBH2

## Comparative advantages and disadvantages of Polyacrylamide, SDS and IEF

	<b>Polyacrylamide</b>	<b>SDS</b>	<b>IEF</b>
<b>Advantages</b>	<ul style="list-style-type: none"><li>■ Technical system well defined</li><li>■ Excellent band resolution</li></ul>	<ul style="list-style-type: none"><li>■ Technical system well defined</li><li>■ Inexpensive</li><li>■ Gels can be sliced</li></ul>	<ul style="list-style-type: none"><li>■ Technical system well defined</li><li>■ Uses charge rather than charge/density and size of proteins</li><li>■ Gels can be blotted</li><li>■ Short running time</li></ul>
<b>Disadvantages</b>	<ul style="list-style-type: none"><li>■ Expensive</li><li>■ Can not slice gel</li><li>■ Potentially toxic</li></ul>	<ul style="list-style-type: none"><li>■ Standardization of gels</li><li>■ Long running time(5-6h)</li><li>■ Poor band resolution</li></ul>	<ul style="list-style-type: none"><li>■ Expensive</li><li>■ Can not slice gel</li></ul>
<b>IEF-Isoelectric Focusing</b>			

# Demerits

- ▶ **Stage specific**
- ▶ **Less number of plant morphological markers Less number of protein and isozymes markers**
- ▶ They are not affected by the field or greenhouse environment.
- ▶ They are cost effective compared to other methods and the turnaround time is relatively rapid.
- ▶ Multilocus analysis provide useful information for verifying inbred and hybrid genotypes.
- ▶ Most are co-dominant and many loci express at all stages of life cycle.
- ▶ An array of enzymatic analysis can be made using small quantities of leaf and seed material.
- ▶ There are limited number of marker isozymes as compared to molecular markers.
- ▶ **Stage specific expression of isozymes markers**



# Need for Molecular Markers

- **Time consuming**
- **Requires large areas of land and skilled personnel**
- **Effect of environment**
- **Less number of plant morphological markers Less number of protein and isozymes markers Stage specific expression of isozymes markers**

# **Varietal Identification – Principle**

- ▶ **Draw the representative submitted sample from seed lot**
- ▶ **Compare the DNA profile developed from seeds/seedlings/plants of prescribed size (working sample) obtained from the submitted sample with that of authentic sample of the variety**
- ▶ **Express the GP in % of seeds/seedlings/plants that are true to the type over the total used in test**

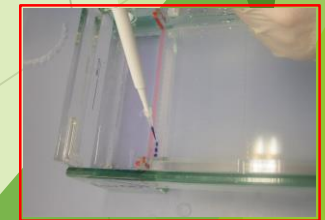
# General methodology for molecular markers

- ▶ DNA extraction
- ▶ PCR amplification using nucleotide primer Initial Denaturation
- ▶ Repeated Cycles Denaturation Annealing Extension
- ▶ Final Extension
- ▶ Electrophoretic run and identification of PCR amplified product.

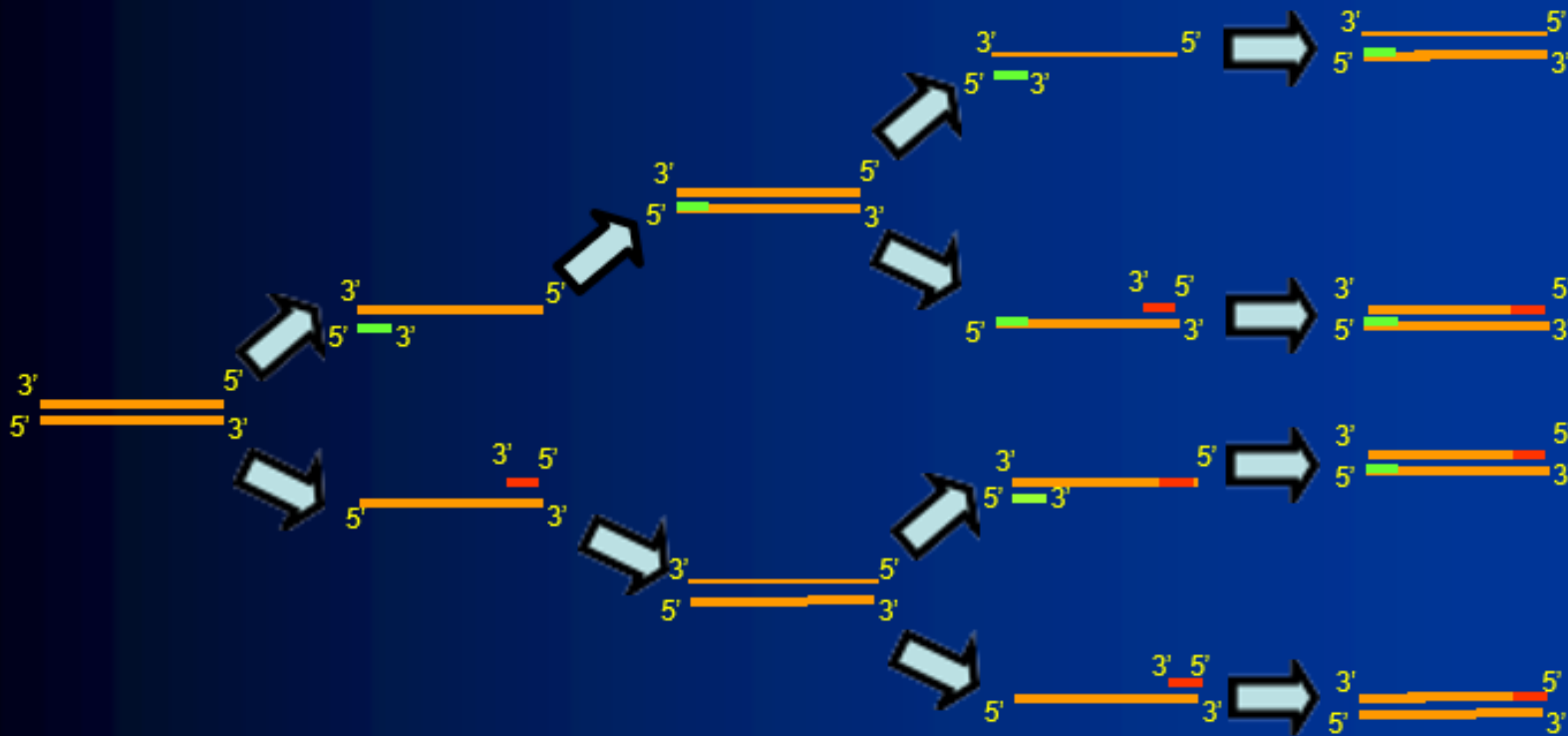
# Developing DNA profile

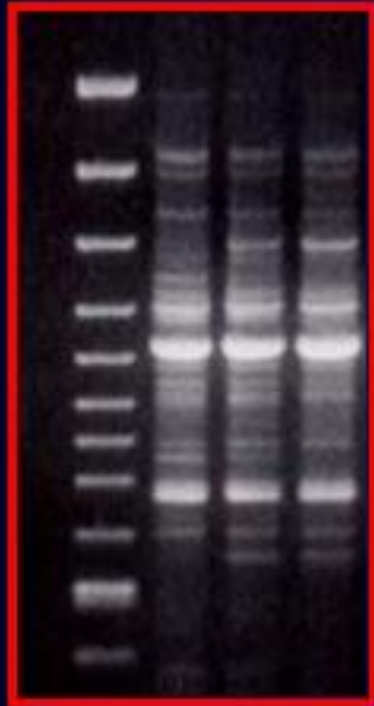
- ▶ DNA extraction from seeds/seedlings/plant tissues
- ▶ Generating the DNA fragments either by digestion of DNA with restriction enzymes (RFLP and AFLP) or by amplification of particular DNA fragment by PCR
- ▶ Separation of the DNA fragments in Agarose/polyacrylamide medium

primers

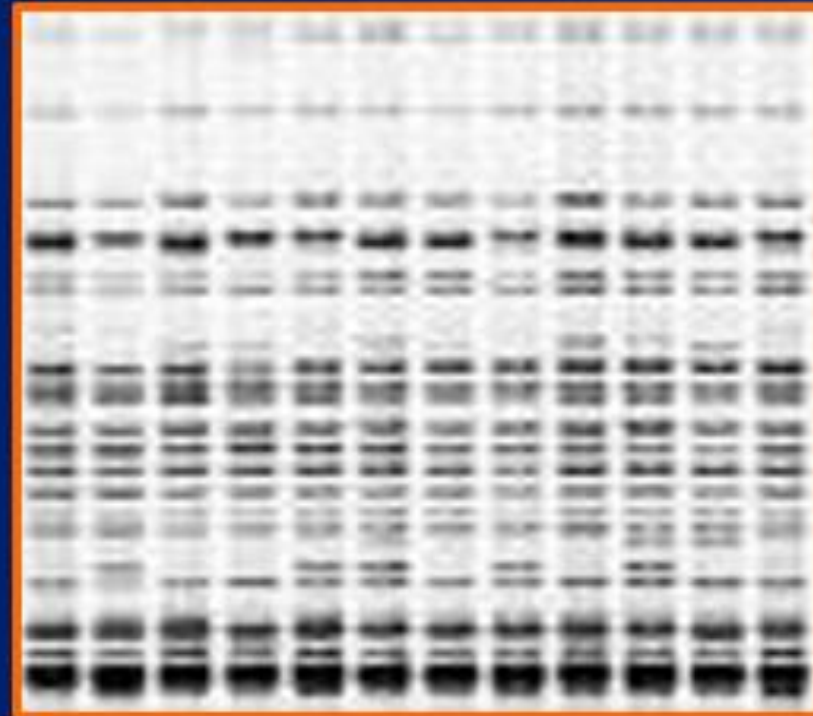


# Polymerase Chain Reaction: Principle





**Ethidium Bromide Stain**



**Auto Radiographic picture of  
the gel**

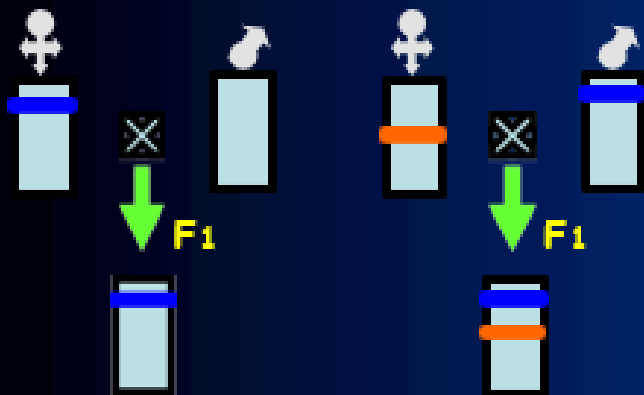
# DNA Markers

## Dominant Markers

- RAPD
- AFLP

### Demerits:

Hybrids can not be distinguished from self seeds of parental lines

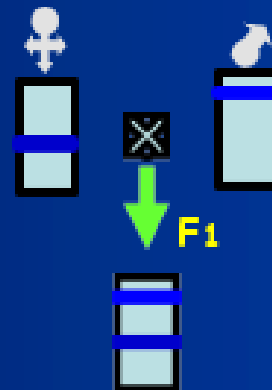


## Co-Dominant Markers

- RFLP
- SSR

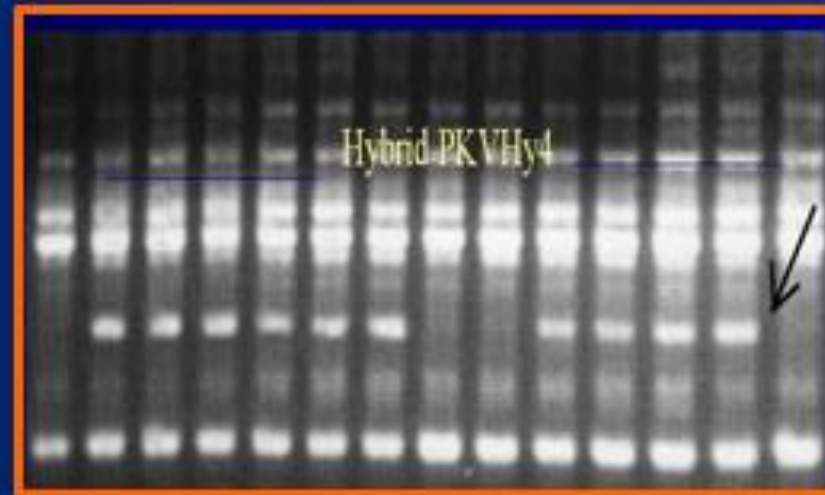
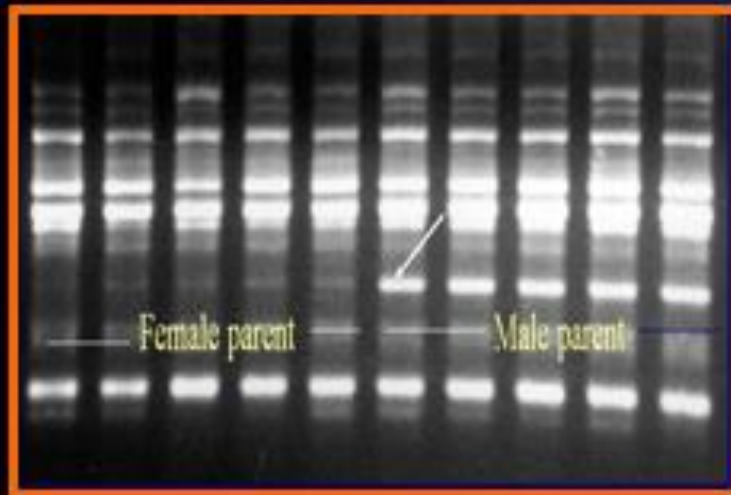
### Merits:

Hybrids can clearly be distinguished from self seeds of both the parents

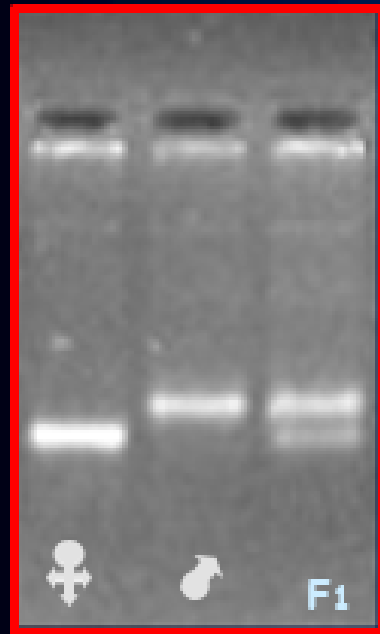




## Application of RAPD Marker to Assess the Purity of Cotton Hybrid Seed Lots



## Application of SSR marker to test the purity of Rice hybrid PRH10

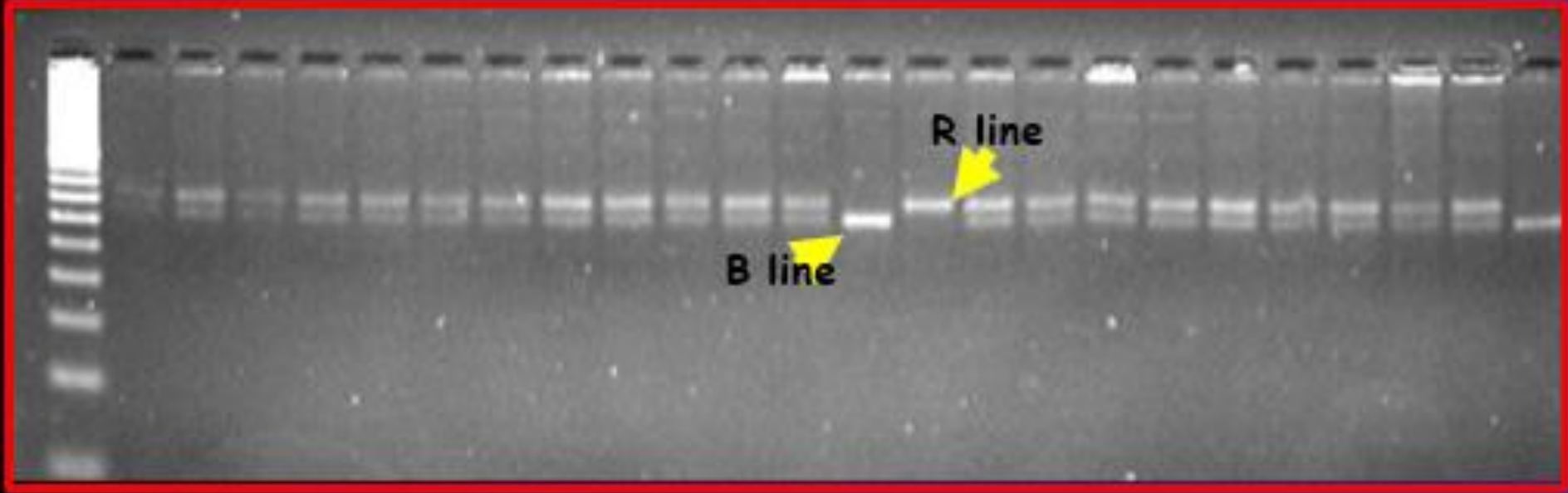


PUSA 6A

X

PRR 78

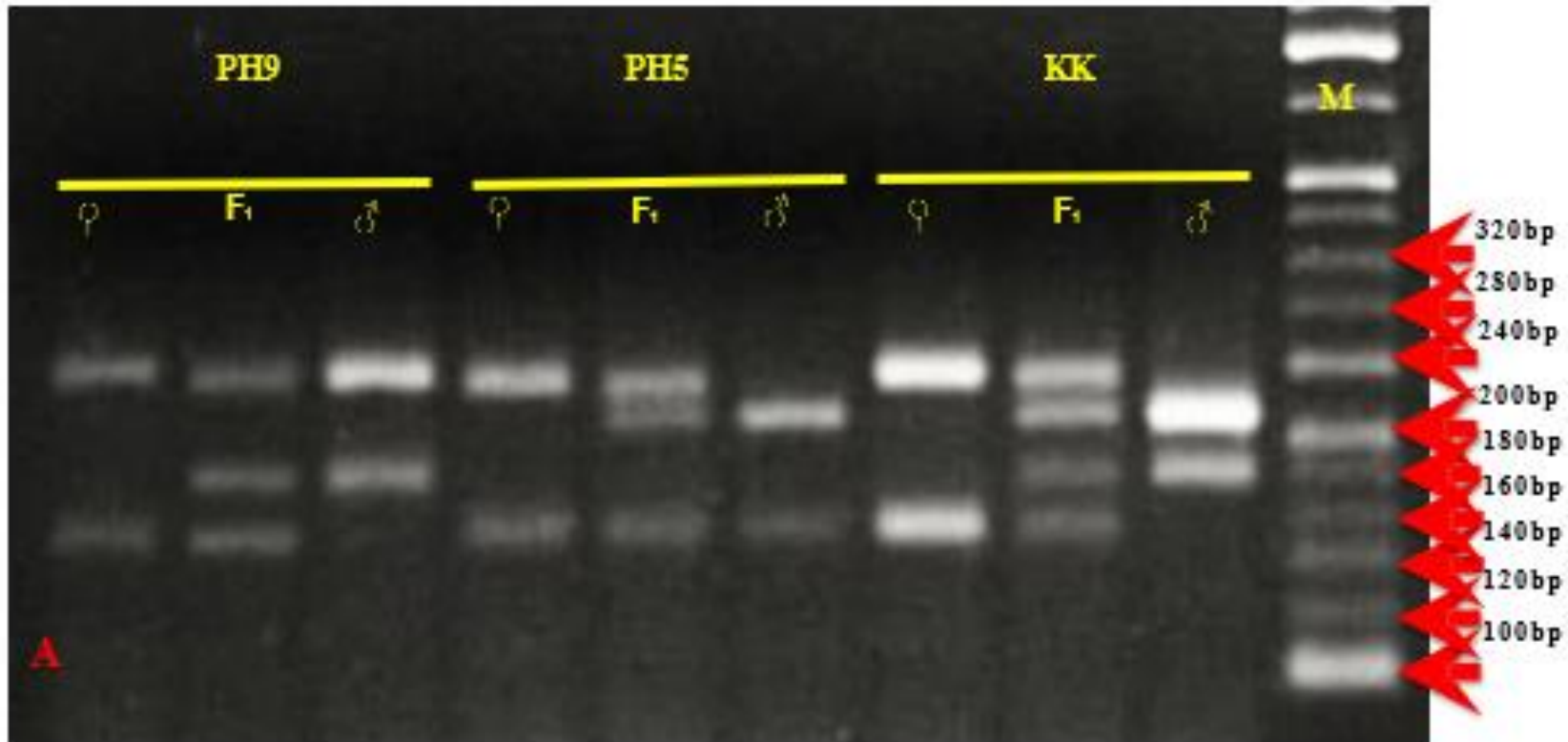
PRH 10



**B line**

**R line**

# Application of SSR marker to establish the identity of Brinjal hybrids



## Comparison of molecular techniques and their applicability

Characteristics	RFLPs	RAPDs	SSRs	AFLPs
Develop. costs (Rs. per probe)	Medium ( 4000)	Low (none)	High (20000)	Low (none)
Level of Polymorphism	Medium	Medium	High	Medium
Automation	No	Yes	Yes	Yes
Cost of Automation	High	Medium	High	High
Reliability	High	Low	High	Medium
Cost (Rs. per assay)	High (80)	Low (40)	Low (40)	Medium (60)
Radioactivity	Yes	No	Yes/No	Yes
Samples/day	20	50	50	50

## Advantages of molecular techniques

- It has very large number of polymorphism development as compared to the bio-chemical markers.
- Residual heterozygosity can be detected.
- It is reliable to all crops.
- Very fast method

## Limitations of molecular techniques

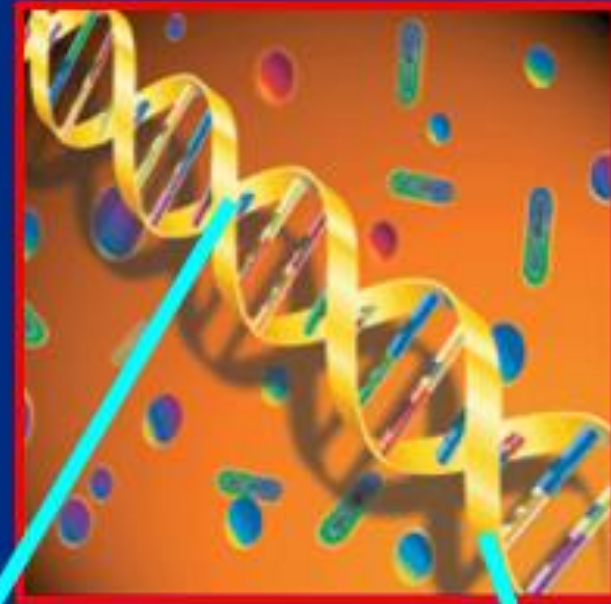
- Sophisticated instruments required.
- Very costly.

# Testing varietal purity for transgenic crops



# Transgenic Crop

The plant in which gene or genes from alien species are incorporated to improve certain economic traits like insect pest resistance, nutritive value of produce etc., is called Genetically Modified crop /Transgenic crop



# GM crop detection - the rationale

- ▶ To ensure the **varietal purity** of GM seeds
- ▶ To **detect and quantify** the adventitious contamination
- ▶ To protect **the new GM crop** under PPV& FA
- ▶ To prevent the entry of **unapproved transgene**
- ▶ To certify that the seeds used in **organic farming** are free from GM seeds or its contamination

# Criteria for fixing the thresholds limits

- ▶ Depends on the allowable content of GM contamination in the harvest
- ▶ Germany : Permitted adventitious GM
- ▶ material in food product is 1%
- ▶ 0.3% as threshold limit in seeds of cross pollinated crops
- ▶ 0.5% in case of self pollinated and vegetatively propagated crops

# Phenotypic characterization (Herbicide Bioassays)

- ▶ Germination tests on solid germination media in the presence of a specific herbicide, where non-GM and GM seeds show distinct characteristics



# Immunological Assays

## 🌍 Lateral Flow Sticks



## 🌍 Enzyme Linked Immunosorbant Assay (ELISA)

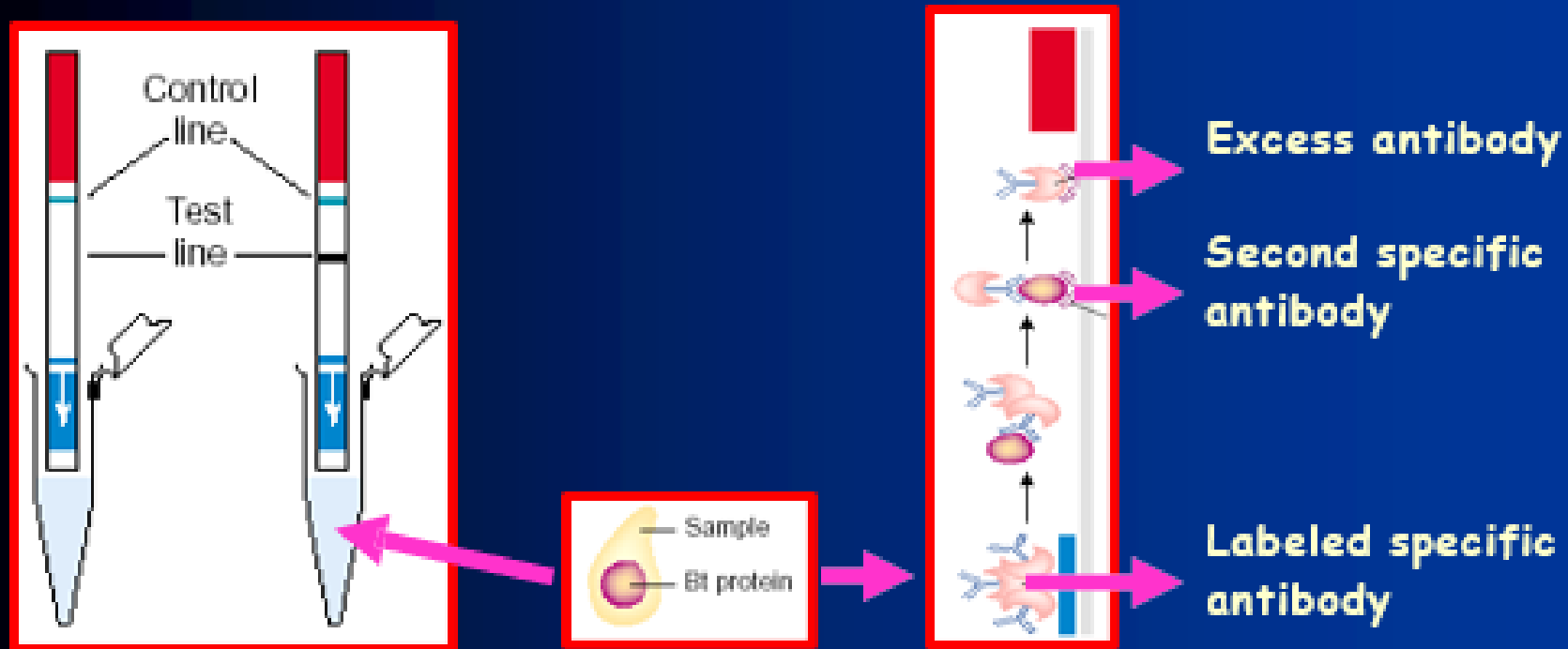


# Lateral Flow Strip Protocol



- 🌍 Punch leaf disc/seed
- 🌍 Add buffer and grind in tube
- 🌍 Insert flow strips for testing
- 🌍 Observe for band development

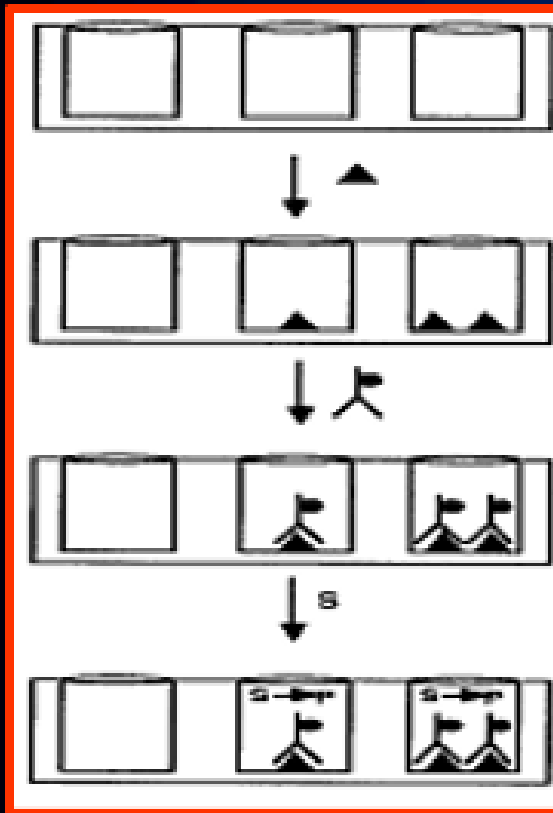
# Lateral flow strips – the principle



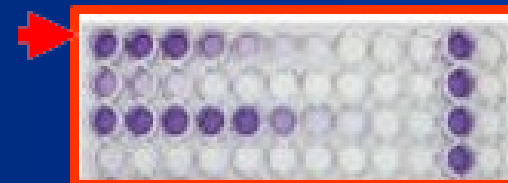
- ELISA variation with immobilized double antibodies, specific to expressed proteins are coupled to a colour reactant and incorporated to a nitrocellulose strip



# ELISA - Protocol



- Antigen added ELISA wells
- Enzyme-linked antibody added
- A colorless substrate added
- A colorless substrate is converted to a color product by the enzyme linked to antibody



# Molecular detection of GMO

- ▶ PCR followed by electrophoresis
- ▶ Rt PCR

## **Seed Drying**

The process of elimination of moisture from the seed is called drying. Seed drying should reduce the seed moisture content to safe moisture limits to maintain its viability and vigour during storage, which may otherwise deteriorate quickly owing to mold growth, heating and enhanced microbial activity. Seed drying also permits early harvesting, long term storage of seeds, more efficient use of land and manpower, the use of plant stalks as green fodder and production of high quality seed.

Depending upon the climate and method of harvesting adopted the threshed seed may or may not be dry enough for safe storage. Under less favorable conditions, threshed seed needs further drying.

### **Stage of moisture elimination**

The moisture from the seed is eliminated in 2 stages

1. Surface moisture of the seed that initially removed by the drying air.
2. The removal of the moisture in the surface cause an imbalance in the moisture potential in the surface of the seed and the inner portion of the seed which leads to the migration of moisture from the inner organ to the surface.

The migration of moisture to the surface is slower than the evaporation and a moisture gradient is developed in the kernal.

Elimination of moisture from the seed depends upon the relative humidity and temperature of the environment surrounding the seed. When RH of the atmosphere is less than the seed, moisture is eliminated from the seed. While drying, care should be taken to minimize /prevent oxidation and decomposition and volatilization. In this process there will be loss of dry weight of seed which is widened when the processes take place at high temperature. Hence, high moisture seeds should be dried at low temperature.

## **Equilibrium moisture content**

A seed is in equilibrium with the environment when the rate of moisture loss from the seed to the surrounding atmosphere is equal to the rate of moisture gained by the seed from the atmosphere.

## **Drying temperature**

Greater the seed moisture content lesser should be the drying temperature and vice versa.

10%	MC and below	110 ° F (43.3° C)
10-18 %	MC	100 ° F (42.2 ° C)
18-30 %	MC	90 ° F (32.2 ° F)

The rate of drying depends on

- Initial seed moisture content
- Size of the bin and capacity
- Depth of spread of seed
- The rate of air blow
- Atmosphere air temperature and relative humidity
- Static pressure
- Drying temperature

## **Methods of drying**

I. Physical drying (or) natural drying (or) traditional sun drying

II. Mechanical (or) artificial drying

- a) Drying with forced natural air
- b) Drying with forced artificially heated air
- c) Drying with desiccants
- d) Drying with infrared rays

## **I. Physical drying / Natural drying / Traditional Sun drying**

This is the common conventional method in which drying of the harvested crop is carried out in the field or threshing floor by the radiant energy of the sun. This does not involve any expenditure. To achieve uniform drying, the seed should be spread in thin layer. High moisture content seed with a moisture content of more than 17% should be dried first under shade / light to reduce the moisture content less than 17% and then dried under heavy sun i.e. noon drying. Sun dried seeds should not be allowed to remain open in the floor during night, since seed will absorb moisture from air. 2-4 days are needed to reduce the moisture content to 10-12%. Direct sunlight also can adversely affect seed germinability owing to high temperature and ultraviolet radiation, especially if the moisture content of the seed is high.

### **Advantages**

1. Easy and cheap
2. Does not require any expenditure or fuel.

### **Disadvantages**

1. The rate of drying is slow
2. Loss due to attack by insects, birds and animals
3. Large floor area is required
4. Involves extra labour for collecting and exposing during the day
5. Sun drying cause sun checks or hot spots due to variation in temperature from time to time. This checks or spots induce high amount of breakage while processing
6. mechanical admixtures are possible
7. Dust, dirt and other foreign materials get admixed
8. High weather risks and damage by heavy wind and rains

## **II. Mechanical drying or artificial drying**

### **Forced air drying**

In forced air drying, natural air or air supplemented with heat is blown through a layer of seed until drying is completed.

Generally ordinary seed godowns are provided with two types of ventilators for free movement of air circulation. In modern godowns, provisions are to be made for forcible circulation of air with the help of an electronic blower. The outside air which is comparatively dry is circulated in the godown and thereby the seed get dried up in this process. This is possible only in dry months.

Two types of driers are used: batch and continuous flow driers.

#### **a) Batch dryers**

In batch drier, relatively dry air is blown through a layer of seed until the seed is dried completely, after which it is removed and replaced by another batch of seed. The method is simple and well suited to small quantities of seed, allows easy cleaning and is recommended for farm drying.

In horizontal drier, the seed is contained in a box or chamber with a perforated floor through which the air is blown. Air ducts can be installed in a barn floor and the seed to be dried piled over them.

In a modified sack drier, seed contained in a woven sack is placed on a grid through which air is blown. A cylindrical storage bin with raised perforated floor arranged to blow air underneath the floor can also be used.

A vertical batch drier consists of two concentric perforated cylinders. The space between the two cylinders is filled with seed and air is blown into the inner cylinder from where it passes outward the seed. The size of the batch determines the drying rate.

In horizontal batch drier, the seed at the bottom dries first, with the dry zone extending gradually upward. The drying of the uppermost seed may be delayed unduly if the seed layer is too thick or the airflow is inadequate. The seed layer should not exceed a depth of 3m and for high moisture forage seed, it should be reduced to 1m or less. If the seed is dried in a storage bin, a layer of undried seed can be added on top of the dried batch and drying continued, but only if the seed is already fairly dry and air is not too hot. Seed loss also can be avoided by drying in

two stages. After the first batch has partially dried, the emerging air is passed through a second batch held in another chamber, repeating the process with second batch and so on.

The air blown through a batch must not be too hot, because the seed at the bottom may be overheated by direct exposure to the entering hot air. It is often not necessary to heat the air at all, and heating to less than 10° C above the ambient temperature can be very effective, but on a hot humid day in the tropics even a few degrees above ambient temperature can harm the seeds. Dehumidifiers may need to be used under these circumstances.

An appropriate drying rate is very important. Too rapid drying may harm the seed because of the high drying temperature or a quick loss of water from the seed. Slow drying may mean maintaining a high moisture seed at a higher temperature for a prolonged time, resulting in deterioration of seed.

## **2) Continuous flow dryers**

In this type of drier, the seed moves horizontally or vertically through a stream of hot air and then into a cooling chamber. These driers are however difficult to clean when there is a change of cultivar. These driers can use air temperature higher than those of batch driers, because the seed is heated for a much shorter time.

### **i) L.S.U. dryers (Louisiana State University dryers)**

This is a continuous column heated air drier largely used for paddy. The paddy seeds are fed from the top with the help of gravity force in zig zag manner and heated air is blown from the bottom usually at right angles to the direction of seed motion. The falling seeds get dried up by the heated air and this process is repeated till to get a reduction of moisture content to the expected level.

### **ii) Non mixing column dryer**

These dryers consist of a tall vertical column through which paddy flows by gravity. No provision is made for agitating the paddy as it flows and hence there is no attempt to drive the paddy from a straight path. Paddy descends gradually between two parallel screens and heated air is forced through the screens.



### **Advantages over bin dryers**

1. Short drying period
2. Less damages or spoilage during wet weather
3. Drying is more uniform.

### **Advantages of mechanical drying**

1. Quick method, timely and uniform drying is possible
2. Makes early harvest possible
3. It reduces the chances of losses due to over ripening and shattering of seed
4. Losses due to rodents and birds are prevented.
5. Less damage during processing operation.
6. Permits long time storage by preventing sun checks and other damages.

### **Disadvantages**

1. Initial cost of drying the equipment is high
2. Fuel is expensive
3. It produces possible fire hazards
4. Considerable supervision is necessary.

### **Storage structures for Seed drying**

Building requirements for a seed drying system depend upon the size of operation, the number of different seeds to be dried, the level of mechanization desired and future expansion. Different types and forms of storage structures can be built for handling seeds to be dried with forced air. These may be made of steel, wood, plywood or concrete and they may be cylindrical or rectangular in shape.

Regardless of the type of structure, all storage bins used for forced air drying in storage of seeds must have the following features.

1. Small grain seeds in bulk exert large pressures against the sidewalls. The side pressures are converted to a vertical load on the foundation, which should be strong enough to hold the seed lots.
2. The roof and walls of bins must be airtight for drying to proceed satisfactorily.
3. The openings for filling and removal of seed should be large and convenient to use. A full size entrance door is desirable.
4. A hand space about 1 m should be provided for easy inspection of seed. Cleaning and spraying operations should be convenient. For fumigation, the structures should be airtight, with a provision for temporary sealing of all openings.
5. The structure should be able to dry and store more than one kind of seed.
6. The drying air should be uniformly distributed through all portions of the seed lot for efficient drying.
7. The flow of air leaving the seed should proceed rapidly so that back pressures do not hinder the flow of drying into the seed.

### **Air-Distribution Systems**

Agrawal described three types of air-distribution systems used for seed drying.

- a) The main and lateral duct system
- b) a single central perforated duct and
- c) the perforated false floor system.

Multiple bin storage structures for drying can be built so that they are arranged to enable the drying of several seed lots simultaneously using the same drying fans. Alternatively, different seed lots can be dried successively with sliding air gates controlling the flow of air to the respective bins. A multiple bin arrangement is particularly useful to dry more than one kind of seed simultaneously.

### **Heated air drying system**

Heated air driers consist of (a) a heater unit where fuel is burned and (b) a

fan to force the heated air through a canvas connecting duct into the air distribution system of the drying bin. Safety features such as automatic thermostatic high limit temperature control, which cuts off the burner flame if the air temperature exceeds a certain safe maximum and flame failure control, which automatically cuts off fuel flow to the burner if the flame goes out are provided. A thermostat can also automatically maintain the air temperature at a desired setting. In many driers, such thermostats are provided as a standard feature.

Two main types of driers are available, which differ in the manner heat is supplied to the air. Direct fired and indirect fired. In a direct fired drier, the fuel is burned and the hot combustion gases are thrown directly into the air distribution system. Although the heat is used very efficiently, there is possibility of blowing soot, unburned fuel and objectionable fumes into the seed. The burner, therefore, needs to be adjusted properly to burn the fuel completely. With certain fuels, there is also a danger of blowing small sparks into the seed.

In indirect fired driers, the hot combustion gases pass into a chamber. The drying air circulates around this chamber and picks up heat as in a hot air furnace. The drying air thus does not include combustion gases, sparks, soot or fumes. These driers are less efficient in the use of heat, but are safer than direct fired types.

The driers are designed to burn various types of fuels (eg. liquid propane or butane, natural gas, fuel oil and coal. Both liquid propane and natural gas burn readily with minimum soot and are the best fuels for direct driers and kerosene oil is better for indirect fired driers.

Two important aspects that must be considered while calculating the requirements of a suitable to crop drier are the required air flow volume and the heat capacity (BTU/hr) for drying seeds at the specified desired rate. The fan requirements can be computed by knowing the total air flow at the static pressure of the seed at a given drying depth and heater requirement are estimated by calculating the amount of water to be removed from the seed per hour. Based on these calculations, a suitable crop drier can be selected to provide a minimum required airflow volume(bin capacity x air flow rate) and heat capacity in BTU/hr.

Agrawal categorized types of heated driers as layer-in -bin, batch-in-bin, batch and continuous driers and described their functions.

Stirring devices keep the seed in a loose fill condition, allowing easy airflow through the bottom layers. Such mechanisms alleviate the problems of uneven drying (or over drying) by breaking up pockets of fires and trash and blending the seed by constant mixing.

Large differences in the degree of drying between the top and bottom layers of seed have been noticed during drying by heated air. It is therefore, advisable to dry seed at shallow depths to minimize these differences and avoid overheating of the bottom layer. Agrawal recommended maximum seed depths and temperatures for batch drying of seeds of different crop species in bins.

Crop seed	Maximum depth (cm)	Recommended maximum temperature (°C)
Shelled corn	50.8 (20 in)	43.3 (110 ° F)
Wheat	50.8 (20 in)	43.3 (110 ° F)
Barely	50.8 (20 in)	40.4 (105 ° F)
Oats	91.4 (36 in)	43.3 (110 ° F)
Rice	45.7 (18 in)	43.3 (110 ° F)
Soyabean	50.8 (20 in)	43.3 (110 ° F)
Peanuts	152.4 (60 in)	32.2 (90 ° F)
Grain Sorghum	50.8 (20 in)	43.3 (110 ° F)

Heated air drying requires higher rates of airflow, because water is evaporated faster and more air is needed to carry it away. The higher air flow rate also ensures more uniform drying of the top and bottom layers of the seed, completing the drying much faster at the recommended temperatures.

The general procedure for bin drying of seeds with heated air consists of charging seed into the bin to the recommended depth. The drier is operated at the recommended temperature of the seed using either manual or thermostatic controls to set the desired temperature. After drying is completed, blowing of the air

through the seed is continued for sometime without heat to bring the seed to an ambient temperature.

Some variations of batch drying with heated air include wagon drying, bag drying and box drying. In wagon drying, the seed is loaded directly onto a wagon especially constructed for drying. The wagon is then drawn to the drier unit and connected with a canvas distribution duct. Forcing the air up through the perforations in the wagon floor dries the seed. After drying, the wagon is disconnected from the canvas duct and the seed is cooled with a fan towed to the storage bins. Wagon drying provides continuous drying, versatility, easy cleaning and low initial cost.

Bag drying is another suitable variation to handle several varieties of smaller quantities of seed simultaneously. Seed received in jute bags is exposed to airflow with minimum static pressure, because the drying bed is only one sack deep. Typical design criteria provide 25 - 40m<sup>3</sup> of air/min/m<sup>3</sup> seed at a static pressure of 3cm less. The construction is simple and inexpensive.

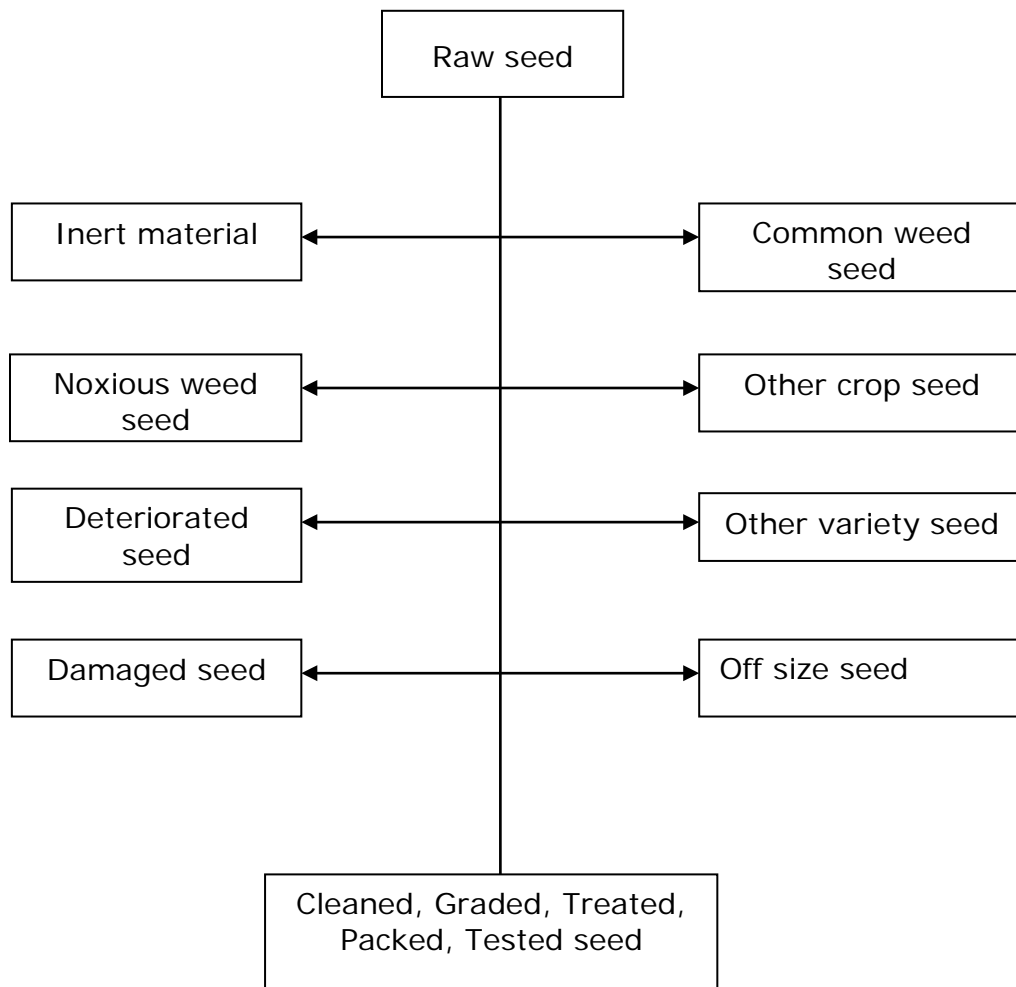
A box drier is modified bag drier well adopted to dry smaller quantities of basic or foundation seed. With box driers, it is possible to maintain the identity of small seed lots despite handling. The boxes can be constructed of locally available materials, which are fitted with perforated metal or woven wire bottoms.

### Tempering

Seed is usually dried in stages with heated air each stage consisting of a pass through the drier. Between passes the seed is stored in bins for an equilibrium period known as tempering period. This period of tempering shortens the total drying time. During drying, surface moisture is removed and internal moisture moves towards the surface are slower than evaporation, and a moisture gradient develops in the kernel. The outside becomes drier than the inside and evaporation rate decreased. During tempering moisture concentration equalizes in the kernel and then evaporation of surface moisture is nearly as rapid as at the start of drying.

## SEED PROCESSING

Seed lots received from the field are often at high moisture content and contain trash and other inert material, weed seeds, deteriorated and damaged seeds, off-size seeds, etc. Seed processing is necessary in order to dry the seeds to safe moisture level; remove or reduce to the extent possible the various undesirable material, weed seeds, other crop seeds, deteriorated or damaged seeds.



Other than this the seed lot heterogeneity in its physical characters like size, colour, shape etc. The seed lot is heterogeneous due to the following reasons

1. The soil is heterogeneous and there is a lot of variability in the fertility status of the soil due to the availability of nutrients, physical, chemical and biological properties.
2. Variability is introduced due to the position of seed set on the plant/fruit , time of pollination and fertilization over a period of time
3. Variability is created by biotic factors like pest and variability infestation.
4. Variability is also due to the management practices like water, land preparation, leveling, staggered sowing, and uneven distribution of fertilizer and irrigation water, uneven plant protection sprays and uneven maturity at harvest.

The inherent qualities such as germinability and vigour are exemplified by certain physical characteristics of the seed i.e., large size, a denser seed, optimum length etc., So, if grading is done to obtain a particular range of size, shape, length and density of the seeds, the quality of the lot is upgraded.

In its common usage in India, seed processing refers to all the steps necessary for preparation of harvested seed for marketing, namely, handling, drying, shelling, preconditioning cleaning, size grading, treating and packaging, etc.

### **Seed Processing Plant Layout Planning**

Layout plan for construction of a seed processing plant should be carefully planned to ensure that the thorough seed cleaning, upgrading, seed treatment and other seed processing operations are carried out efficiently, without mixing and damaging seed lots, with a minimum of equipment, personnel, time and at minimum cost. The following factors should be considered in planning and designing a seed processing plant:



1. Kinds of crop seeds to be handled and 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 the plant
6. Source of power for running machinery
7. System of seed delivery to processing plant and
8. Availability of labour

The key to efficient plant layout is a thorough knowledge of what needs to be done, and sound planning. First, the general sequence of processes involved between the time seeds enter the processing plant and the time they are cleaned, packaged and ready for shipment, must be charted. The sequence of operations depends upon the kind of crop and the initial quality of seed lot, type of contaminants, moisture content of the seed lot, etc. The layout planner must have an intimate knowledge of the seed to be processed, its physical characteristics, the contaminants in it, and also of the selection of machines used to bring the seed to acceptable marketing standards.

### **Seed Processing Plant Building Layout**

Seed processing plant building will comprise of following components:

1. Receiving-cum-drying platform
2. Processing area
3. Auxiliary building

### **Receiving-cum-drying platform**

This area will be utilized to receive the raw seed and to sun dry small lots of crop seeds. This area can also be utilized for storage of seeds on wooden

palettes. The platform will be connected to processing shed through a rolling shutter.

### **Processing area**

The processing area should be situated between the shed and ventilated storage building. The hall should be connected to ventilated flat stores through a covered gallery for easy movement of processed and packaged seed to seed stores. The hall should have a big rolling shutter in the processing plant to permit entry of seed processing equipment into the hall for installation.

Height will be kept to facilitate installation of the seed processing equipment and machinery. A sequence of processing machines to be installed is shown in Fig. 1. Floor of the processing hall should be above the ground level.

The shed should have sufficient provision for natural as well as forced ventilation in order to maintain congenial atmosphere inside the shed. The shed should accommodate seed scalping, seed processing and packaging equipment and will have sufficient space for weighing and packaging.

### **Auxiliary building**

In addition to building discussed above, a provision should be made for generator room. Sufficient length of road should be provided to connect various functional buildings with each other and main highway. Boundary wall should be provided all around the complex for security reasons. Entire complex should have a good drainage system.

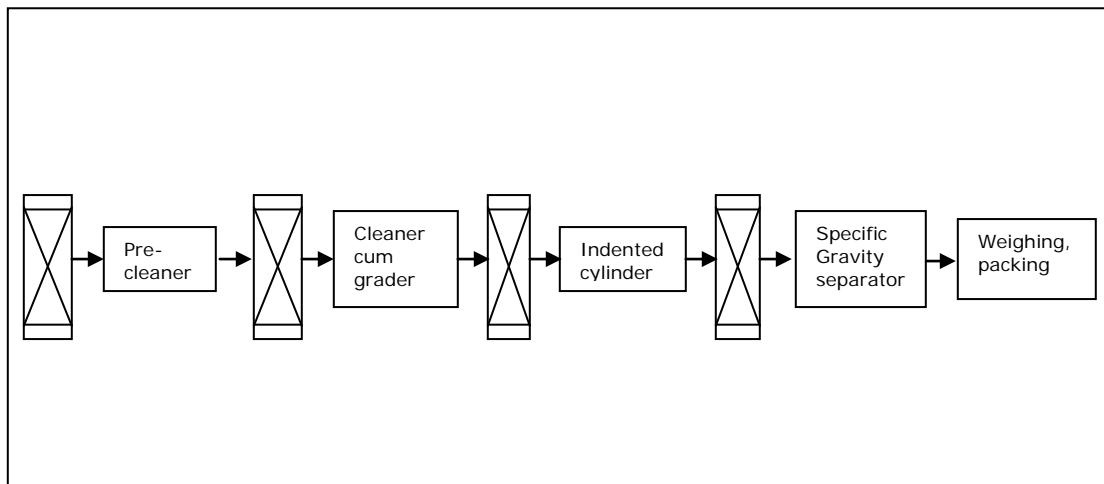
Provision for firefighting equipment such as extinguishers, water buckets, sand buckets etc. should be made to fight minor fire hazards.

The processing plant building should be constructed as per CPWD/PWD norms. It should have tubular trusses, AC sheets pitched hole roof, cement concrete flooring finished with water-proofing cement paint, aerated, ventilated, rat proof and bird protection. Sealed doors should be provided in

these buildings. Buildings will be suitably planned to have interconnection for movement of seeds and materials.

### Analysis of Operation

**a) Processing sequence:** After the machines needed have been identified, the next step is to determine the proper processing sequence. The seed separators, elevators, conveyors and storage bins should be so arranged that seeds flow continuously from beginning to end, and yet be flexible enough to bypass a machine or return to a part for re-cleaning.



**b) Matching capacity:** Equipment size of capacity must be carefully planned to prevent bottlenecks. When the overall operating capacity needs have been determined, all machines must be able to handle that capacity with some reserve capacity for problem lots. Surge bins can handle variations in individual machine capacities. But when differences are great, either larger models, or more than one machine installed in parallel flow, must be used to maintain uninterrupted flow.

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

## Type of Layouts

There are three main types of processing plant layouts: multistorey, single level and combination.

**Multistorey:** In this system, seed is carried by elevators to the top floor and emptied into large bins. Cleaning machines are then arranged in a vertical series on the lower floors. Seed flows from one machine down into the next by gravity.

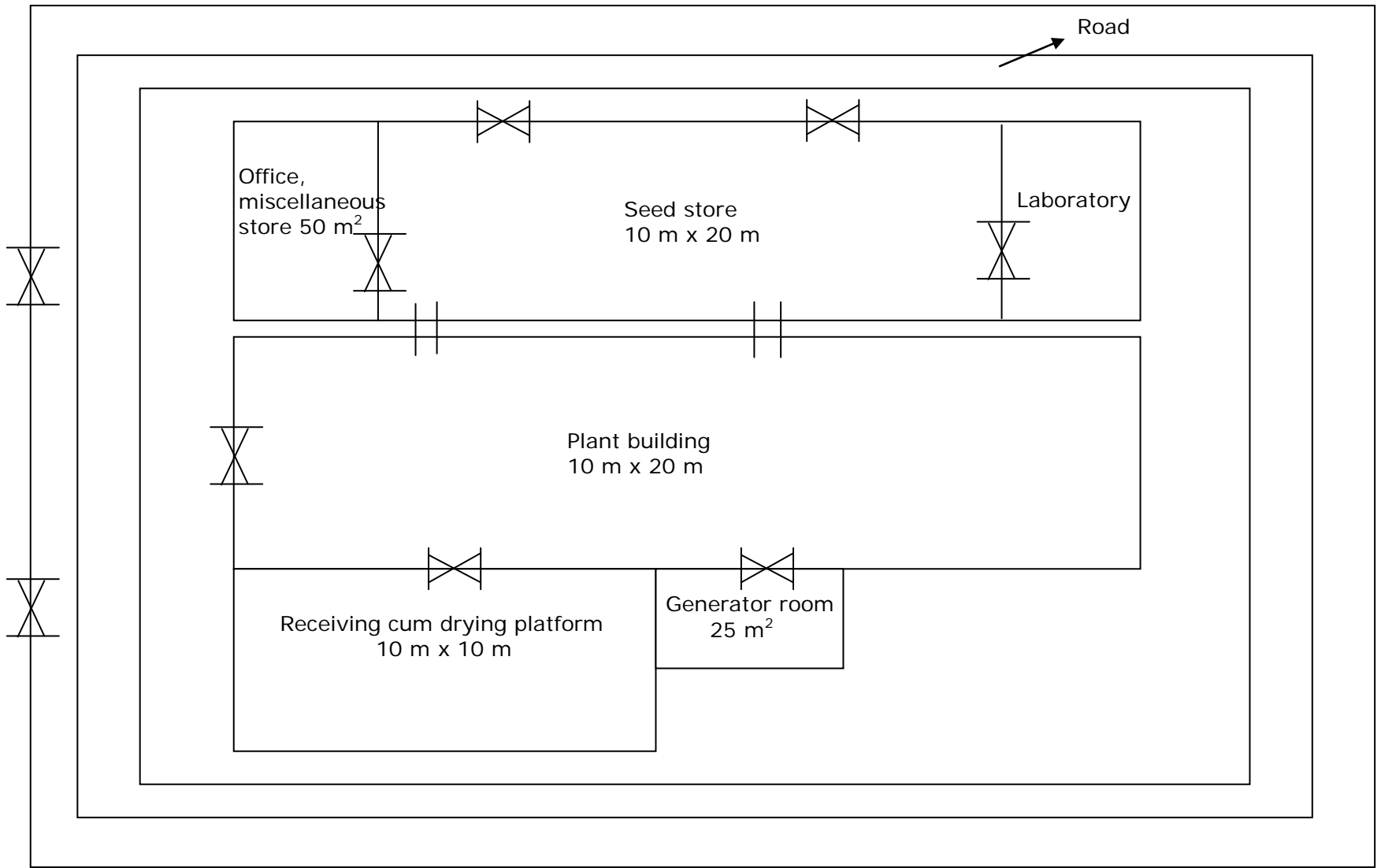
**Single level:** In the single storey plant, seed is moved from one machine to the next by elevators placed between the machines. A great advantage of the single level system is that one man can supervise the processing line without running up and downstairs. He can thus maintain closer supervision of all operations.

**Combined designs:** A compromise between the single and multistorey system could also be adapted.

## Planning

After the proper machines, elevator capacities, cleaning sequences, and lay out design have been selected, detailed layout planning can begin. Careful layout planning can identify and remedy bottlenecks and trouble spots before the plant is built, and thus prevent trouble later.

As the lay out or design develops, it should be drawn on paper. A good method is to draw lines of flow first and then convert these flow lines into machine lines. After appropriate revisions, detailed drawings can be made to show exact locations of equipment and distances. Scale drawings are the most widely used method of layout planning. Scale models and scale templates are also very effective, but are more expensive.



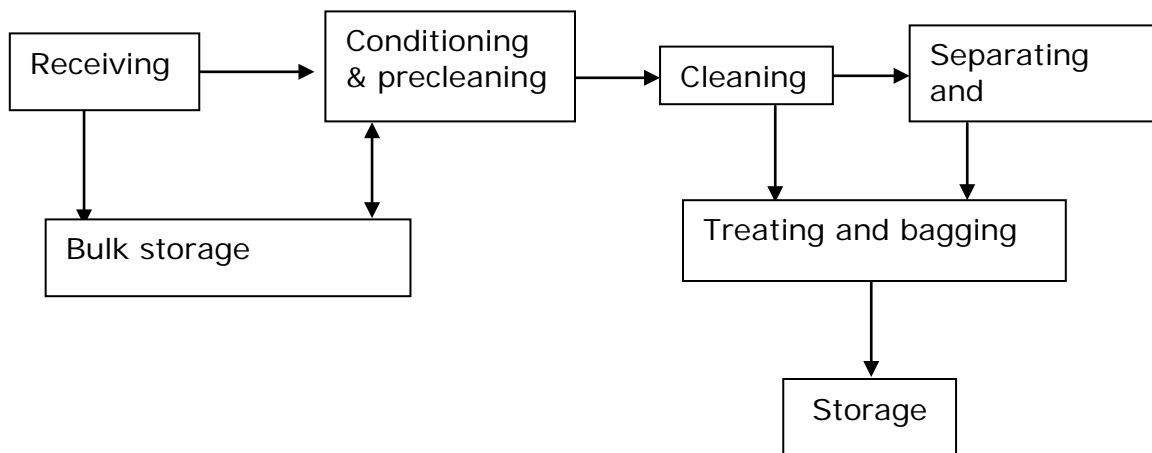
Building layout plan

## Requirements in seed processing

1. There should be complete separation
2. Minimum seed loss
3. Upgrading should be possible for any particular quality
4. Efficiency
5. It should have only minimum requirement

## Movement of seed in a processing plant

Handling of seed at the processing plant adheres to a definite path irrespective of crop for easy management of seed which is sensitive at each and every step of handling and ready to lose or gain its quality all through the steps.



## Physical characteristics used to separate seeds are

1. Size grader : Based on size it can be separated with air screen cleaner cum
2. Length : Disc or indented cylinder separator
3. Weight : Specific gravity separator
4. Shape : Spiral separator or draper separator for round and flat seeds
5. Surface texture : Rough from smooth surface seed- dodder mill

6. Colour : Electronic colour separator

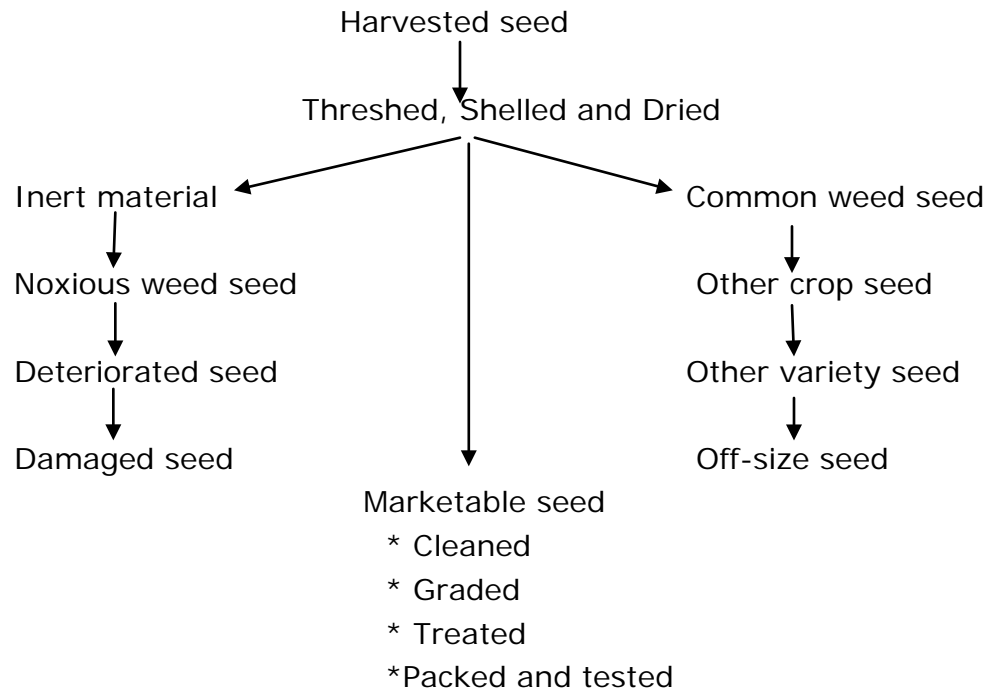
7. Electrical conductivity

Seed differing in their ability to conduct electrical charge can be separated with electronic separator.

8. Affinity to liquid

The seed coat of seed will absorb water, oils etc., which provides a means of separating seed on the magnetic separator.

**The flow charts illustrating the types of materials removed from harvested produce during processing.**



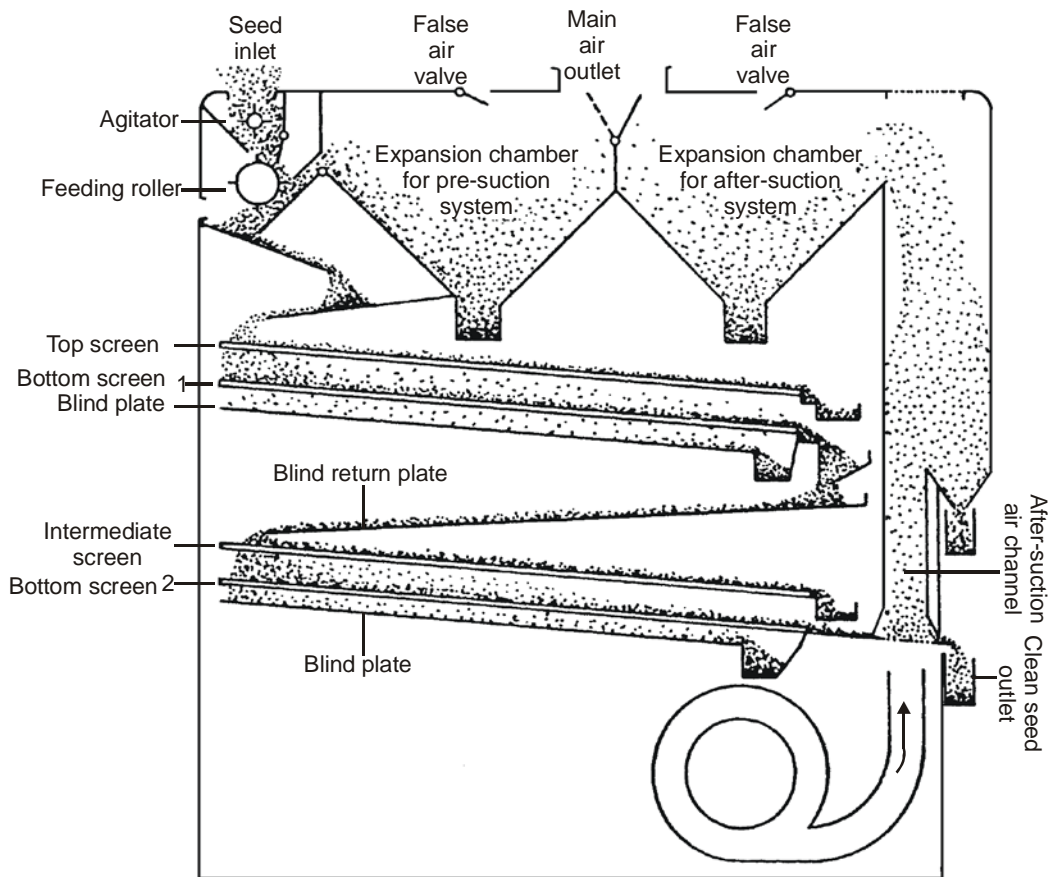
## Seed processing equipments

### I. Air screen cleaner

This is the most important machine of every cleaning plant. It uses screens and aspiration (air blow) for two separations (Fig.6). A coarse upper screen removes larger material, a lower fine screen stops the seeds and lets through fine matter and then the seed fraction passes through a transverse or nearly vertical air stream which can separate light impurities such as



empty or partly filled seeds, husks and glumes from the seed. In most cases a number of sieves with different sized perforations are used and the cleaning is a process of gradually shifting out smaller particles. Factors which determine the quality and quantity of seed cleaned include (i) size of the perforations, (ii) the precision of the perforation, (iii) the angle at which the sieves operate, (iv) the amplitude and speed of movement of the sieves and (v) correct cleaning and maintenance of the equipment.



## II. Cleaner cum grader

The dried seeds should be cleaned and graded with help of a cleaner cum grader. For large scale cleaning and grading the commonly available machine is the "Crippen Model Seed Cleaner cum Grader".

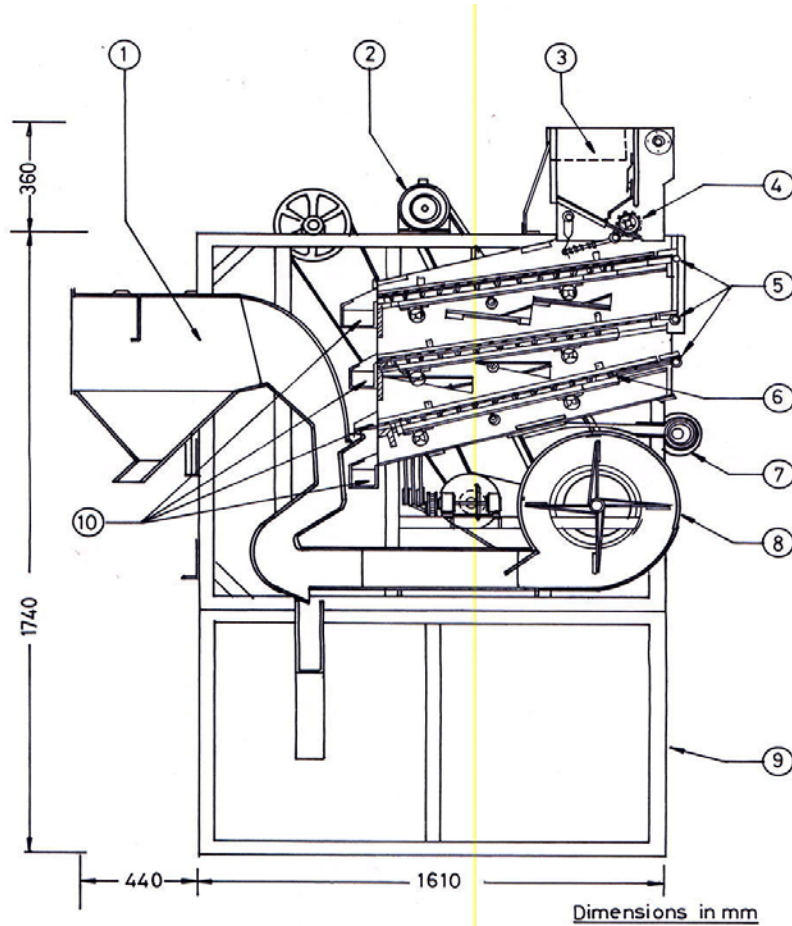
### It consists of the following parts

- ❖ A hopper in the top for seed filling

- ❖ A fluted roller below the hopper to regulate the seed flow to the screen.
- ❖ Screen (or) sieves: Perforated metal sheet with specific size of perforation in which there are two types.
  - Rectangular perforations for paddy and
  - Round perforations for seed other than paddy
- ❖ Screen shaking unit : for oscillating the sieves to move the seeds on the screens
- ❖ Screen brushes to remove the blocked seeds
- ❖ Air blower with adjustments for air outlet
- ❖ Collecting outlet
- ❖ Air duct for directing the blown up light particles to outside
- ❖ Collecting bins.

### **Working principle**

The seeds are fed into the hopper and they are guided to fall on the first sieve. The first sieve is a scalping screen which scalps all the foreign materials larger and heavier than seed and the entire quantity of seed passes through the first sieve. The second sieve is a cleaning sieve which removes all the unwanted particles larger in size than the seed. The third sieve is actually the grading sieve which size grade the seed lot and bring into a uniform size and which also screen the undersized, shriveled and immature seed, dust and dirt. The seeds are then rolled and passed through air column, where they are relieved of the light chaffy and other materials by the blowing air.



- Dimensions in mm
- |                      |                   |
|----------------------|-------------------|
| 1. IMPURITIES OUTLET | 6. NYLON BRUSHES  |
| 2. MOTOR             | 7. ECCENTRIC      |
| 3. FEED INLET        | 8. BLOWER         |
| 4. FEED ROLLER       | 9. STAND          |
| 5. VIBRATORY SCREENS | 10. GRAIN OUTLETS |

## Adjustments

### Fluted roller

The speed of this roller can be adjusted so as to increase (or) decrease the flow of seeds to the hopper of the sieves.

### Slope (or) inclination of the screen

The angle of inclination of the screens can be adjusted according to the nature of seeds.

### Rate of vibration of sieve

This can be adjusted either to increase or to decrease the speed of the rolling seeds on the screen.

**Volume of air flow:** By increasing (or) decreasing the air inlet.

**Choice of screens:** According to variety we have to change the screen

### **Screen dams**

Small check dams, which can be provided here and there on the screens so that the seeds can be stopped a while and takes the charge either to pass or to roll.

### **Types of seed cleaner cum grader**

- I) Crippen model cleaner cum grader
- ii) Clipper model cleaner cum grader
- iii) Petkas cleaner cum grader

### **III. Disc separator**

It consists of a series of discs, which revolve together on a horizontal shaft inside the cylindrical body. Each disc contains many under cut pockets. The seed enter the intake end of the separator and move through the open centers of the discs towards the discharge end of machine. As the discs revolve through the seed mass the pockets lift out short seed but rejects longer seed. Longer seeds are conveyed by flights on the disc spokes towards the discharge end of the machine where they go out through the tailings gate. The rate of seed travel through the open disc centers is controlled by conveyor or blades attached to the spokes of the discs. The disc separator makes a very precise separation. No factor other than seed length and shape affects its separation. Flexibility is obtained by varying size of the pockets.

### **IV. Indented cylinder separator**

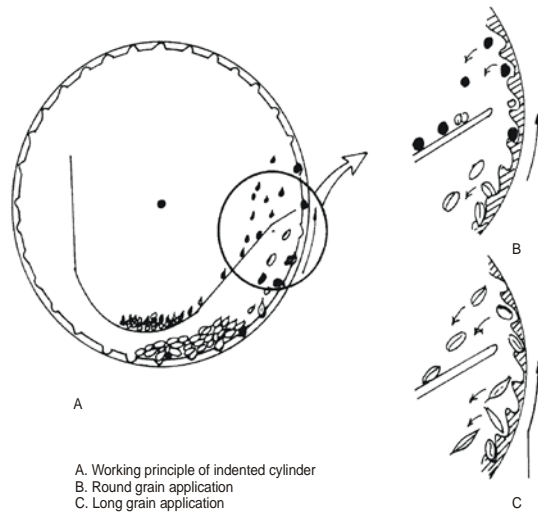
The indented cylinder separator is a rotating, almost horizontal cylinder with movable, horizontal separating adjustments which are mounted inside it. Indent lines are there inside the surface of the cylinder. The

indented cylinder revolves, turning the seed mass to give each seed a chance to fit into indent. Short seeds are lifted out of the seed mass and are dropped into the lifting and long seeds remain in the cylinder and are discharged out via., a separate spout at the end of the cylinder.



***Lab Model***

As the cylinder revolves, it creates centrifugal force which helps to hold the seed in the indent. Short seeds are held in the indent until the cylinder turns to the point where the indent is inverted enough for gravity to cause the seed to fall out of the indent. The length, surface texture and size of seeds determine how they fit into the indent, so that it can be lifted out of the seed mass. The speed of the cylinder creates centrifugal force which holds the seeds in the indent as it are lifted upward. Thus the shape and size of the seed to cause some seeds to fall out after being lifted only a short distance, while other seeds are lifted closer to the top of the cylinder before they fall out.



### ***Working principle of the indented cylinder separator***

As the seeds enter the cylinder, the small, short, easy to separate seeds are quickly removed. The center cylinder section removes the intermediate sizes of seeds still in the cylinder. All indents in a cylinder are the same size, only the progressively declining amount of material to be lifted causes this difference in separating action.

### **Adjustments**

- 1) Cylinder speed
- 2) Size of the indent
- 3) Trough setting
- 4) Tilt of the cylinder
- 5) Adjustable retarder.

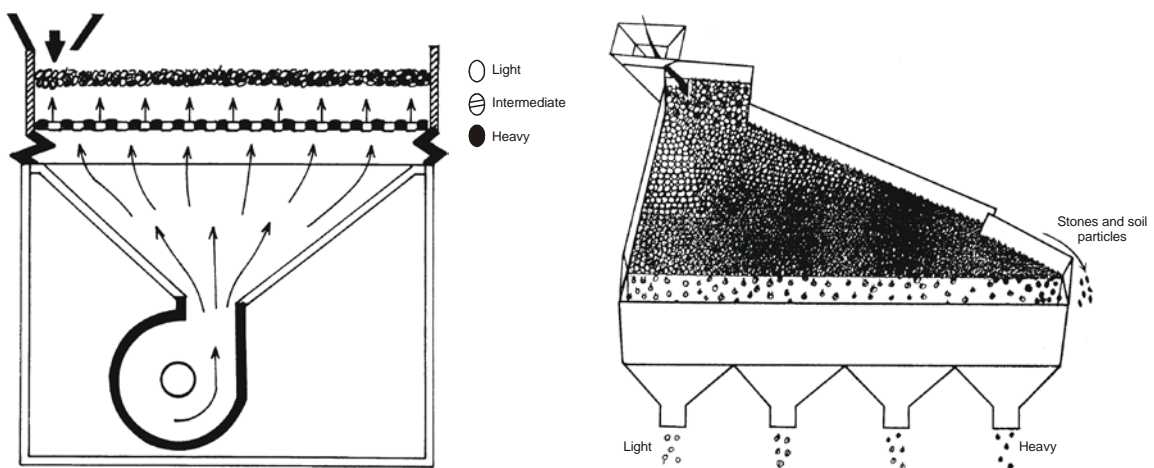
### **V. Specific gravity separator**

Seeds of the same size and general shape can often be separated because they differ in specific gravity or relative weight. This difference is very useful in removing light, immature seeds or heavy sand and rocks to improve the purity and germination of crop seeds.



**Lab Model**

If seeds which differ in specific gravity (relative weight / unit of volume) are placed on substrate of intermediate density, seeds of higher specific gravity will fall down through the substrata, while seeds of lower specific gravity will be buoyed up the substrata. Here air is used as separation substrata.



**Working principle of the specific gravity separator**



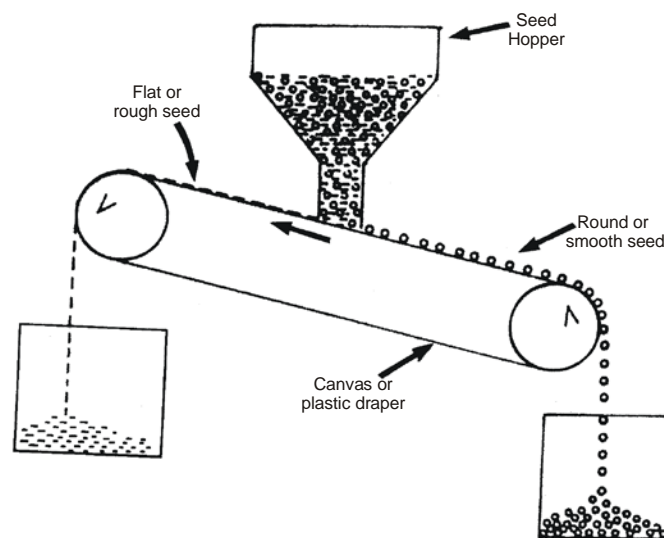
As seeds flow on the deck of the gravity separator, they enter a column of air coming up through the porous surface of the deck. The pressure of terminal velocity of the air rising through the deck can be controlled very closely to separate two kinds of seeds differing in specific gravity, the air is adjusted so that only the lighter seeds are lifted up off the deck surface. These lighter seeds are held up by air pressure and tend to float on the deck surface. The heavier seed possess a velocity greater than that of the air columns so they are not lifted and so will lie on the deck surface. The air column thus stratifies the seed mixture into vertical zones of relative weight with the heavier seed lying on the deck and the lighter seeds lifted up to the top of the seed mass.

### Adjustments

1. Feed rate 2) Air flow 3) End slope 4) Side slope 5) Deck oscillation speed 6) Deck speed.

### VI. Roll mill or dodder mill or velvet roll mill

It is used to separate the seeds based on surface texture and shape. This separator should be used only after the seed has been carefully cleaned and separated from the chaff. These are effective in separating seeds with a rough seed coat or shape angles from smooth seeds.



***Working principle of the roll mill***

The roll mill consists basically of two rollers, covered with flannel or velvet, placed side by side, so that they touch each other down their entire length. The rollers are mounted on an incline and they turn in opposite directions. A curved adjustable shield is mounted above the rollers.

### **Separating action**

The mixture of smooth and rough seeds is fed into the place, where the rollers touch each other, at the high end of the machine. As the rollers turn up and out, seeds that are rough or have sharp or broken edges are caught by the nap of the fabric covering the rollers. These seeds are thrown up against the curved shield. They strike the shield at an angle, bounce back down to the roller and are again thrown up against the shield. Smooth seeds bounce down the inclined position forward between the rollers, and discharge at the lower end of the machine. They are not affected by the fabric roller covering, and are not pitched over the side of the rollers.

### **Adjustments**

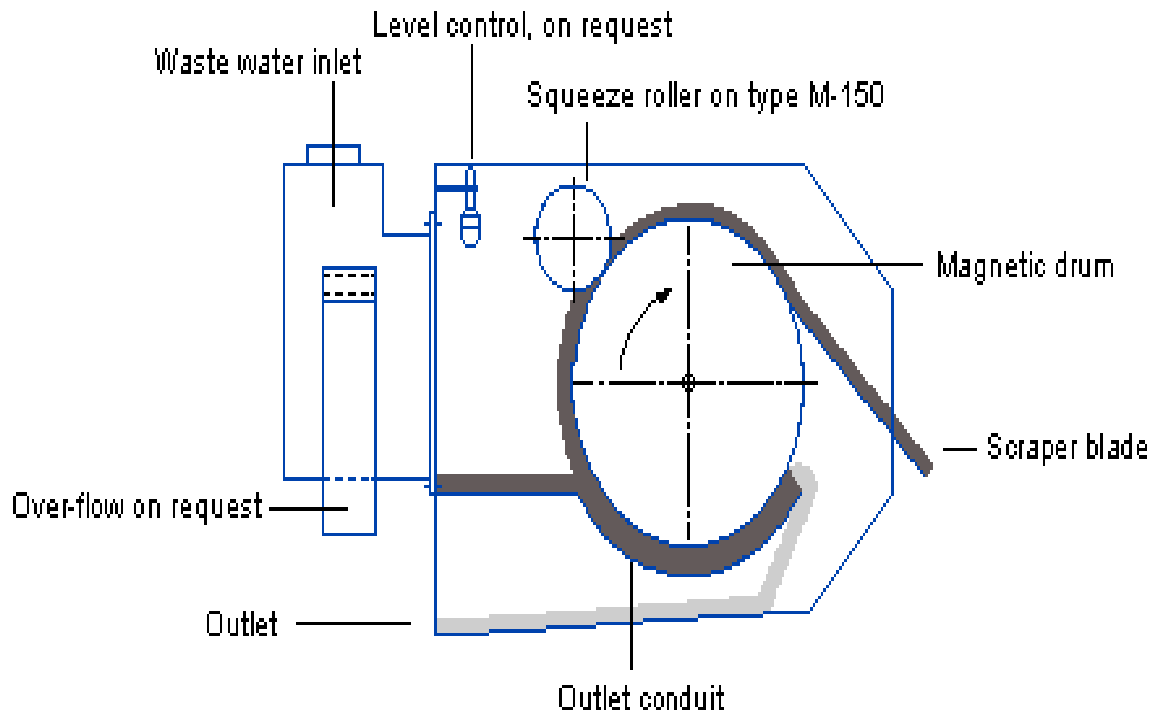
1) Rate of feed 2) Speed 3) Clearance between shield and rolls 4) The angle of inclination of rolls.

### **VII. Magnetic separator**

The separation is mainly based on the affinity for liquids which is used for separation. Since seeds contain no free iron and are not attracted by a magnet they must be selectively pretreated with a magnetic material such as finely ground iron powder. Rough seed coats, cracked or broken seed coats, dirt lumps, chaff or seed with a sticky residue on the surface will hold the liquid and become sticky, so that iron powder will adhere to them. Smooth coated seeds will not absorb liquid. So no iron powder will adhere to them.

The seeds are then discharged from mixing chamber and brought into contact with a powerful magnet, which removes the iron coated seeds. Most magnetic separators pass the seeds over a revolving drum which has a high intensity magnetic field. Seeds with an affinity for liquids which are now

coated with iron powder are attracted by the magnet and adhere to the drum until they are removed by a brush or scraper. Seeds which are relatively free of iron powder are not attracted by the magnet and will fall into a separate discharge spout.



The first requisite of magnetic seed separation is that the seed to be separated must possess different seed coat characters. Crop seeds should have a smooth surface, while the seeds to be removed should have a rough surface which will retain liquid and can accept the iron powder. Success in separating the components depends upon the magnitude of seed coat differences and thoroughness with which the moistened seeds and the iron powder are blended.

### VIII. Colour separator

Many large crop seeds such as peas and beans differ in colour between varieties. Colour variation may also occur due to immaturity or disease. Electronic colour sorting machines can separate such seeds by difference in

colour and also remove mud balls and discoloured seeds in the same operation.



The electronic colour sorter views each seed individually with photo electric cells. The seed is compared with a selected back ground or colour range and is discharged from the machine according to its colour. If it is the great desired colour, the seed is discharged through the good seed spout. If its colour or shade falls within the reject range, a blast of compressed air deflects the seed and sends it in to the reject discharge spout. These are highly sensitive. Since the machine views each seed individually, capacity is low, but the initial cost is high and operating cost is less. The usefulness of machine is greater with large seeded crops.

### **IX. Spiral separator**

The separator, which classifies seed according to its shape and rolling ability, consists of sheet metal strips fitted around a central axis in the form of a spiral. The unit resembles an open screw conveyor standing in a vertical position. The seed is introduced at the top of the inner spiral. Round seeds roll faster down the incline than flat or irregularly shaped seeds, which tend to slide or tumble.



The orbit of round seed increases with speed on its flight around the axis, until it rolls over the edge of the inner flight into the outer flight where it is collected separately. The slower moving seed does not build up enough speed to escape from the inner flight. Most spirals have multiple inner flights arranged one above the other to increase the capacity.

### **Processing equipments used for improving the quality of the seed**

From harvest upto final stage of seed storage, the seeds are to pass through various seed proessing equipments depending upon the speciality and specificity. But some equipment like driers and seed cleaner cum graders are common for all types of seed. The processing machineries and equipments used in the seed handling are as hereunder.

S.No.	Processing equipments	Usage with reference to specific seed management
A.	Threshing with extraction equipments	
1.	Thresher	To remove the seeds from the inflorescence especially in cereals
2.	Ginning machine	To separate the lint and seed from kapas in cotton
3.	Maize sheller	To shell the seed from the cobs
4.	Pulse thresher	To remove seed from the pods
5.	Tomato seed extractor	To extract tomato seed from fruit without wasting the pulp
6.	Chilli seed extractor	For easy removal of seed from chilli fruits
7.	Groundnut decorticator	To shell the kernel (seed from the pods)
8.	Sunflower thresher	For removal of seeds from the head
9.	Debearder	To remove the awns form (Barley) the seed
10.	Mechanical scarifier	To scarify the hard seed mechanically to improve the germination of seeds
11.	Pebble mill	To remove webby hairs from grasses
12.	Timothy bumper mill	To remove weed seed from timothy seed
13.	Hammer mill	To remove the hook or appendages from the seeds (i.e. Stylosanthus)
B.	Driers	To reduce the moisture content to lower or needed level for safe handling both for processing and for storage at the final stage

C.	Grading equipments	
14.	Cleaner cum grader	This homogenize the precleaned seed based on size and is known as basic grading in seeds. The sieve sizes requirement vary with crop
15.	Precleaner and aspirator	This remove the inert material and dust particles from seed and improve the grading efficiency
D.	Upgrading machines	
16.	Specific gravity separator	Improve the quality of graded seed further using its weight or specific gravity. Heavier seeds are good storers and expresses maximum field establishment
17.	Indent cylinder	In lengthier seeds it maintains the size of seed (breadth and length). The broken / damaged are removed and good seeds are selected
18.	Disc separator	It is for removal of weed seeds and to improve the general appearance of seed
19.	Roll mill	To separate smooth seed from rough seed based on the surface texture especially the weed seed
20.	Magnetic separator	Removal of weed seed from clovers, alfalfa, trefoils and vetch
21.	Inclined draper	Separation of smooth or round seeds from rough, flat or elongated seeds
22.	Electronic colour sorter	Separation of off-coloured seed
23.	Electrostatic	Based on electrical properties removes



	separator	Johnson grass from sesamum seeds (Specific utility)
24.	Spiral separator	Separation of seeds based on shape (eg.) separation of rape, vetch and soybean seed from wheat, oat or rye grass
25.	Polishers	To improve the luster of seed
26.	Picker belts	To remove undesirable ears / pods from shelled seeds (eg.) Groundnut, Corn
27.	Vibratory separator	Removal of weed seed
28.	Seed treater	To treat the seed with fungicide and pesticide
29.	Seed packing machine	To easier the work and to avoid human error of mixing
30.	Conveyors / Elevators (Belt , Bucket)	Easier the transfer of seed from machine to machine and avoids the contamination of seed at various level.

Though all the machines are highly useful in improving the seed quality, specific machines are utilized for specific crop. The sequential usage of machineries varies with crop seeds (Gregg, 1967).

### **Precautions in handling processing equipment**

All machine adjustments like the speed, oscillation and duration should be perfect. Otherwise, it will result in mechanical damage of seed which reduces the quality of seed in terms of vigour, viability, storability and field stand. Drying of seed should be designed properly as the moisture content needed for threshing; grading, treating and bagging vary with operations. Dosage, exposure period and choice of chemical are important in mechanical seed treatment.

# Seed Treatment

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**By**

**Dr. Aninda Chakraborty**

# Definition

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Biological, Chemical, mechanical or physiological process designed to mitigate external and internal seed borne organism. Resulting in emergence of healthy seedling and subsequently healthy plants.

Or

It refers to the application of fungicides, insecticides or both or any other treatment given to seed for improving its quality either in storage or in field.

# Types of Seed Treatment

**A. Pre sowing seed** -Treatments-treatments given to the seeds before sowing to improve the germination and vigour potential and as well as to maintain the health of the seed.

I. Chemical treatments to improve germination and vigour potential.

II. Insecticidal and fungicidal treatment.

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III. Special treatments

A)Seed hardening

B) Seed fortification

C) Moist sand conditioning

D) Seed pelleting

E) Seed infusion

F) Priming

G) Fluid drilling

H) Separation of viable seeds

**B) Pre storage treatments**-primarily aimed towards protection against deteriorate senescence during storage

I. Halogenation

II. Antioxidant treatment

III. Seed sanitation

**C) Mid storage treatments**

I) Hydration – Dehydration

# I. Chemical treatments to improve germination and vigour potential

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

**Paddy:** Seeds can be soaked in 1 % KCl solution for 12 hours to improve the germination and vigour potential.

**Sorghum:** Seeds could be soaked in  $\text{NaCl}^2$  (1 %) or  $\text{KH}_2\text{PO}_4$  (1%) for 12 hours for improving the germination and vigour potential.

**Pulses :** Seeds can be soaked in  $\text{ZnSO}_4$ ,  $\text{MgSO}_4$  and  $\text{MnSO}_4$  100 ppm solution for 4 hours to improve the germination and vigour potential.

## **II. Insecticidal and Fungicidal treatments**

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Seed may be affected by viruses, bacteria, fungi, nematodes and insects.

### **Benefits of the insecticidal and fungicidal treatments:**

1. Prevents the spread of plant diseases
2. It protects the seed from seed rot and seedling blights.
3. It improves the seed germination
4. It provides protection from storage insects.
5. It controls the soil insects.

# Seed Treatment Fungicides

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Fungicides are applied to seed prior to planting to provide effective protection against many seed and soil-borne plant pathogens.

## Types

**Seed disinfection** - Disinfection is the elimination of a pathogen which has penetrated into living cells of the seed, infected it and become established—for example, loose smut of barley and wheat.

**Seed disinfestations** - Disinfestation is the control of spores and other forms of pathogenic organisms found on the surface of the seed.

**Seed protection** - Seed protection is chemical treatment to protect the seed and young seedling from pathogenic organisms in the soil.



# Seed treatment materials are usually applied to seed in one of four forms

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## 1. Dust

Main dis-advantage is dusty condition will prevail during the seed treatment and after handling.

## 2. Slurry (a mixture of wettable powder in water)-

Fungicide is applied to the seed along with soap like water suspension which can be mixed with seed by using special slurry treater

## 3. Liquids

Volatile fungicide is applied to the seed and it throughly mixed with them

## 4. Planter-box formulations.

# III. Special treatments

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## A) Seed hardening treatment

Purposes I) Drought tolerance ii) Cold tolerance

Applied to the seeds mainly to tolerate initial drought and cold. Cold tolerance treatment is given to germinated seeds, such treatments are given only to temperate crop and tree seeds.

The most important factors to be considered while seed hardening are

1. Seed : solution ratio (1:1)
2. The duration of soaking
3. Method of drying.

Chemicals used:  $\text{CaCl}_2$ ,  $\text{KCl}$ ,  $\text{KH}_2\text{PO}_4$ ,

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## **B) Seed fortification**

- Aim is to supply nutrients to seeds
- Main objective is to achieve the high vigour to overcome unfavourable soil reactions

Eg.) seed fortification with  $\text{MnSO}_4$  @ 0.5 to 1 %. will improve oxidation - reduction potential of seeds, which ultimately leads to higher germination.

## **C) Moist sand conditioning**

- Protinaceous seeds should not be soaked in water (e.g) soybean, etc. for these seeds, mix the seeds with moist sand @ 5 to 10% MC.



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## D) Seed pelleting

Nutrients are coated on the seeds

### Importance

- Normally in small seeds this technique is adopted .
- By pelleting we can increase the size of sees and we can make it free flowing one.
- Through this we can able to reduce the seed rate.
- It is also important for aerial sowing (gum arabica) in tree seeds.

**Materials used :** Nutrients , adhesive, filler material.

**Inert materials:** Lime,  $\text{CaCO}_3$ , Chalk powder.

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### E) **Seed infusion**

- Infusion of nutrients and growth promoting substances with organic solvents like acetone and dichlormethane.
- organic solvents, slowly increase the chemicals in to the seed.

### F) **Priming**

Controlled hydration of seeds to start early events of germination followed by drying back before radicle emergence

Types

1. Hydro priming
2. Osmotic priming
3. Matrix priming

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## G) Fluid drilling

- Mechanical sowing of germinated seeds.
- seeds are coated with a jelly material called guar gel.

## H) **Separation of viable seeds**

This can be done in 2 ways

1. Manual separation based on radicle emergence (groundnut)
2. IDS (Incubation - Drying and Separation) method

# B. Pre storage treatments

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Prestorage treatments of harvest-fresh seed are primarily aimed towards protection against deteriorate senescence during storage. Seed storage which is again threatened by insect and pathogen attack, can also be taken care of by prescribed prestorage seed treatments.

i. Halogenation

ii. Antioxidant treatment

iii. Seed sanitation



# C. Mid storage treatments

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Seeds in storage accumulate damage to cell membranes during senescence. Mid storage seed treatments are capable of reducing the age induced damages and restoring the seed vigour to a certain extent besides, the seed viability and productivity of stored seeds are also improved.

## **i) Hydration – Dehydration**

Soaking the low and medium vigour seeds in water with or without added chemicals usually for short durations to raise the seed moisture content to 25 – 30% and drying back the seeds to safe limits for dry storage.

# The hydration – dehydration treatments

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1. Should be given only to **stored seeds**.
2. Is effective in **low and medium vigour non- leguminous seeds**,
3. The **moisture equilibration and moist sand conditioning** treatments in which moisture is taken up by the seed in a slow and progressive manner, are recommended for **relatively high- vigour seeds and seeds of pulses and leguminous vegetable crops**
6. **Direct soaking of leguminous** seeds should be avoided.
7. **Would not make a seed germinable**, which has already lost viability.

## Types of H-D treatments

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1. Soaking-drying
2. Dipping-drying
3. Spraying-drying
4. Stepwise Hydration-drying
5. Moisture Equilibration-drying
6. Moisture Equilibration Soaking-drying
7. Moist And Conditioning-drying

# SEED TREATING EQUIPMENT

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1. Dust Treater
2. Slurry Seed Treater
3. Mist-O-Matic Seed Treater



# SEED STORAGE



By  
**Dr. Aninda Chakraborty**



## **Definition:**

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

## **Purposes 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.
- To protect seeds from insects, pests, and diseases.
- To conserve seeds until they germinate for subsequent crop production.

# STAGES/SEGMENTS OF SEED STORAGE

1	<b>Post maturation/ Pre harvest segment</b>	Period from physiological maturity to harvest (seed in field).
2	<b>Bulk seed segment</b>	Period from harvest to packaging (bulk seed in aeration drying bins, surge bins, etc.).
3	<b>Packaged seed segment</b>	Period from packaging to distribution (seed in Packages in warehouse).
4	<b>Distribution /Marketing Segment</b>	Period during distributing and marketing (packaged seed in transit and / or retailer's storehouse).
5	<b>On-farm segment</b>	Period from purchase to planting of seed (seed in on-farm storage).



# Types of storage

## **a) Storage of commercial seeds**

This storage of commercial seed requires the largest storage need from harvest until planting. The storage period ranges from 8-9 months. Seed must be dried to 14 per cent moisture content for starchy seed and 11 percent for oilseeds.

## **b) Carryover seeds**

About 20-25 per cent of stored seed may have to be carried over through one season to the second planting time. The storage period may range 1-1½ year. Storage of seeds in metal bins with tight fitting lids or in a moisture proof bag will solve the problems of moisture penetration, provided the seeds are already dry enough for sealed storage.

### **c) Foundation stock and enforcement seed sample**

It is desirable to store foundation and enforcement seeds for several years since genetic drift are minimized by reproducing foundation or stock seeds. Since the quantity of seeds involved is not large, the storage room is only a small part of the total storage area and in fact, is often a small room within a large warehouse. Relative humidity and temperature combination has to be provided for maintaining the viability. A combination of 25 per cent RH at 30°C temperature or less or a RH of about 45 per cent at 20°C or less will be ideal. The required RH can be achieved by making the room moisture proof and by using a dehumidifier.

### **d) Germplasm seed storage**

Germplasm seeds are required to be kept for many years, perhaps very long periods. Basic requirements for such long term storage are the coldest temperature economically possible and seed moisture is in equilibrium with 20-25 per cent RH. Germplasm storage built up so far have rooms which can be maintained at 5°C to 10°C and 30 per cent RH. In addition, the stored samples are dried to perfect moisture level.

# PRINCIPLES OF STORAGE

- a. Seed storage conditions should be dry and cool
- b. Effective storage pest control
- c. Proper sanitation in seed stores
- d. Before placing seeds into storage they should be dried to safe moisture limits.
- e. Storing of high quality seed only i.e., well cleaned treated as well as high germination and vigour.



# **FACTORS AFFECTING SEED LONGEVITY IN STORAGE**

## **1. Kind or variety of seed**

Seed storability is considerably influenced by the kind or variety of seeds. Some seeds are short lived. E.g.: Onion, Soybean and Groundnut. As a general rule starchy seeds can be stored considerably for a longer period compared to proteinaceous or oily seeds because of their hygroscopic nature.

## **2. Initial seed quality**

Seed lots having plumpy, vigorous undamaged seeds store longer than that of deteriorated. Even seed lots having good germination at the beginning of storage period, may deteriorate at a faster rate depending upon the severity of weathering damage, mechanical injury or otherwise in the field. The low quality seeds should invariably be rejected. Even at best storage conditions, the initial quality of the seed cannot be improved (except for the dormant seed) but can only be maintained.

### 3. Moisture content

The most important factor influencing seed viability during storage is the moisture content and the rate of deterioration increases, as the seed moisture content increases. The drier the seed the higher will be the storage life.

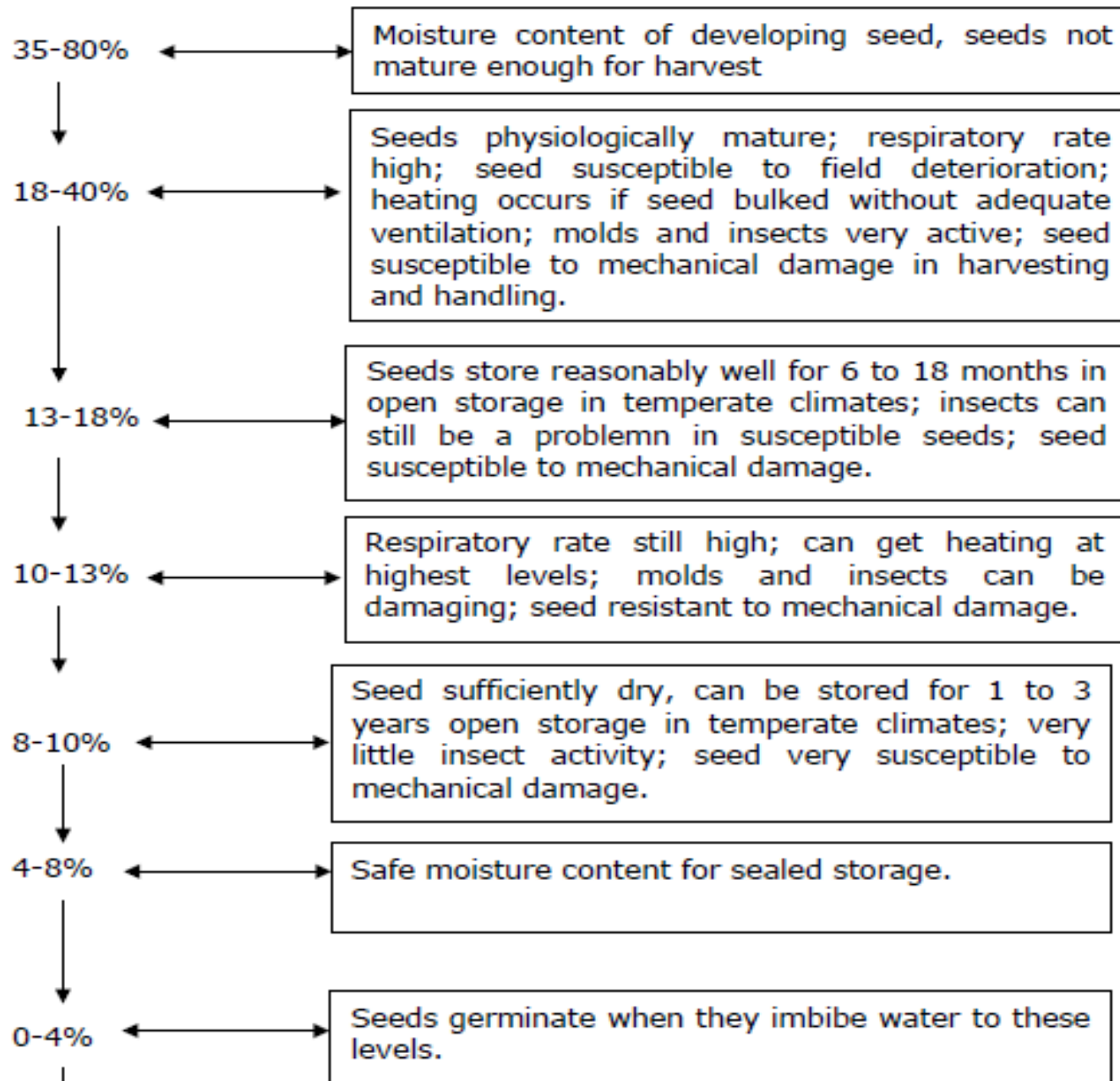
#### Seed moisture content (%) Storage life

11-13	-	½ year
10-12	-	1 year
9-11	-	2 years
8-10	-	4 years

### 4. Relative humidity and temperature during storage

Seeds are hygroscopic. They attain rather specific and characteristic moisture content when subjected to given level of atmospheric humidity at a particular temperature (equilibrium moisture content). The equilibrium moisture content for a particular kind of seed at a given relative humidity tends to increase as temperature decreases and the deterioration starts.

# Role and importance of moisture content in the life of seeds





# Harrington's rule:

- A one per cent decrease in moisture content nearly doubles storage potential of seed.
- A 10° F decrease in temperature nearly doubles storage potential of seed.
- Good seed storage is achieved when the percentage of relative humidity in storage environment and the storage temperature in degrees Fahrenheit add up to one hundred



## 5. Provenance

The seeds harvested in different climates (or) at different times show differences in viability. Because they would have been subjected to different pre harvest conditions which will have caused different amounts of deterioration by the time, the seeds are harvested.

## 6. The activity of organisms associated with seeds in storage

The bacteria, fungi, mites, insects, rodents and birds may do harm to seeds in storage. The general limits of temperature and relative humidity for the multiplication of the various biological agencies infesting stored seeds are,

Organism	Temperature		Relative humidity
	Range for multiplication	Optimum range	
Insects	21-42°C	27-37°C	30-95%
Mites	8-31°C	19-31°C	60-100%
Fungi	8-80°C	20-40°C	60-100%
Microbes	8-80°C	26-28°C	91-100%

# Classification of packing materials or containers

## 1. Moisture and vapour pervious containers

These containers allow entry of water in the form of vapour and liquid. These are suited for short term storage. The seeds in these containers will attain seed equilibrium moisture with the surrounding atmosphere (eg) cloth bags, gunny bags, paper bags etc.

## 2. Moisture impervious but vapour pervious containers

These allow entry of water in the form of vapour and not in liquid. The seeds in the containers can't be carried over for long period in hot humid conditions (.g.) polythene bags of <300 gauge thickness and urea bags.

## 3. Moisture and vapour proof containers

These containers will not allow entry of moisture in the form of liquid or vapour. These are used for long term storage even in hot humid conditions if the seeds are sealed at optimum m.c. eg. Polythylene bags of >700 gauge thickness, aluminium foil pouches, rigid plastics etc.

# Seed selection for extended storability

- ✓ Store well mature seeds.
- ✓ Store normal coloured seeds
- ✓ Seeds should be free from mechanical injury
- ✓ Seeds should not have met with adverse conditions during maturation
- ✓ Seeds should be dried to optimum moisture content.
- ✓ Seeds should be treated with fungicides before storage.
- ✓ Suitable packaging materials should be used for packing.



# STORAGE GODOWNS AND THEIR MAINTENANCE

- For construction of a godown, the points to be noted are as follows-
- Seed godown should be in a place where transport facilities are easily available.
- Seed godowns should not be constructed in areas near seashore. Since the high RH of atmospheric air accelerate the deterioration of seed.
- Seed godown should not be constructed in low lying water stagnating areas.
- Seed godown should be constructed in places where atmospheric RH is low, free circulation of air is possible, sunlight is adequate and elevated in nature.
- The ventilators should be at bottom for free air circulation.
- Ground moisture should not reach the floor.
- Should be rat proof with wire mesh
- Should not be near industries as smoke is injurious

## **In maintenance of seed in godown following points are to be considered**

1. Godown should be clean and dry
2. Seed bags should not be stacked directly on floor. Should be stacked on wooden ballets.
3. The height of the stack should not be more than 6-8 bags.
4. Different seed lot should be kept separately.
5. Godown should be sprayed periodically once in a week or fortnightly with Malathion 50 EC (1 : 300 Chemical : Water) @ 5 lit. sq. m<sup>-1</sup> or 0.25% Nuvan @ 1 lit. 100 m<sup>3-1</sup>.
6. Altering the chemicals at weekly intervals will give better control.
7. Seed lots can be fumigated with Aluminium phosphide @ 3 gm/cu.m in air tight condition for 7 days. This can be done as prophylactic measure and on minimum infestation by insects.
8. Seed lots should be periodically (once in month) tested for seed quality.
9. Based on seed testing result, seeds can be dried under sun for the removal of moisture. It reduces insect and pathogen infestation.
10. New seed lots should be kept away from old seed lots to avoid secondary infestation of insects.
11. Seeds should be treated with combination of fungicide and insecticide (eg.) Thiram @ 2 g kg<sup>-1</sup> + carbaryl @ 200 mg kg<sup>-1</sup>.
12. Frequent supervision of each and every lot is must.
13. Seed bag should be restacked once in 3 months for free aeration.
14. Instead of gunny bags low cost interwoven polythene bags should be used to prolong the life of seed.
15. Pesticides, fungicides, fertilizers, rejects should not be stored with seed.
16. Each lot should be labeled accurately and registers for stocks should be maintained.

# Maintenance of store house hygiene

1. Cracks and crevices around corners have to be brushed to eliminate hiding pests. All debris should be removed. Provision of wire meshes to windows, ventilators, gutters, drains to prevent entry of rats, squirrels, birds, etc.
2. Reduce the moisture content of seed to prevent insect build up (usually below 10%). Previously used bags, bins, etc. should be dried in the sun repeatedly.
3. Elimination of conditions which favour storage pests. Uniformly graded seeds should be used, broken seeds should be removed before bagging since they favour pest build up. Stitching of all torn bags, filling bags up to the brim, no loose packing.
4. Surface treatment of storehouse before storage with malathion dust 4% @ 25 g/sq m or malathion 50% EC spray @ 10 ml/lit of water and 3 lit of solution per sq. metre.
5. Good dunnage by arranging wooden planks or bamboo poles or spreading thick polythene sheets on the floor. Treatment of dunnage materials with malathion as specified, arrange the bags in crisscross pattern with a maximum of 15 bags and provide adequate space between the roof and the seed bags.



# Prophylactic treatment of seeds

**Phosphine** : Available in a solid form (0.6 g pellets, 3 g tablets). The active ingredient is Aluminium phosphide mixed with Ammonium carbonate and Paraffin. After exposure to the atmosphere, the pellets decompose and release the active substance, hydrogen phosphide ( $\text{PH}_3$ ), which has the same specific weight as air, and is thus evenly distributed in the fumigated material or chamber. Phosphine is also able to penetrate bags, carton boxes and other containers.

It must be borne in mind that fumigation particularly repeated fumigation, may seriously reduce the vigour and viability. This is particularly true for seeds with a higher moisture content of 14 per cent. Seeds with moisture content above 14 per cent should be dried, before fumigation.

**Aluminium phosphide:** Three tablets of 3 g each per ton of seed for cover fumigation (only selected blocks of bags)

Twenty one tablets of 3g each for 28 cubic metres, for shed fumigation (entire godown).  
Period of fumigation - 5 days. The major advantages of Phostoxin are that it lacks residues and does not affect flavor or germination and is easy to handle.

**Methyl bromide:** Above  $5.6^\circ\text{C}$ , methyl bromide is in the gas phase and is available in cylinders similar to those used for cooking gas. Since, it is odorless, other gases such as chloropicrin are sometimes added to facilitate detection of leaks. Because methyl bromide is 3.5 times heavier than air, care has to be taken that it is properly distributed within the goods to be fumigated (fan can be used). The recommended dosage is  $20 \text{ g/m}^3$  for 24-48 hrs.



# Biotic factors of Seed Storage

**Primary feeder-** These insects mostly lay eggs inside or on the seed and spent a part or entire larval or pupal life inside the seed.

- 1) Rice Weevil- *Sitophilus oryzae*
- 2) Lesser Grain Borer- *Rhyzopertha dominica*
- 3) Pulse Beetle- *Callosobruchus maculatus*
- 4) Angumois Grain Moth- *Sitotraga cereallela*

**Secondary feeder-** This group of insects feed on endosperm from outside.

- 1) Rice moth- *Corcyra ceohalonica*
- 2) Red Flour Beetle- *Tribolium castaneum*
- 3) Khapra Beetle- *Trogoderma granarium.*



THANK  
YOU





## SEED DORMANCY



IOWA STATE UNIVERSITY  
Department of Agronomy  
Crop, Soil, and Environmental Sciences

## Seed dormancy definitions

- Seed dormancy is a survival mechanism by which seeds can delay germination until the right environmental conditions for seedling growth and development.
- Seed dormancy is a mechanism that prevents a viable seed from germinating when placed in an ideal environment for germination



Reasons for dormancy

## Seed dormancy

- Seeds are dispersed from the parent plant with different degrees of dormancy.
- Adaptation – avoidance of seed germination under unfavorable weather conditions.



## Seed dormancy

- Dormancy also helps distribute the germination in time through its dependence on environment.
- Distributes germination in space reducing competition

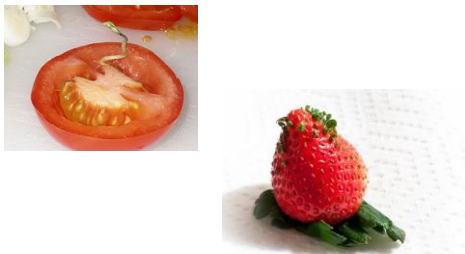


Importance of dormancy

### Is seed dormancy important?

- Important survival mechanism of weedy species, desert species, and over-wintering species
- Seed Bank
- Optimize germination over time and space
  - Time: environmental cue for germination
    - Temperature, Light
  - Space: transportation means may help break dormancy
    - Animal digestion

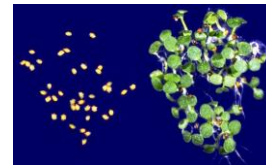
### Lack of Dormancy



Types of dormancy

### Primary and secondary seed dormancy

- Primary dormancy- present at dispersal
- Secondary dormancy- develops after dispersal



"Primary embryo dormancy is the inability of mature seed to germinate until specific environmental stimuli are perceived."

<http://www.plantbio.uga.edu/~galau/>

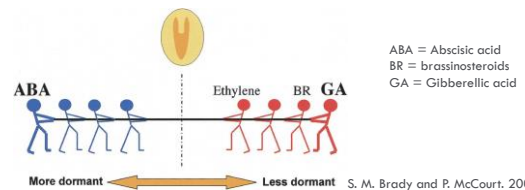
### Types of seed dormancy are based on mechanisms for dormancy

- **Physical dormancy mechanism (exogenous)-** a physical characteristic of the seed or seed coat prevents germination. EX: Hard Seeds

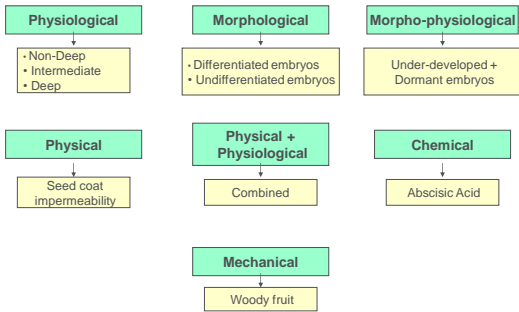


### Types of seed dormancy are based on mechanisms for dormancy

- **Physiological dormancy mechanism (endogenous)-** a physiological mechanism of the seed prevents germination. EX: Immature embryo, Hormonal inhibition.



## Types of seed dormancy



## Dormancy Mechanisms: Seed Coat Impermeable to Water

- No water uptake
- Caused by genetic or environmental factors
- AKA hard seeds
- Alfalfa, Lathyrus, Red Clover, Vetches, Cotton
- Break dormancy with scarification, hot water, acid, and fire.



## Dormancy Mechanisms Seed Coat Impermeable to Gases

- No exchange of oxygen or in some cases carbon dioxide
- Slows respiration and metabolism
- Coffee and Cocklebur
- Break dormancy by leaching with water, chilling, removing seed coat, scarification



## Dormancy Mechanisms: Immature Embryo

- Embryo may be an undifferentiated mass
  - American Holly, Viburnums, Buttercups
- Embryo may need to increase in size
  - Ash trees, Pine trees
- After-ripening
- Break dormancy by alternating warm and cool temperatures, cool temperatures, hot temperatures, or long periods of storage

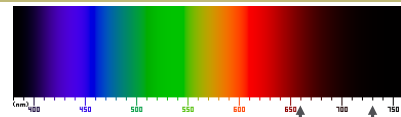


## Dormancy Mechanisms: Light Requirement

- Specific light quality (wavelength or intensity) or quantity (photoperiod) required for germination
- Lettuce, Birch, native grasses such as western wheatgrass, Virginia Pine, Tobacco, and Shepherds purse
- Break dormancy with Light



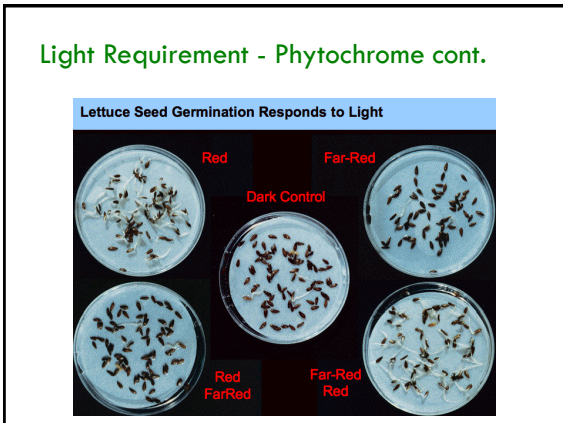
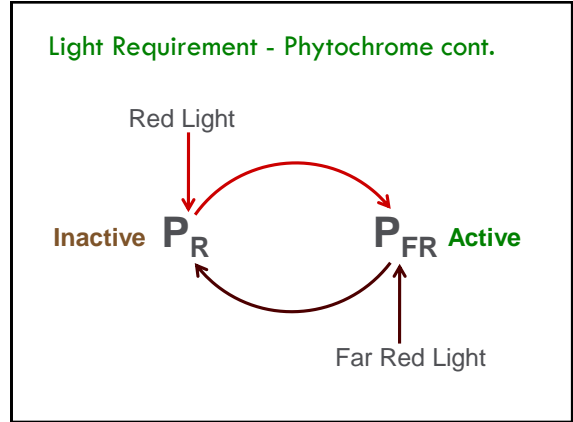
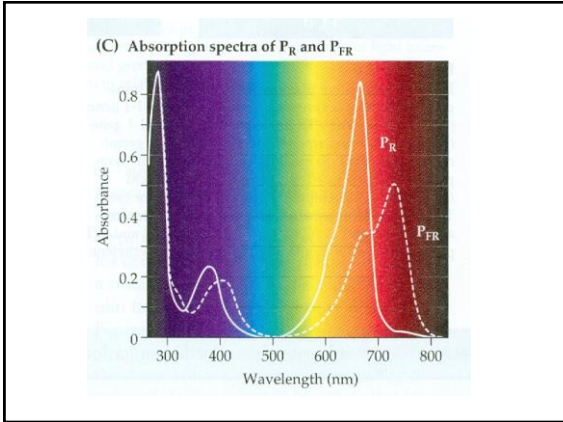
## Light Requirement - Phytochrome



Phytochrome is a plant pigment protein

- Phytochrome R is cis form
- Phytochrome Fr is trans form

Red Light (660nm) Far Red Light (730nm)



### Light Requirement - Phytochrome cont.

- Physiological role of phytochrome is unclear. Although, there are some theories.
  - ▣ Influences gibberellin synthesis
  - ▣ Selectively activates specific genes
  - ▣ Changes membrane permeability

(D) Phytochrome activities

### Dormancy Mechanisms: Temperature Requirement

- A certain temperature (high or low) is required for the seed to break dormancy.
- Stratification
- After-ripening

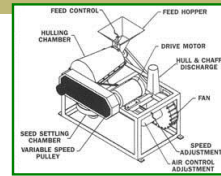
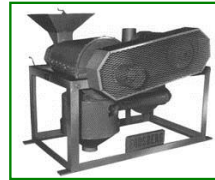
### After-ripening

- A progressive loss of dormancy in mature dry seed. During this period changes occur in the seed to allow it to germinate after time.

## Mechanically Breaking Dormancy

- Risky, seeds are easily damaged
- May reduce storage life of seed
- Horticulture industry uses other means of propagation if seed dormancy cannot be broken easily

## Huller and Scarification



## Brush Scarification





## **SEED MARKETING**

### **A definition of seed marketing**

Seed marketing should aim to satisfy the farmer's demand for reliable supply of a range of improved seed varieties of assured quality at an acceptable price.

- To the retailer in the agricultural sector, for example, it is selling seed along with other inputs to the farmer.
- To the farmer it is simply selling what he produces on his farm. However, whatever the circumstances, a well-defined sequence of events has to take place to promote the product and to put it in the right place, at the right time and at the right price for a sale to be made.
- Too many people think of marketing solely in terms of the advertising and selling of goods, whereas in reality marketing starts long before the goods exist and continues long after they are sold. Therefore, for the marketing process to be successful: the farmer consumer's needs must be satisfied; the seed company's objectives must be realized.

### **MARKETING STRUCTURE**

#### **Seed distribution systems**

Seed distribution can be carried out by government, public sector agencies, co-operatives and the private sector or, as is often the case, by a combination of all of these. Channels for seed marketing may be described as:

#### **Direct**

The seed producing organization supplies the farmer directly. Some features of direct channel distribution are:

- the supplier has direct contact with the consumer
- a high level of service and customer support can be maintained
- direct control is maintained over the quality of the product

- the upkeep of such a system can be expensive, with high fixed costs if a sales force is employed
- a responsive management structure and well-motivated staff are required where there are many staff involved in a direct sales organization there can be an inbuilt inertia to change so the system may lack flexibility.
- the revenue necessary to pay for the high fixed costs will only come from having a wide product range and achieving good market shares or selling high value products such as horticultural seeds.

### **Single level**

The seed producing organization supplies the farmer through independent retail outlets. The main features of this system are that:

- the seed supplier relies on the retailer for contact with the consumer
- retail networks require strong service and support from the supplier
- good administrative control must be provided by the sales management
- the supplier's distribution system must be well organized and responsive
- product quality at the retail level must be monitored for deterioration and adulteration and a return system should be considered
- although the products may be well promoted, the supplier relies on the retailer to make the final sale.

### **Multilevel**

The seed producing organization supplies a national distributor, wholesalers or regional distributors who, in turn, supply sub-distributors or the retail outlets.

This system is characterized by:

- the supplier having no direct contact with the consumer
- products being strongly promoted in order to create demand
- supplying seed to the distributors in sufficient time to achieve timely availability at the retail level

- management ensuring that there is a good system of monitoring sales and obtaining feedback from the consumer
- the distributor being interested only in the strongest selling lines.

If neither infrastructure nor the economy are well developed, national distributors may simply not be available and the seed producer will have to supply seed to regional wholesalers or distributors.

### **Sources of seed available to farmers**

For farmers there are a number of sources available for the purchase of seed. These are:

#### **Direct sales**

The seed producer supplies the farmer directly from central seed stores and a network of his/her own supply points

#### **Farmer producers**

Farmers with seed production contracts are licensed to supply other farmers within their zone of influence

#### **Cooperatives**

Cooperatives act as 'farmer producers' and/or as suppliers of inputs to members

#### **Farmer dealers**

Farmers act as dealers, supplying their neighbours; this can evolve into a highly developed system

#### **Commission agents**

These work directly with the producer or his/her intermediaries, passing on orders from the farmers

## **Grain merchants**

Traders involved in the seed and grain business who are also licensed seed producers

## **Crop buyers**

Collectors and crop or commodity traders who provide a point of contact with farmers and can be used to market seed

## **Retail store dealers**

Town and village dealers who retail a range of agricultural inputs, with the larger operators possibly having sub-dealers

## **Industrial processors**

Processors interested in specific crops including oilseed crushers and vegetable canners, who may have an interest in supplying seed as part of a growing contract or integrated production system

## **Cold store operators**

Potato cold store operators trade potato seed since they deal directly with the growers and have the appropriate storage

## **Consumer outlets**

Garages, shops and supermarkets (are best suited to display small packets of seed)

## **Mail order**

Suitable for low volume, high value products such as vegetables and flowers.

Although government extension outlets are not strictly retail outlets, seed is sometimes supplied to the farmer through government sponsored agencies and departments which administer crop or regional development and credit programmes.

## **ORGANIZATIONAL CHART**

### **1. Product management**

Concentrates on developing and implementing marketing policy for a seed product or range of products

### **2. Advertising, promotion and public relations**

Aims to create product awareness, influence farmers' buying decisions, (PR) and build up a positive perception of the company

### **3. Sales order administration and dispatch**

Involves receiving and processing orders, allocating stock and dispatching orders, and maintaining stock records

### **4. Stock control and quality assurance**

Involves managing the inventory for each class of seed, crop and variety, to ensure maintenance of germination and vigour

### **5. Distribution and transport**

Entails moving the seeds from the point of production to the point of sale

### **6. Sales and invoicing**

The process of making the actual sale and receiving payment for it, i.e. the end result of the marketing activity

## **7. Management information**

Involves collating and interpreting sales information and other information as a basis for monitoring operations and planning future activities

## **8. Customer care**

Involves after-sales service, dealing with complaints and maintaining customer loyalty

## **THE PROMOTIONAL ACTIVITIES**

Resources invested in variety development and seed production will be wasted if farmers are not persuaded to use the improved varieties. All promotional activities involve sending messages to the distributors and consumers in order to inform them about a company's products and help them to make their decision to buy a particular variety or brand of seed.

### **➤ Advertisements**

Messages sent via the media to inform and influence the farmer

### **➤ Sales promotions**

Specific techniques designed to increase sales of particular seeds

### **➤ Personal selling**

The importance of salesmanship

### **➤ Publicity and public relations**

Generalized communication which is designed to promote the company's image rather than that of specific seeds

## ➤ **Extension**

Farmers in developing countries have certain characteristics:

- They have low purchasing power coupled with a low rate of return from farming.
- They are generally conservative and therefore are slow to adopt new products.
- They may not be well informed.
- They often lack mobility and the means to transport goods.

It should also be recognized that educational and literacy standards will not always be high in rural communities. The use of visual material will help to overcome some communication problems. In all forms of communication, companies should always try to make the subject of seeds interesting and relevant to the consumer.

## **Advertising**

### **The published print media**

This includes newspapers, periodicals, magazines, trade and professional journals. There may be both advantages and disadvantages when advertising in this manner.

### **Some advantages of the printed media are that:**

- good coverage can be obtained and, by using the local press and specialist papers, accurate targeting can also be achieved
- it is relatively cheap and immediate
- complex messages can be given in print; these can be read again and again
- reply and cut-out coupons with an exchange value can be used to encourage farmers to request further information and buy the product.



### **Some disadvantages of the printed media are:**

- the text, and therefore the message, may not be well understood due to language and literacy problems
- only limited space may be available
- printed text has limited impact and colour does not always reproduce well in newspapers
- a daily paper has a limited life and the advertisements will have to compete for attention with stories and other information.

As well as placing advertisements, press releases can be given to newspapers or features written that carry the name of the company and its products.

**The broadcast media:** This includes television, radio and cinema.

### **Television**

Some advantages of television are:

- the impact will be greater as both sound, colour and movement can be used to convey the message
- massive coverage can be achieved and some local targeting may be possible.

Some disadvantages of television are:

- it can be very expensive and is only suitable for simple messages
- the exposure time is short and the advertisement may miss the target audience
- TV reception may be poor and if local targeting is not possible the message will not be relevant to many viewers
- there may not be any related interest programmes that will be viewed by the target audience

- in many countries farmers cannot afford television, although televisions are often available in clubs, bars and other public places.

## **Radio**

Some advantages of radio are:

- good coverage is achieved; this is not confined to the home as people listen to the radio everywhere, including when they are working on the farm
- it is relatively cheap to broadcast on radio compared to television and advertisements are easier to prepare
- the incidence of local broadcasting, in local languages, is greater than with television
- related interest programmes and farming information spots are usually more frequent.

Some disadvantages of radio are:

- reception may be poor in certain areas
- people don't always listen closely and consequently may have poor recall of the message.

Language problems can be overcome through local broadcasting and there is always the possibility of involving local personalities to add interest and relevance to the area. Radio is useful for making announcements, such as the availability of seed in the area. Another form of broadcasting is the loudspeaker van which can be used to tour villages or towns to make similar announcements, particularly on a market day.

## **Cinema**

In rural locations where cinema is the main entertainment a high proportion of the audience will be involved in farming so this medium could be considered for advertising. Advertising slides are not expensive to prepare and these can be shown during the show.

## The outdoor media

Outdoor media include posters, signs and advertising on transport, bus shelters, walls and buildings. These forms of advertising can be used to increase the visibility of the company and its products. Outdoor advertising may have considerable and lasting impact at a low cost if it is well situated and if there is not too much competition for the available space. Exclusive arrangements can always be made for the use of space.

In addition to commercial advertising, retailers should be supplied with signs and crop boards. It is important that good sites are chosen which are highly visible and strategically placed to ensure maximum exposure.

## Packaging design

Packaging is a form of advertising. Clear printing, the use of colour, brand or company logo and well reproduced photographs or images are all important components of design.





## **PRICING POLICY**

Seed pricing involves setting prices when a new product is launched or a new distribution channel is used. Also, decisions may need to be taken to change the price in response to competition and to the general market situation.

In the public sector prices are often based on an economic pricing policy. Economic pricing considers the effect of seed price on the economy, taking into account the amount officials think farmers can afford to pay and the role of the seed industry in the development of agricultural production. Ideally, however, the public sector should follow a more commercial pricing policy which accounts for all costs and allows for an element of profit.

Some objectives in government seed pricing could be:

- to induce farmers to use certified seed of improved varieties in order to increase national production
- to provide adequate incentives to seed producers to supply seed in sufficient quantity to meet demand
- to encourage the development of private distribution channels
- to implement government agro-economic policies.

Some objectives in private sector seed pricing are likely to be:

- profit maximization which will be the long-term target although there may be many other shorter term considerations which will influence pricing policy, such as increasing market share and gaining acceptance of new products
- price competition, may be achieved by setting a price that gives a competitive edge in the market place but may not be lower than that of a rival because other factors, such as service, will be contributing to a company's competitive advantage
- a yield 01? investment which must be at least as good as other uses for investors' funds.

### **Pricing strategies**

Once a company's seed pricing objectives have been established, different pricing strategies must be considered. These include:

### **Low price strategy**

Low price strategies are used where consumers respond very positively to small downward changes in price, but a company may not always gain from setting low prices as more efficient competitors may respond with similar price cuts. If the product is not particularly price sensitive then the net effect of a price reduction can simply mean a reduction in revenue. A company may be tempted to reduce its price where similar or substitute products are also sold or when there is an oversupply. However, seeds can become devalued by selling them cheaply especially where there are real benefits associated with the product. Imported vegetable seeds are often chosen by farmers in preference to locally produced varieties in the belief that they are better because they are more expensive. It is therefore critically important to understand the likely response of the farmer when adopting a low price strategy.

### **Market price strategy**

Where a few large companies dominate supply, products tend to be similar (known in the seed industry as "me-too" varieties) and the role of price tends to be neutral, i.e. a market price is established.

### **High price strategy**

This strategy can be used as a long- or short-term policy. In the case of the long-term policy the company will have identified a market segment for a high quality, value-added product such as graded and treated seed for precision drilling. A high price will reflect the exclusive image or added value of the product. A short-term, high-price policy takes advantage of a new product introduced onto the market, as may be the case with a new high-yielding variety where supply is limited.

### **Pricing techniques**

The important influences on pricing are cost, demand, prices of the product's main competitors and short-term sales targets.

### **Cost-plus pricing**

This method involves calculating the unit cost of a product and adding the appropriate profit margin to give a base price which might then be altered in relation to prevailing market conditions. While this seems a simple approach the fact that such pricing is production oriented and may therefore not reflect what is happening in the market place, makes it risky. A rigid application of cost-plus pricing may lead to price increases when demand is lower and reductions when demand is strong. This is the opposite of what should normally be done.

### **Contribution pricing**

This is a form of cost-plus pricing which involves separating the different products that make up the product portfolio and allocating to them the direct costs associated with their production. The price is determined at a level which will generate revenues in excess of these costs, thereby contributing towards meeting business overheads. Individual products can be analysed in terms of their ability to cover their direct costs and contribute to overheads.

### **Competitive pricing**

Where there is market competition, costs cannot always be the determining factor in pricing. Here the nature and extent of competition will have a major influence on the price. If a product is faced with direct competition from similar products the price will be restrained. In contrast, when a product is faced by indirect competition from products in different sectors of the market there will be more scope to vary the price. This provides the possibility of using different strategies.

### **Short-term pricing techniques**



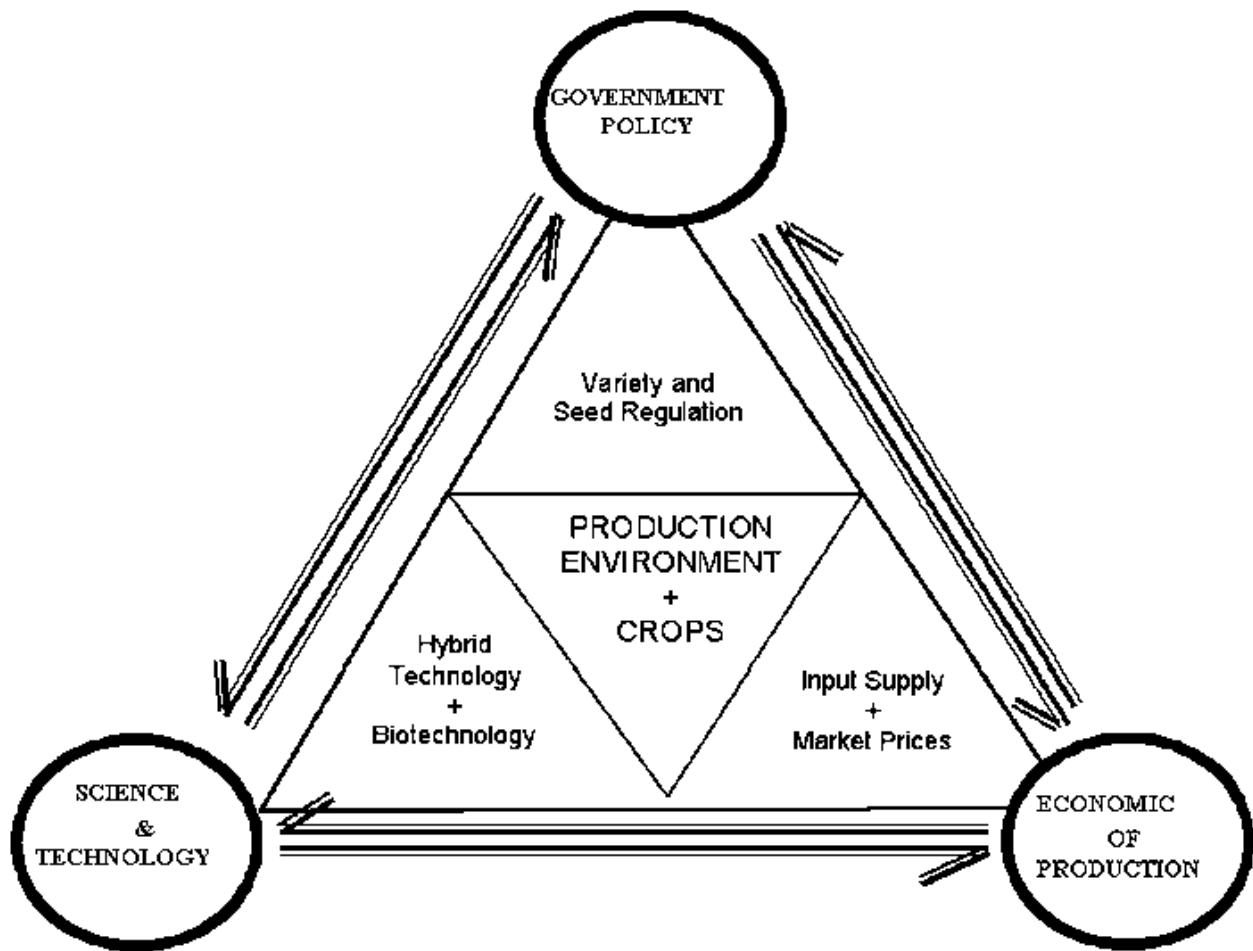
Pricing can be a useful tool for pursuing short-term marketing and sales targets. When a new variety is launched higher prices can be set, providing the opportunity of earning higher returns from those farmers willing to pay the higher prices before seed becomes more widely available. Lower prices may be linked to promotional activities such as boosting sales of established varieties, creating interest in new ones, reducing high stocks and encouraging farmers to buy early.

### **An overview of factors affecting the seed industry**

Three broad influences determine the development and status of the seed industry, namely:

- Technology - especially the flow of new varieties from research;
- Economics - both of seed production itself and of the agricultural sector generally; and
- Policy - creates the commercial and financial environment.

All of these factors can be modified and there are many interactions between them that ultimately determine the size, viability and other characteristics of the seed industry. Figure 1 provides a diagrammatic representation of this analysis, in which various influences on the seed sector are represented within the triangle formed by these three primary elements. Policy has been placed at the top because of the major impact it can have on technology and economics. At the centre lies the production environment, which forms the basis for agriculture, and which cannot be substantially modified, except by irrigation or protected cultivation.



We should recognize seed policy as a major tool for change, but also accept that it cannot alter certain physical and environmental factors and, in a free market, it will always interact with technology and economics. In addition to the policy designed specifically for seeds, wider social and environmental policies may also have an impact on the seed sector and these may be driven by public awareness. For example, the current debate in Europe about the use of genetically-modified crops is not primarily conducted on technical issues about seeds but on wider environmental and food safety concerns. It has nonetheless had a major effect on the seed industry.



# **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-dependes 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).<sup>1</sup>
- 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.

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