anujjindal.in

CHAPTER – 8 SEED PRODUCTION

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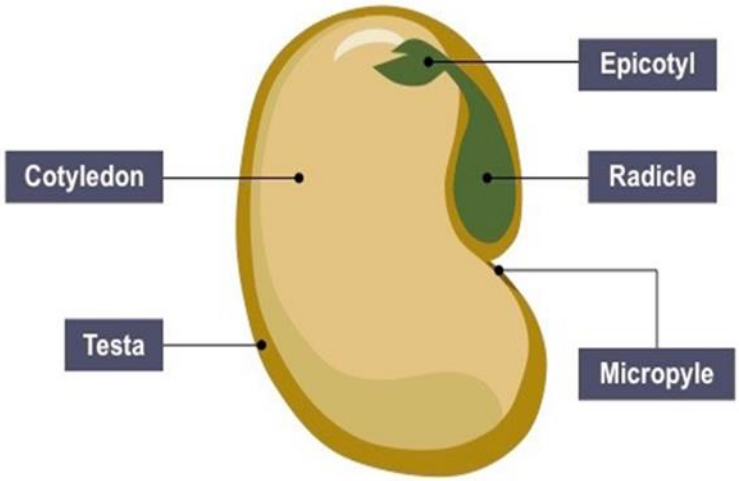
1. What is Seed?

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



1.1 Characteristics of Good Quality Seeds

1.1.1 Seed Health

Seeds with good germination capacity and seed vigour are considered as quality seeds. Seeds should be devoid of insect damage and infestation by any microbes like bacteria and fungi.

1.1.2 Physical Purity of Seeds

- The physical purity of the seeds should be maintained at 96-98% and the seeds should be of uniform size and shape without any damage.
- The seeds should be devoid of inert matter like dust, stones, seeds of other crop varieties, broken seeds, weed seeds, etc.
- After harvest, seeds should be separated from chaffy seeds and insect or disease affected seeds in order to maintain the physical purity of the seeds.

1.1.3 Genetic Purity

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

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

1.1.4 Moisture Content of the Seeds

- Seeds with high moisture content will lose its germination vigour and viability soon. Hence, it is necessary to maintain correct moisture content of the seeds in order to ensure the good germination capacity and viability.
- It is also essential to protect the seeds from pest infestation and attack by diseases.
- Seeds should be stored at a safe moisture level of 9 – 13%. Moisture content of the seeds is measured directly using digital moisture meter.

फसल (Crop)	नमी की मात्रा (Moisture Content)
धान्य फसलें (Cereals)	12%
कपास व सोयाबीन (Cotton and Soybean)	10%
दालें (Pulses)	9%
तेल बीज (Oil Seed)	8 – 10%
सब्जियाँ (Vegetables)	8%

1.2 Factors Influencing Seed Production

During seed multiplication, certain guidelines should be followed - otherwise the quality of the seeds will be affected.

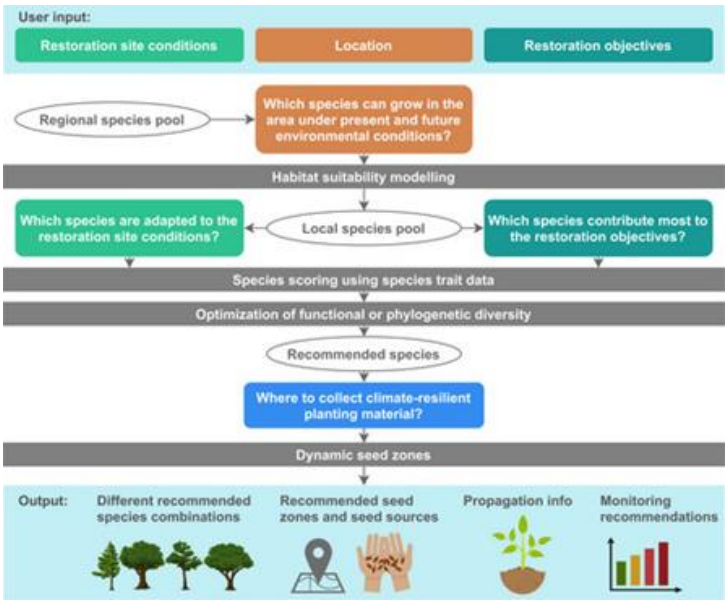
Site / Land Selection

- The soil in the seed production field should be fertile with adequate irrigation and good drainage facilities.
- The field should be devoid of high weed incidence and free from volunteer plants (Volunteer plants are the unwanted plants growing in the seed production field from the previous seasons' crop).
- The field should not be cultivated with the same crop variety in the previous season.
- It should have enough sunlight and proper aeration for the effective control of pest and diseases.

Selection of Species and Seed Source

- Healthy and uniform sized seeds from a reliable source should be selected.
- Seeds should be selected based on the type of seed production (i.e.) breeder seeds are required for the production of foundation seeds; foundation seeds are required for the production of certified seeds.

- Selected seeds should be genetically pure with high germination percentage and vigour.



Field Preparation

- Soil condition in the selected field should be suitable for the crop.
- The field should be ploughed thoroughly without any lumps.
- Green manure crops can be raised in the field in order to enhance the nutrient content of the soil.
- Organic manures like farm yard manure, compost and vermicompost can be used to enhance the soil fertility.
- Field should be irrigated well within three days of sowing to avoid hardness of the soil.

Seed Selection

- Salt solution can be used to remove the chaffy seeds from good seeds.
- Take some water in a vessel and drop an egg in it. Keep adding salt to it slowly until the egg reaches the surface of the water.
- When the seeds are dropped in this water, the good quality seeds will sink into the water. Remove the unviable seeds that float on the surface of the water.

- Wash the selected seeds in good water for 2 - 3 times to remove the salt deposits. If this is not done, the germination capacity of the seeds will be affected.

Seed testing

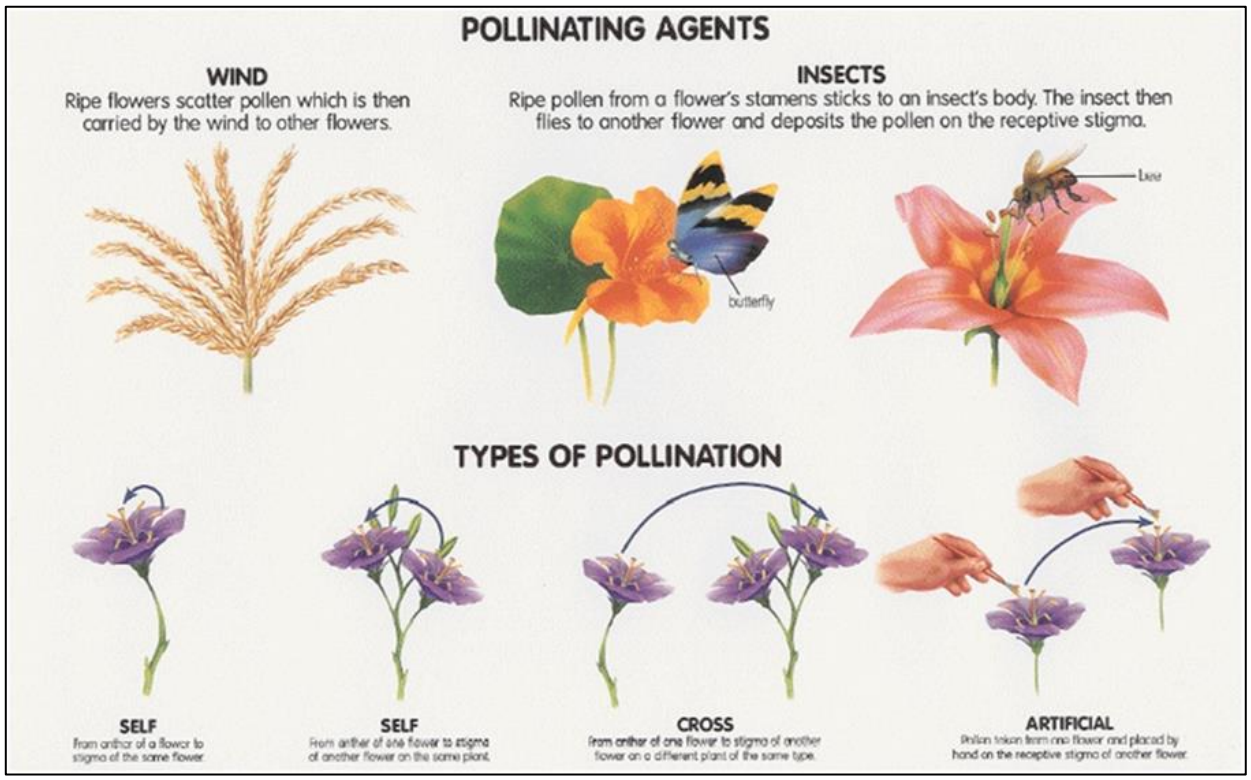
- The selected seeds should be tested for its viability, i.e. seed germination.
- Seed production and multiplication is possible only when the germination capacity is high. If the germination rate is high ultimately the seed multiplication can also be higher.

2.Maintenance of Pure Accessions

2.1 Pollination

In order to maintain pure accession, one has to ascertain the nature of pollination of the seed crop.

- **Self-pollination:** It can produce seeds without another plant. Pollen from the same flower or from the different flower of the same plant is utilized for pollination. Eg. Paddy, Green gram, Groundnut, Tomato etc.,
- **Cross pollination:** Pollen needed for pollination comes from the flower of another plant, hence two plants are necessary for cross pollination. Eg. Sunflower, Castor, Maize, Bajra, Cucurbits etc.,
- **Often cross pollination:** Here both self and cross pollination may occur. Eg. Chillies, Red-gram, Sesame etc.



2.2 Isolation distance

- It is the distance maintained between the seed crops and the different varieties of the same crop located in the adjacent area in order to maintain the genetic purity of the seeds.
- Maintaining appropriate isolation distance avoids cross pollination and crossing of genes. Two types of isolation are followed – space isolation (planting distance) and time isolation (difference in the time of sowing.

Crop species	Isolation distance
	(x 1000 m)
Onion (hybrid) (*Allium cepa*)[1]	3–5
Cotton (hybrid) (*Gossypium hirsutum*)[2]	2
Crucifers (*Brassica* spp.)[1]	1–1.5
Cucumber (*Cucumis sativus*)[1]	1–1.5
Carrot (*Daucus carota*)[1]	1–1.6
Sunflower (*Helianthus annuus*)[3]	2

Minimum isolation distance requirements of some crops:

Sr. No.	Crop	Minimum solation distance (m)	
		Foundation seed	Certified seed
A	**Self-pollinated crops**		
	Rice, Wheat	3	3
	Oat, Barley	3	3
	Soybean, Groundnut	3	3
	Black gram, Green gram	20	10
	Chick pea, Field pea	20	10
	Tomato	50	25
B	**Cross pollinated crops**		
	Maize, Mustard/Rapeseed	400	200
	Sunflower, Safflower	400	200
	Pearl millet	1000	200
	Cabbage, Cauliflower	1600	1000
	Onion	1000	400
C	**Often cross pollinated crop**		
	Cotton	50	30
	Sorghum	200	100
	Red gram	200	100
	Brinjal	200	100
	Okra, Chilli	400	200

फसल (Crop)	परागण (Pollination)	पृथक्करण दूरी (Isolation Distance)	
		F. S.	C. S.
गेहूँ (Wheat)	स्व (Self)	3m	3m
जौं (Barley)	स्व (Self)	3m	3m
धान (Rice)	स्व (Self)	3m	3m
ज्वार (Sorghum)	स्व (Self)	200m	100m
मक्का (Maize)	पर (Cross)	400m	200m
बाजरा (Bajra)	पर (Cross)	1000m	200m

2.3 Bagging Technique

- In order to protect the pollination through insects or wind , covering the floral portion of a plant is practiced.
- Materials like mosquito net, paper bags, and nylon stockings are used for bagging purpose. This mechanical isolation method is suitable for small quantity of seeds. Eg. Tomato.

2.4 Rouging

- It is the process of removing the plant varieties of other than the variety grown for seed production like other crops, weeds etc. to prevent plants with undesirable characteristics from propagating into subsequent generations.
- Off-types should be removed before their flowering stage. Off-types should also be removed after harvest, during drying, processing and storage.
- Timely rouging is critical for the conservation of the genetic purity of the seeds.

2.5 Harvest of the Seed Crop

- Harvest can be done only when the seeds attain complete physiological maturity (full size and maturity).
- Harvest should coincide with the dry season. It will increase the germination capacity of the seeds.
- Method of harvest and harvest time varies from crop to crop. Most preferred method of seed harvesting is manual harvesting. It will reduce the mechanical damage to the seeds.

3.Agencies involved in seed production

Seed sector in India is of two types namely formal and informal.

- **Formal Sector:** follows seed certification procedures and standards to produce a particular variety of seed. It involves mechanised production, quality control system, marketing through central and state agencies, private companies etc.
- **Informal Sector:** is the one where farmers produce seeds without following certification procedures and exchange it amongst themselves. System is locally planned, unmechanized production using local resources, no specialization, heterogeneous in space and time.

Status of Seed Production by different agencies

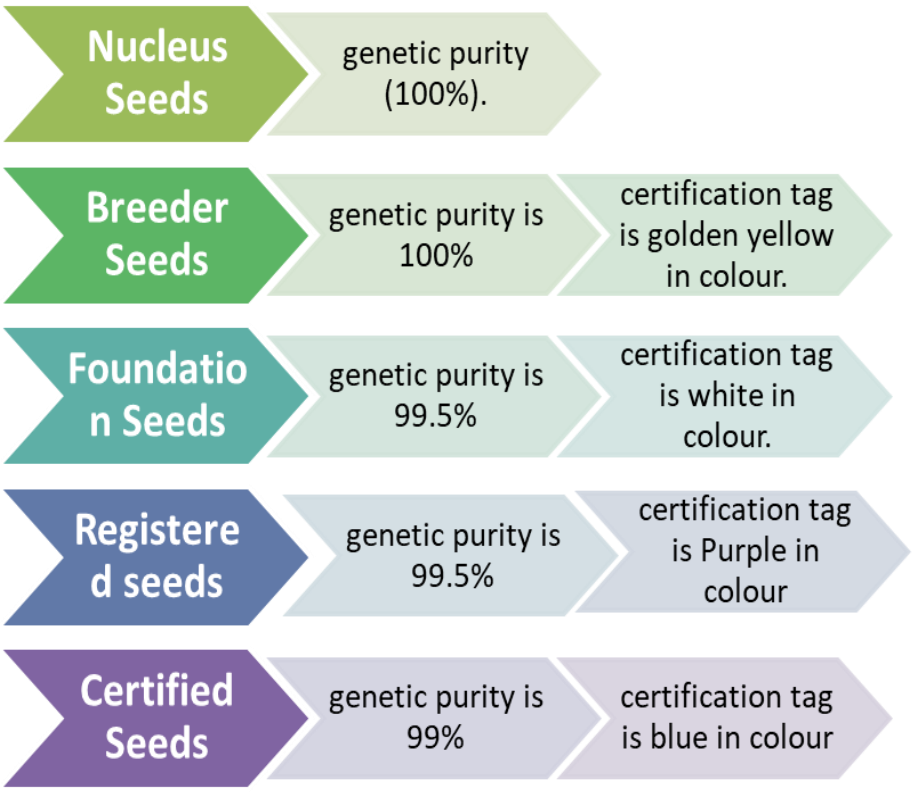
Agencies/Organization	% share of total quantity of seed produced	Kind of Seed produced
Public Institutions	20-22	Self / Open-Pollinated Crops
Private seed companies	5-8	Mainly Hybrid seed
Farmer Saved seed	70-75	Self / Open Pollinated Crops

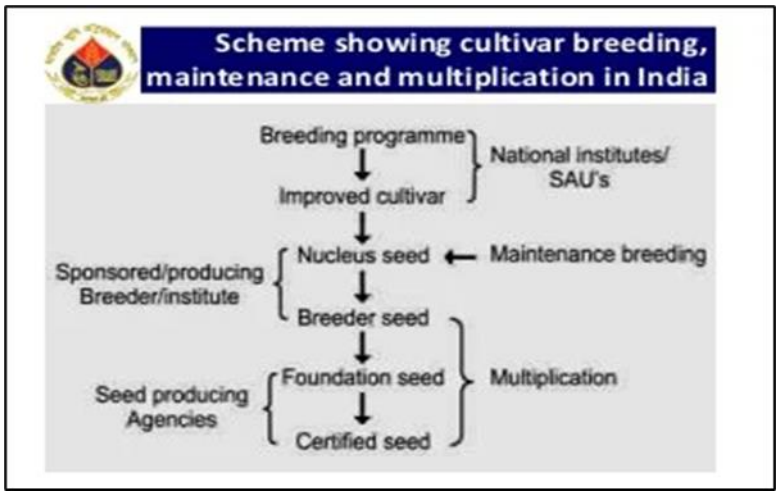
4.Difference between seed and grains used as seed

Seeds that are produced in a scientific manner are superior when compared to the grains that are used as a source of seeds.

Scientifically produced seeds	Grains used as seeds
Production of these seeds follow a well-designed seed programme.	No designed seed programme for production is done.
Varietal purity of the seed is clearly identified from its breeder seed and is genetically pure.	Variety purity of the grain as seed is not known.
During seed production process, quality standards like removal of off-types, diseased plants, weed plants and other crop plants are carried out.	Quality standards are not followed.
Seeds have physical purity and good germination.	Physical purity and germination is not ensured.
Scientific seed production follow the processing, treatment, packaging and labelling procedures.	Processing, labelling and tagging are not followed in grain production.
Drying of seeds is done in a controlled condition.	Grains are dried in higher temperature and thus the quality of the seeds are affected.
During seeds storage, viability and vigour of seeds are maintained.	During storage grains are protected against pests and diseases and not for vigour and viability.
Seeds produced are certified and labeled properly.	Grains which are used as seeds will not have any certification labels and tags.
Seeds can never be converted into grains unless it is directed by the seed inspector.	Can be utilized for commercial grain purpose and sometimes can be utilised for seed purpose

5.Classes/Types of Seeds





5.1 Nucleus Seeds

- Nucleus seeds are the basic seed class for seed production, obtained from the selected individual plants of a particular variety and parental line.
- These seeds are maintained by the breeder for further multiplication. It is used to produce breeder seed and forms the basis of total seed production chain.
- Nucleus seeds possess high percentage of genetic purity (100%).
- A pedigree certificate is issued by the producing breeder

5.2 Breeder Seeds

- The seed are vegetatively propagated material directly controlled by the originating or the sponsoring breeder
- Breeder seeds are produced using nucleus seeds in the Research institutes or Universities under the supervision of a breeder.
- The entire production process will be monitored by the Scientists and Officers of the Seed Certification Department and by the representatives of the National Seed Corporation.
- The genetic purity of the breeder seeds is 100% and the tag provided for the breeder seed is golden yellow in colour.

5.3 Foundation Seeds

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

5.4 Registered seed

- This is the progeny of the foundation seed grown by selected farmers, handled to maintain genetic purity and identity, and has undergone field and seed inspections to ensure conformity with standards.
- Genetic purity of the registered seeds are 99.5% and its certification tag is purple in colour.

5.5 Certified Seeds

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

5.6 Truthfully Labeled (TFL) Seeds

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

Class of seed	Institutes/Organization/Agencies	Supervision	Certification
Nucleus seed	Developer, breeder, parent institutes	Breeder, developers	No need, responsibility of parent institution or developers
Breeder Seed	Developer, breeder, parent institutes, registered organization	Breeder, developers	Members assigned by seed certification agencies
Foundation Seed	Central Government agencies, State Departments, Agriculture Universities, State Farms, Private seed companies, Farmers producer organization	Concern producer	Members assigned by seed certification agencies
Certified Seed	Central Government agencies, State Departments, Private seed companies, Farmers producer organization, Agriculture Universities, State Farms	Concern producer	Members assigned by seed certification agencies
TL Seed	Any organization and farmers	Concern producer	No need, responsibility of producer

6.Differences between certified seed and truthful labelled seed

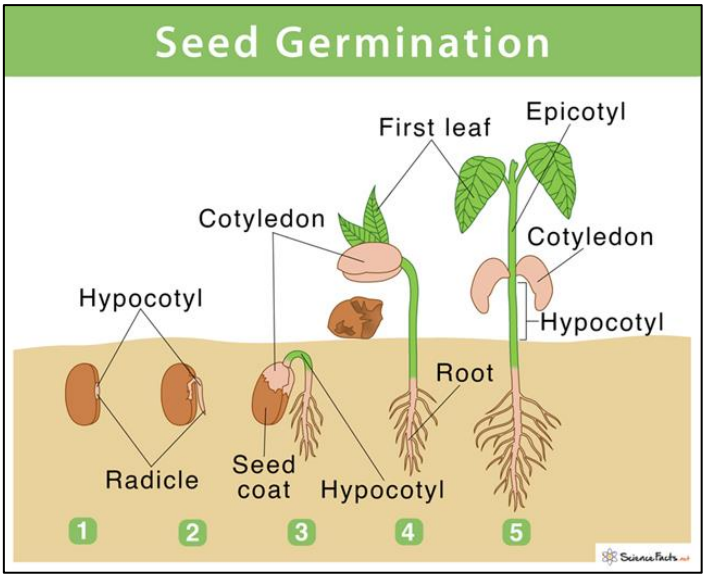
Certified seed	**Truthful labelled seed**
Certification is voluntary	Truthful labelling is compulsory for notified kind of varieties
Applicable to notified kinds only	Applicable to both notified and released varieties
It should satisfy both minimum field and seed standards	Tested for physical purity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

Note: The chain of seed multiplication models could be,

- **Three - Generation model**: Breeder seed - Foundation seed - Certified seed
- **Four - Generation model:** Breeder seed - Foundation seed (I) Foundation seed (II) - Certified seed
- **Five - Generation model**: Breeder seed - Foundation seed (I)- Foundation seed (II) - Certified seed

7.Seed germination

- Germination capacity of a seed lot refers to the capacity of the seeds in that lot, to germinate normally and produce all parts of a healthy seedling and grow.
- The necessary parts of the seedling include well developed primary roots, young pair of leaves and one or two cotyledons.
- A germination rate of 70-80% is an indication of high seed viability.
- After the seed has made it to a new location and is covered with dirt, it can begin germination.
- Germination is the process of seeds developing into new plants.
- First, environmental conditions must trigger the seed to grow.
- Usually, this is determined by how deep the seed is planted, water availability, and temperature.
- When water is plentiful, the seed fills with water in a process called imbibition.
- The water activates special proteins, called enzymes, that begin the process of seed growth.
- First the seed grows a root to access water underground.
- Next, the shoots, or growth above ground, begin to appear.
- The seed sends a shoot towards the surface, where it will grow leaves to harvest energy from the sun.
- The leaves continue to grow towards the light source in a process called photomorphogenesis.



7.1 Types of Germination

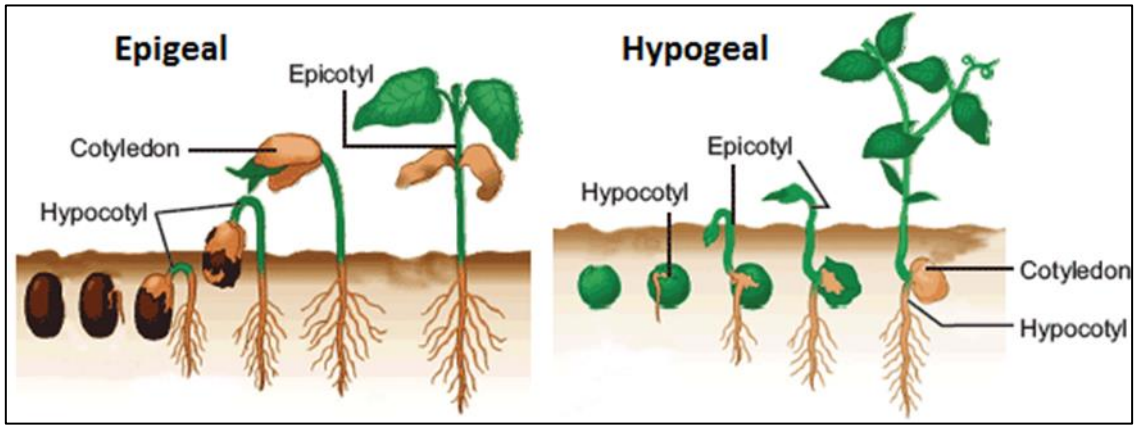
There are two types of germination

1. **Epigeal Germination**

- In this type of germination, the hypocotyl elongates rapidly and arches upwards pulling the cotyledons which move above the soil. Examples: Mustard, Tamarind, Sunflower, Castor, Onion

2. **Hypogeal Germination**

- In this type of germination, the epicotyl elongates and the cotyledons remain below the soil. Examples: Cereals, Gram, Red-gram, Lentil

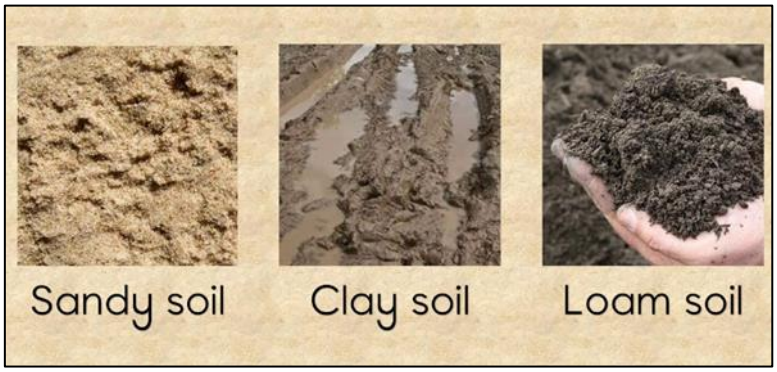


7.2 Factors effecting germination process

The following are the various factors effecting germination process in various crop plants.

Soil

- Soil type, texture, structure and microorganisms greatly influence the seed germination.

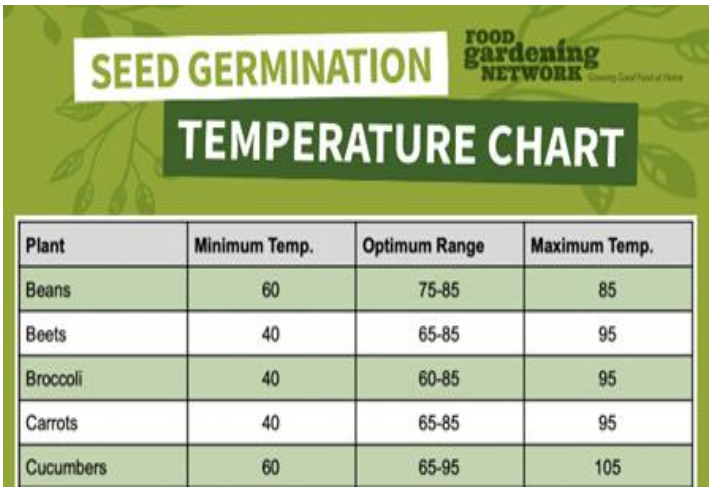


Moisture

- When the seeds do not get required moisture in the soil, the viability is lost. When the moisture is excess after germination, it will lead to rotting of the sprouts.

Temperature

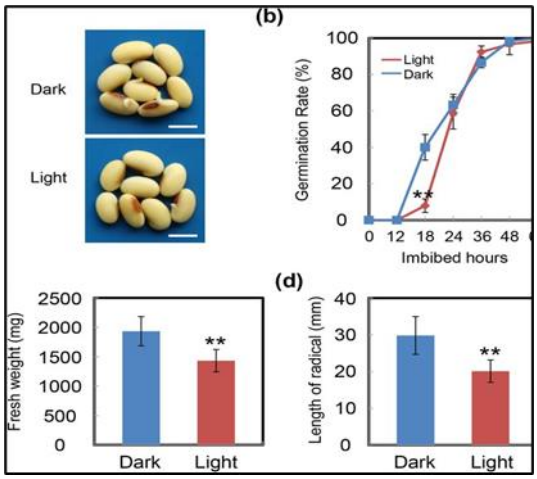
- When it is above and below the optimum temperature, the germination rate will be affected.



Plant	Minimum Temp.	Optimum Range	Maximum Temp.
Beans	60	75-85	85
Beets	40	65-85	95
Broccoli	40	60-85	95
Carrots	40	65-85	95
Cucumbers	60	65-95	105

Light

- The most effective wavelength for promoting germination is red (662 nm) and 730 nm inhibits germination.

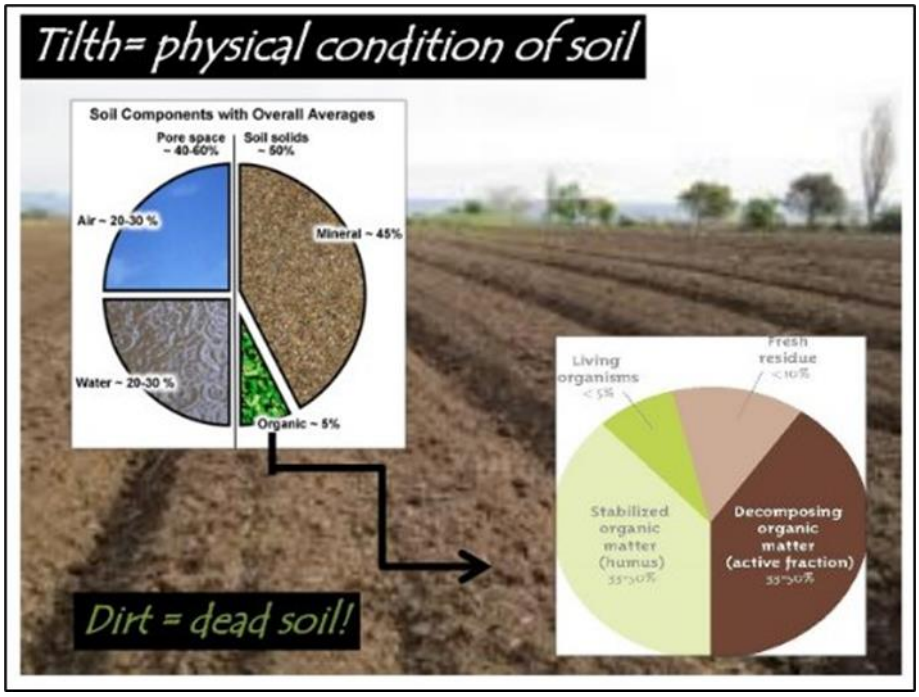


Soil condition-

- It again influences in 2 types.

Tilth

- It is the most important soil factor influences on germination of seed. Small seeds require fine tilth whereas, moderate and larger seeds require medium and coarse tilth soils, respectively.

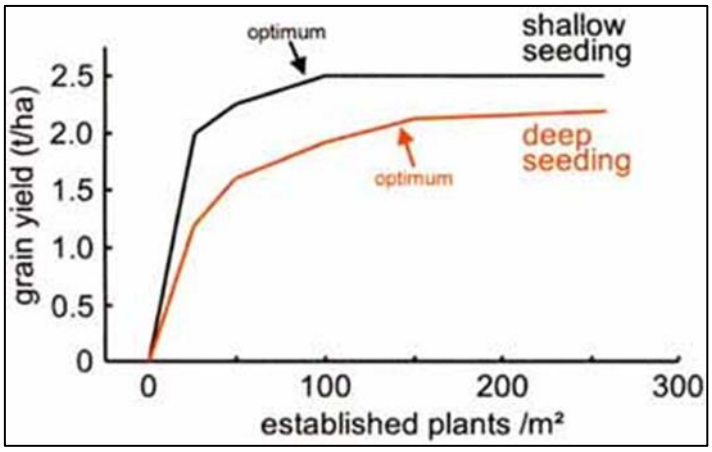


Depth of sowing

- The seeds should be placed at optimum depth. When the seeds are placed at deeper layer they have to spend more energy for germination.
- When it is placed on soil surface, it will be taken away by birds/worked away.
- The thumb rule is to sow seeds to a depth of approximately 3 to 4 times diameter of the seed. The optimum depth of sowing for most of the field crops ranged between 3 and 5 cm depth.

8.Optimum plant population

- Number of plants per unit area in the cropped field is called as plant population.
- Optimum plant population is the number of plants required to produce maximum output or biomass per unit area.
- Under high plant population, individual plant yield will be low due to narrow spacing leading to competition between plants.
- Number of plants per unit area in the cropped field is called as plant population.
- Yield per plant decreases gradually as plant population per unit area is increased but yield per unit area increases up to certain level of population. That level of plant population is called as optimum population.



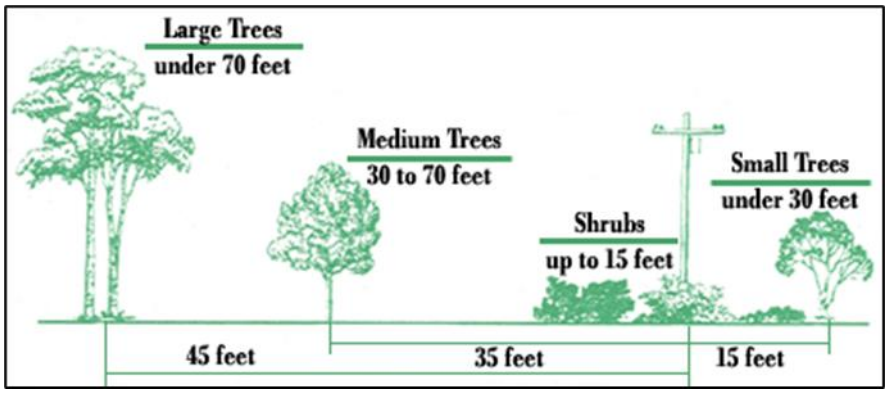
8.1 Factors affecting plant population

The factors affecting plant population can be divided into 2 major categories, viz., Genetic and Environmental factors.

8.1.1 Genetic Factors

Size of the plant

- The volume occupied by the plant at the time of flowering decides the spacing of the crop.
- Plants of red gram, cotton, sugarcane etc. occupy larger volume of space in the field compared to rice and wheat.

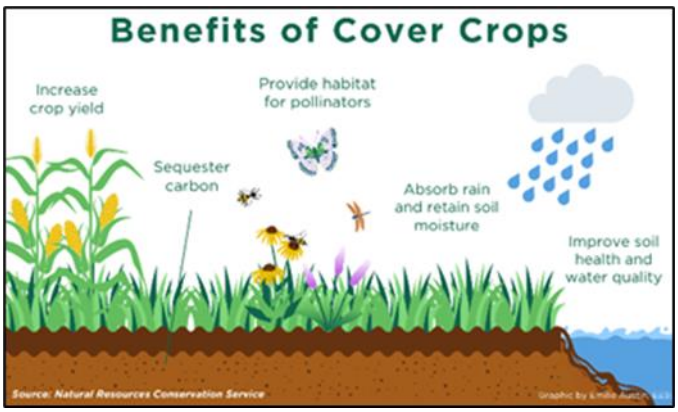


Elasticity of the plant

- Variation in size of the plant between minimum size of the plant that can produce some economic yield to the maximum size of the plant that can reach under unlimited space and resources is the elasticity of the plant.
- The optimum plant population range is less in indeterminate (unlimited branching) plants.
- The elasticity is due to tillering and branching habit of the plants.
- For determinate (limited branching) plants like pearl millet, sorghum elasticity range is less.
- For indeterminate (unlimited branching) plants like cotton and Red gram, more branches will be produced by the crop.

Foraging area or soil cover

- Crop should cover the soil as early as possible so as to intercept maximum sunlight.
- Higher the intercepted radiation more will be the dry matter produced.



Dry matter partitioning

- Dry matter production is related to amount of solar radiation intercepted by the canopy which depends on plant density
- As the plant density increases, the canopy expands more rapidly, more radiation is intercepted, and more dry matter is produced.

Crop and variety

- Depending on the crops and varieties, the plant population varies.
- Rice: Short duration - 6, 66,666 plants/ha (15 cm x 10 cm).
- Calculation Example:
- Plant population = area / spacing
- Rice (Short duration) spacing 15cm x 10cm, Area= 1ha= 10000sqm
- Plant Population: 10000/0.15x0.10
- PP= 666666 Plants/ha

8.1.2 Environmental factors

Time of sowing

- The crop is subjected to various weather conditions when sown at different periods.
- Among weather factors, day length and temperature influence much on the plant population. As low temperature retards growth, high plant population is required to cover the soil.

Rainfall / irrigation

- Plant population has to be less under rainfed than irrigated condition.
- Under more plant densities, more water is lost through transpiration.

- Under adequate rainfall / irrigation, high plant population is recommended.

Fertilizer application

- Higher plant population is necessary to fully utilize higher level of nutrients in the soil to realize higher yield.
- Nutrient uptake increases at optimum plant population.
- High population under low fertility soils leads to nutrient deficiency symptoms leading low yield.

9.Plant Geometry

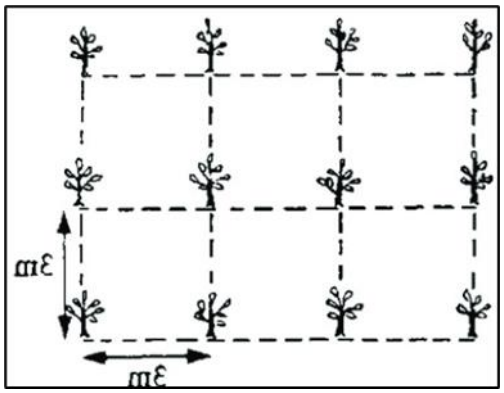
- The arrangement of the plants in different rows and columns in an area to utilize the natural
- resources efficiently is called crop geometry.
- It is otherwise area occupied by a single plant
- Example: Rice – 20 cm x 15 cm

Random plant geometry

- Random plant geometry results due to broadcasting method of sowing and no equal space is maintained.
- Resources are either underutilized or over exploited.

Square plant geometry

- The plants are sown at equal distances on either side.
- Mostly perennial crops, tree crops follow square method of cultivation.
- Example: Coconut – 7.5 x 7.5 m; banana – 1.8 x 1.8 m. But, due to scientific invention, the square geometry concept is expanded to close spaced field crops like rice too.

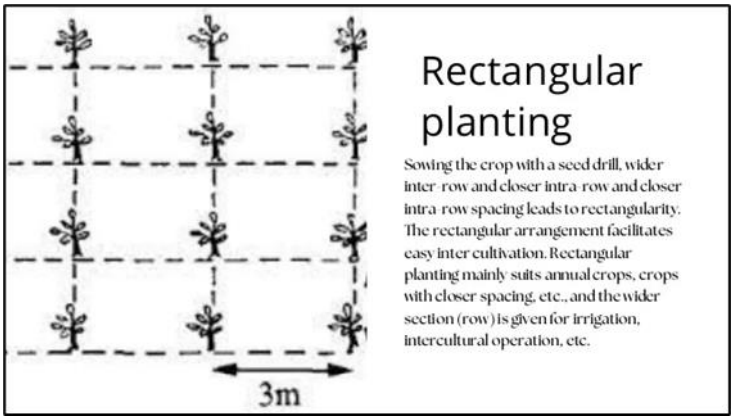


Advantages:

- Light is uniformly available
- Movement of wind is not blocked.
- Mechanization can be possible.

Rectangular method of sowing

- There are rows and columns, the row spacing are wider than the spacing between plants.
- The different types exist in rectangular method are:

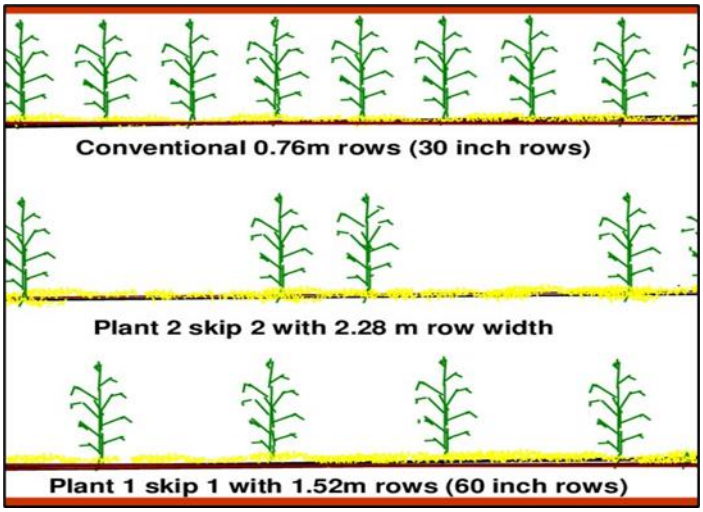


Solid row

- Each row will have no proper spacing between the plants. This is followed only for annual crops which have tilling pattern.
- There is definite row arrangement but no column arrangement. Example: Wheat.

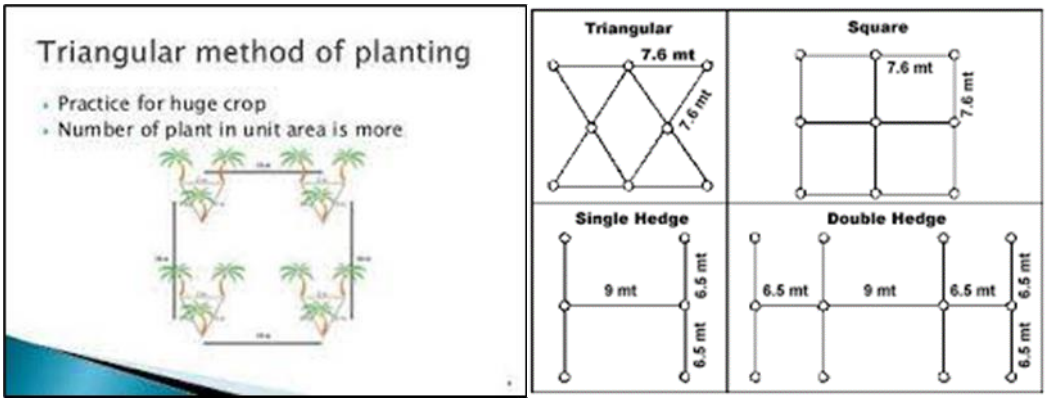
Skip row

- A row of planting is skipped and hence there is a reduction in population. This reduction is compensated by planting an intercrop; practiced in rain-fed or dry-land agriculture.



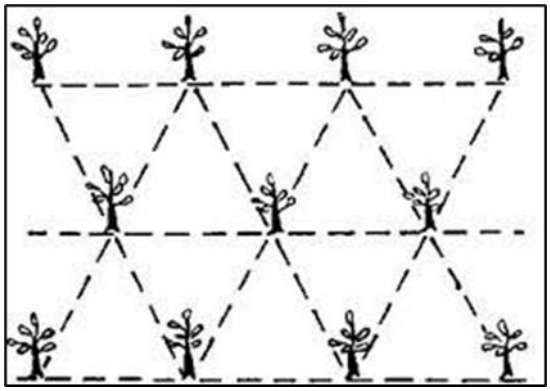
Triangular method of planting:

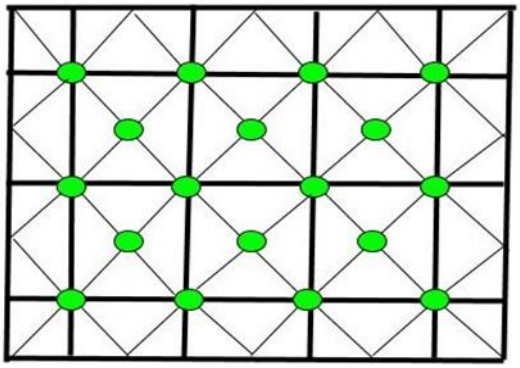
- It is recommended for wide spaced crops like coconut, man etc.
- The number of plants per unit area is more in this system.



Quincunx or diamond pattern:

- The quincunx or diamond pattern of arranging row-planted crops is a modified form of the square pattern. It consists of a square that is formed by 4 closest plants with an additional plant at the center of these 4 plants.
- The 4 plants that form a square are the main crops while the crop at the center is called a filler crop.



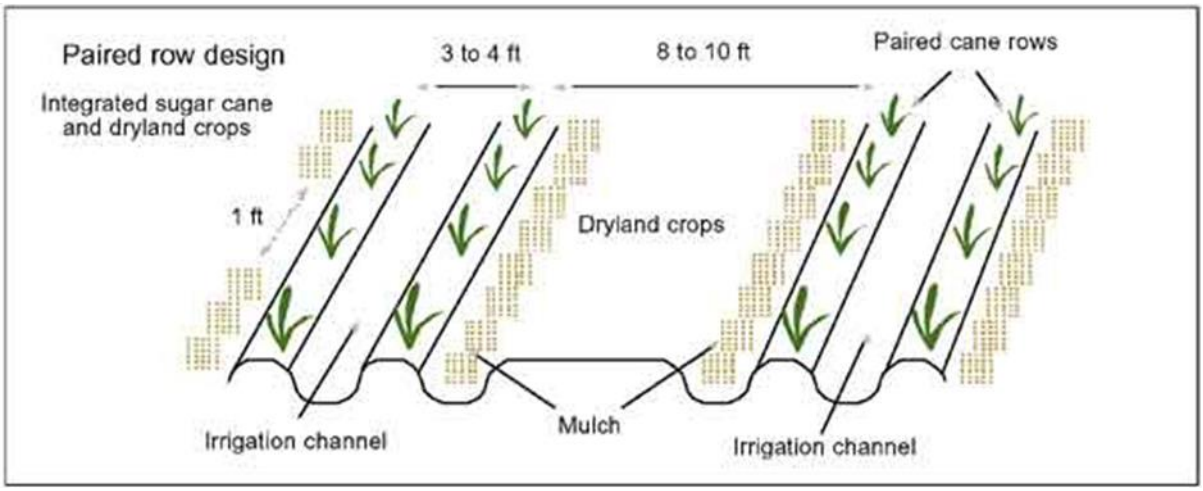


Paired Row arrangement

- The paired row arrangement can be seen both in the Square and Rectangular plant geometry type.
- In some cases, we observe this in triangular method of plant geometry as well.
- In paired row plantation with squared geometry, plant to plant spacing (Z) is same as that of row (X) to spacing while in paired row plantation with rectangular geometry the plant to plant spacing (Z) is more than the row to row spacing (X).
- In both the geometries one lateral is provided at the middle of the two crop rows such that two rows are equally spaced from the lateral.
- Dimension Y is the distance between two paired rows.

Some features:

- The number of rows per hectare remains the same.
- The advantages are that wide spacing is available between the any two sets of paired rows which can be utilized for growing profitable intercrops

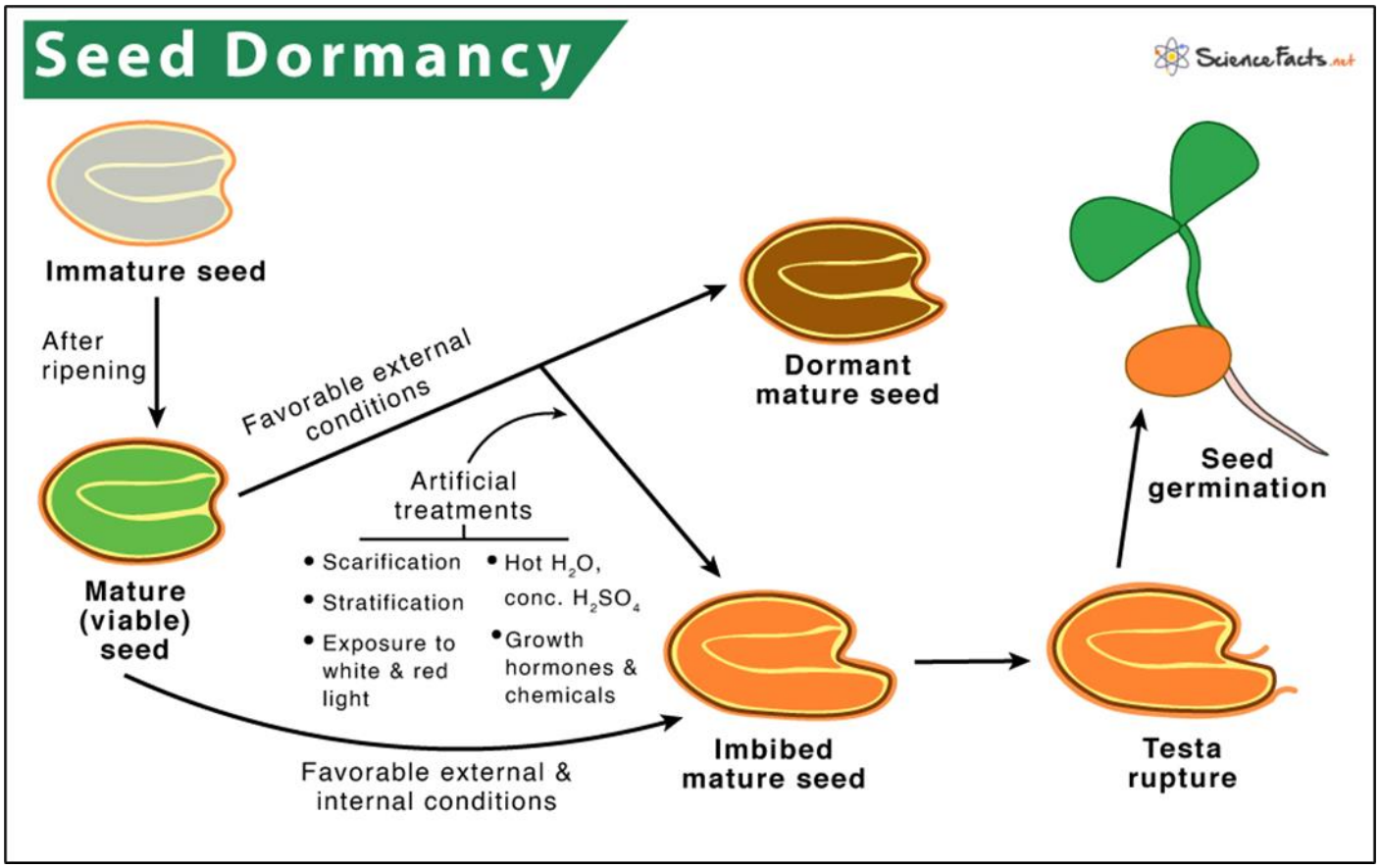


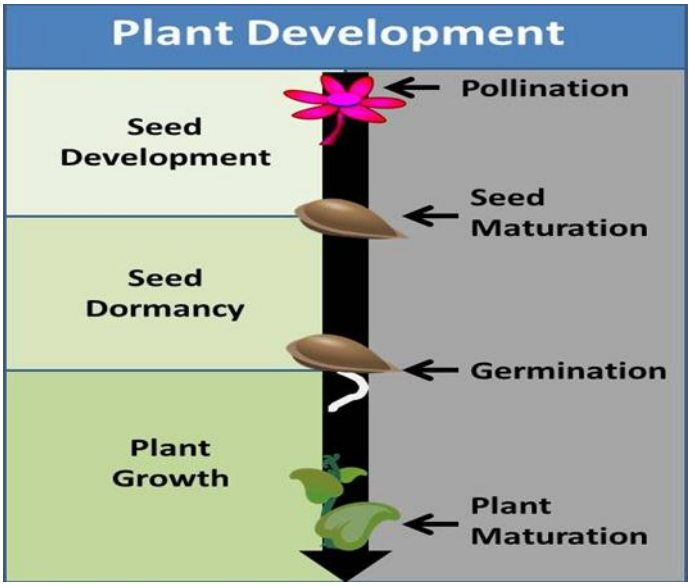
10.Seed Vigor

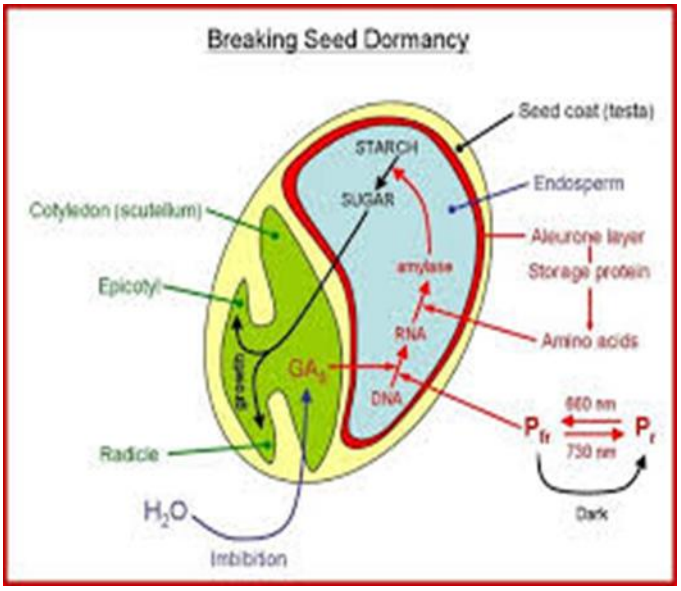
- Seed vigor is the sum total of all the seed attributes that favors rapid and uniform standard establishment in the field under varying field conditions.
- In general, seeds with good germination capacity and uniformity in size will have good vigor.
- Seeds with good vigor will produce good quality seedlings that will grow and give good yields. It varies from species to species.

11.Seed Dormancy

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







Dormancy may occur due to

1. **Unfavourable climatic conditions** like temperature, variation and lack of water
2. the presence of a **hard seed coat, immature embryo** and also due to the presence of **germination inhibitors** in the seeds.
3. the exposure of seeds to **excess heat, light or darkness**
4. the presence of **chemical toxins in the seeds**.

11.1 Types of Seed Dormancy

According to Harper (1977) dormancy may be classified into following,

1. **Nature of origination** i. innate ii. Induced iii. Enforced
2. **Time of origin** i. Primary ii. Secondary
3. **Location of dormancy** i. Exogenous ii. Endogenous

Innate dormancy

- It is the condition of seeds which is incapable of germination even if conditions suitable for seedling growth are supplied. This inability to germinate may be due in certain species to the embryo being immature at the time of dispersal.

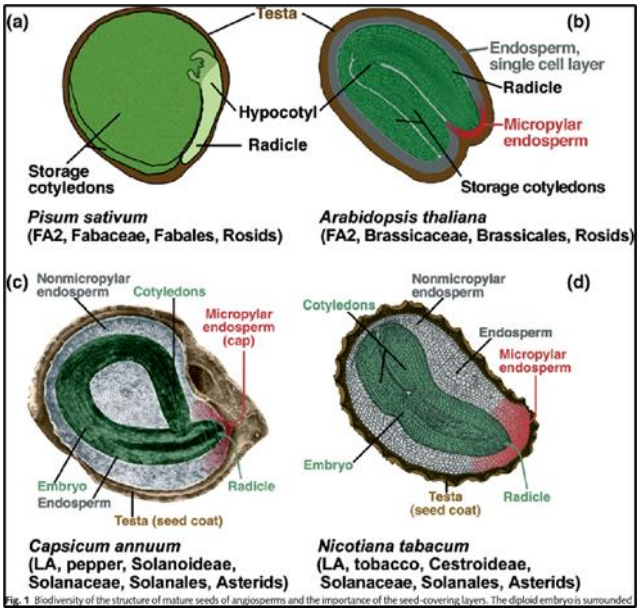
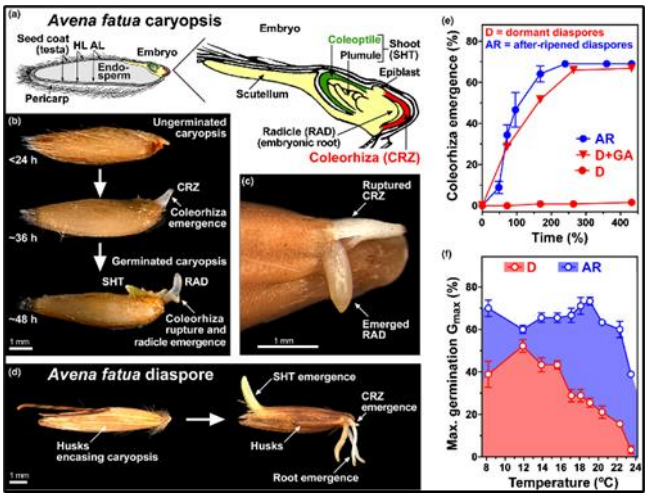


Fig. 1 Biodiversity of the structure of mature seeds of angiosperms and the importance of the seed-covering layers. The diploid embryo is surrounded

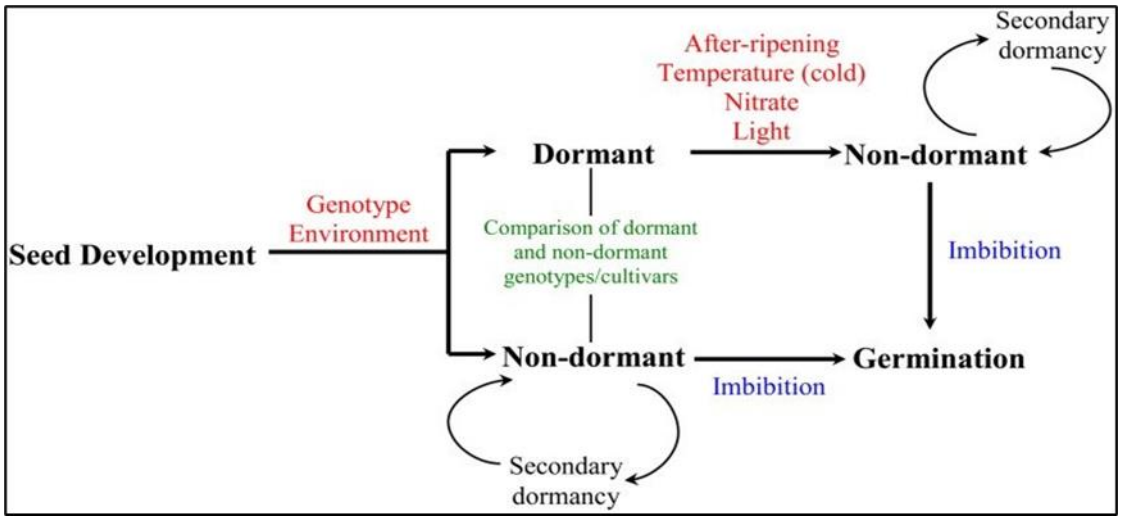
Enforced dormancy

- It is the condition of seeds which is incapable of germination due to an environmental restraint which includes, an adequate amount of moisture, oxygen, light and a suitable temperature.



Induced dormancy

- This type of seed dormancy occurs when the seed has imbibed water, but has been placed under extremely unfavorable conditions for germination. Finally, seed fails to germinate even under more favorable conditions.



Primary dormancy:

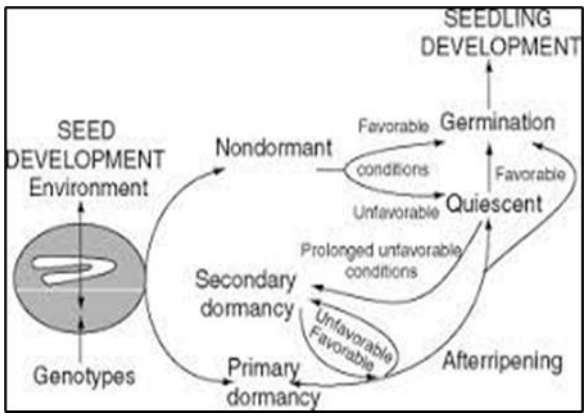
- It is the state of the seed itself or dormancy induced in the seeds at the time of dispersal from the mother plant i.e. the dormancy may be induced before maturity, during maturity and after maturity but before seed is dispersed from mother plant.

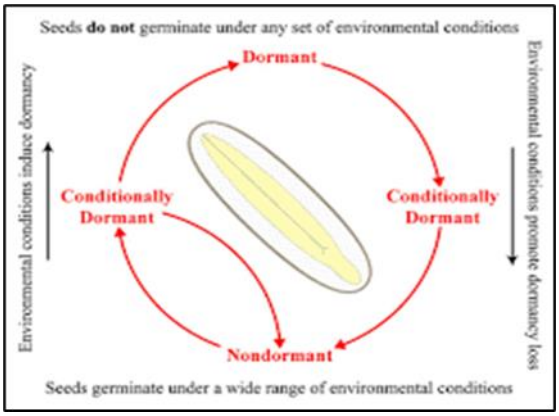
Secondary dormancy

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

1. Exposure of dry barley seed to temperature between **50 and 90 deg.** C

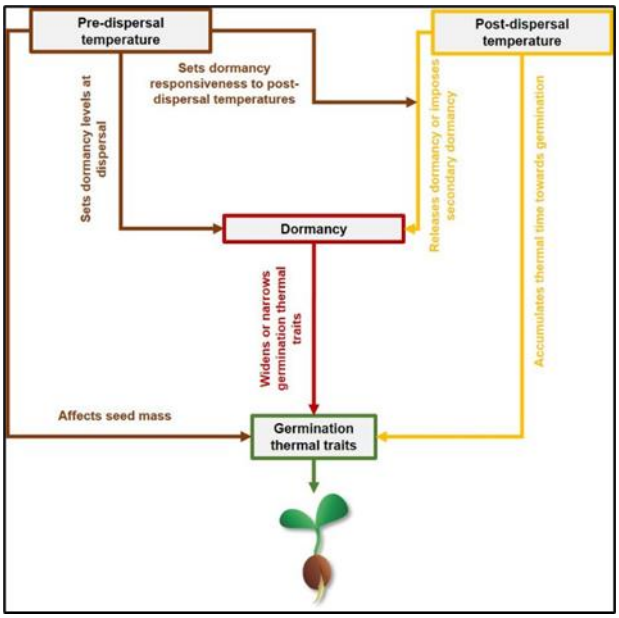
2. Storage of winter barely for seven days in high moisture containers at 20 deg. C.
3. Storage of spring wheat for one day at high moisture content in airtight containers at 50 deg. C.
4. Placement of seed under water and in darkness for 1 to 3 days at 2 deg. C





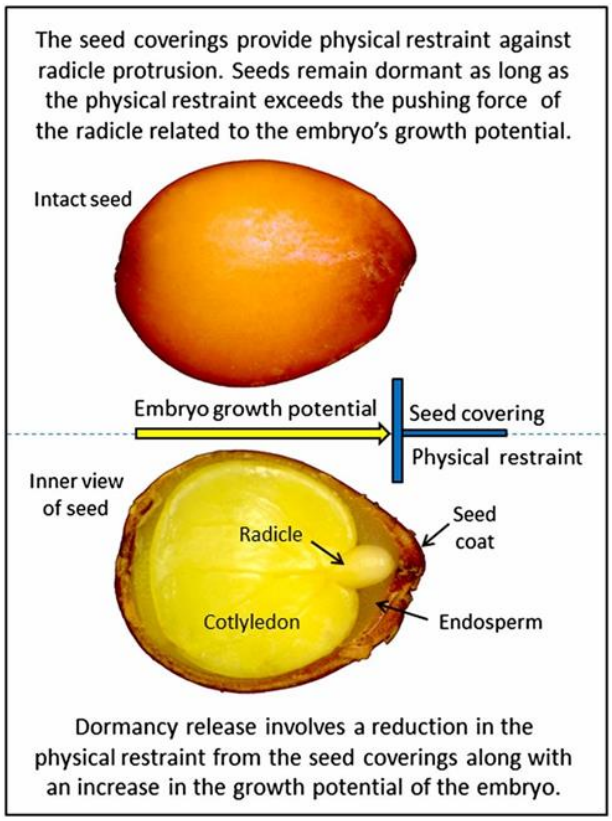
Exogenous dormancy

- It is due to the seed coat factor either due to presence of inhibitors or hard seed nature.
- **Physical** – Dormancy is due to the hard seed coat which prevents the entry of water and sometimes gaseous exchange is also prevented. e.g. Hard seeds of pulses, acacias. Prosopis, sapota etc.,
- **Chemical** – Presence of some inhibitors in the seeds coat which prevents the germination
- **Mechanical** – restriction of the growth of protruding radicle due to structure. (e.g.) inadequate space in the seeds of Terminalia sp



Endogenous dormancy

- Dormancy due to embryo. May be the presence of inhibitors , immature embryo or combination of both



11.2 Breaking Seed Dormancy

Scarification –

- **Chemical Scarification:** seeds are dipped into strong sulfuric acid, organic solvents such as acetone or alcohol, or even boiling water.
- **Mechanical Scarification**: Removal of the hard seed coat by rubbing the seeds with sand paper. Eg. Pulses

Hot water treatment

- Soak the seeds in hot water at 45-50°C. Eg. Tree crops.

Leaching

- The seeds can be soaked in water for 3 days. But once in 12 hours fresh water should be changed to avoid fermentation or seeds can be soaked in running water for a day to leach out the inhibitors. (e.g.) Coriander (Coumarin), Sunflower (Hydrocyanic acid)

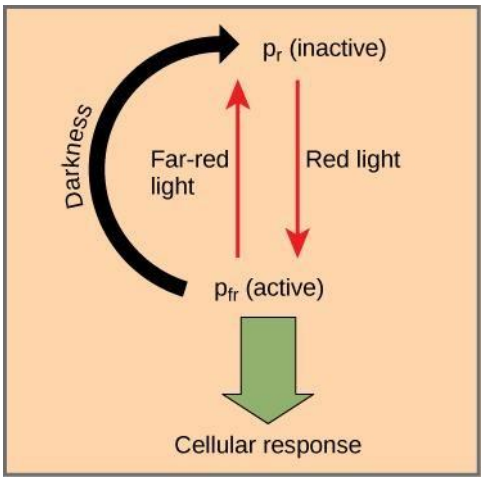
Stratification

- When seed dormancy is due to embryo factor, seeds can be subjected to stratification treatments.
- **Cold stratification:** Incubate the seed at low temperature of 0-5 degree over a moist substratum for 2-3 days to several months. It depends on the nature of seed and kind of dormancy. (e.g.) Cherry & palm oil seeds.
- **Warm stratification:** Some seeds require temperature of 40-50 0 C for few days e.g. paddy.

- In case of palm oil it requires temperature of 40-50^{o} C for 2 months for breaking dormancy. Care should be taken during the treatment and moisture content of seed should not be more than 15%.

Light treatment

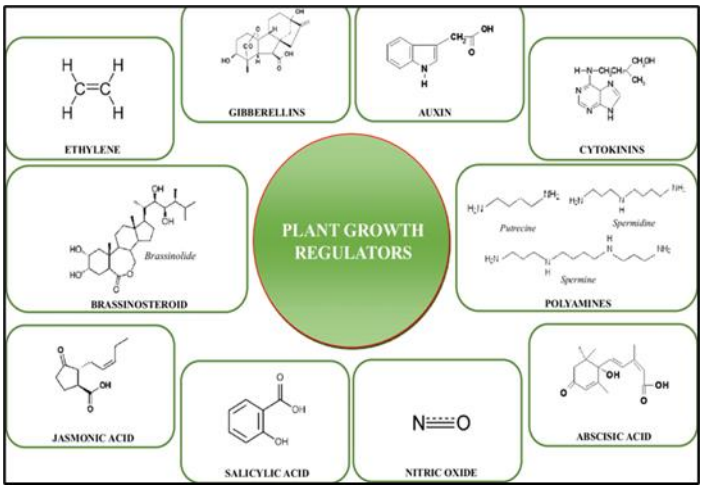
- Some seeds do not germinate in dark and periodic exposure to light is essential to break the dormancy. Eg. Lettuce.

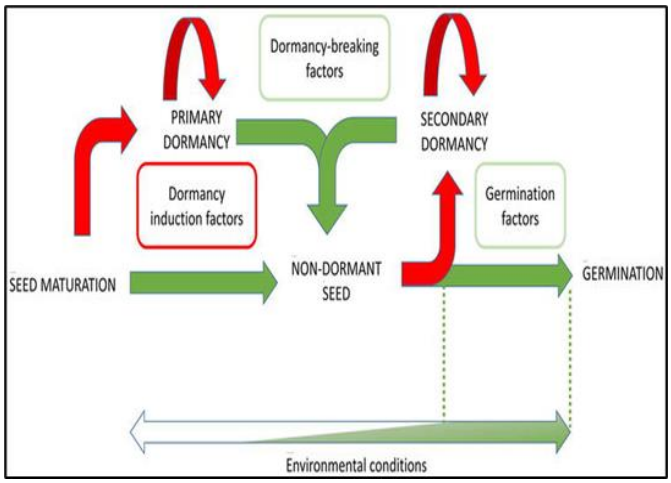


Seed Treatment with Growth Regulators/Chemicals

- If the endogenous dormancy is due to the presence of inhibitors, we can apply growth regulators at the low level to break dormancy.
- **GA & Cytokinin and kinetin** can be used at concentration of 100-1000 ppm to break dormancy. GA is light substituting chemical.
- **KNO3 at** 2% can be used for breaking the dormancy of light requiring seeds (e.g.) Oats, Barley and Tomato.
- **Thiourea** can be used for breaking dormancy for both light and chilling treatment requiring seeds (e.g.) lettuce - thiourea @ 10^{-2} to 10^{-3} M is used.

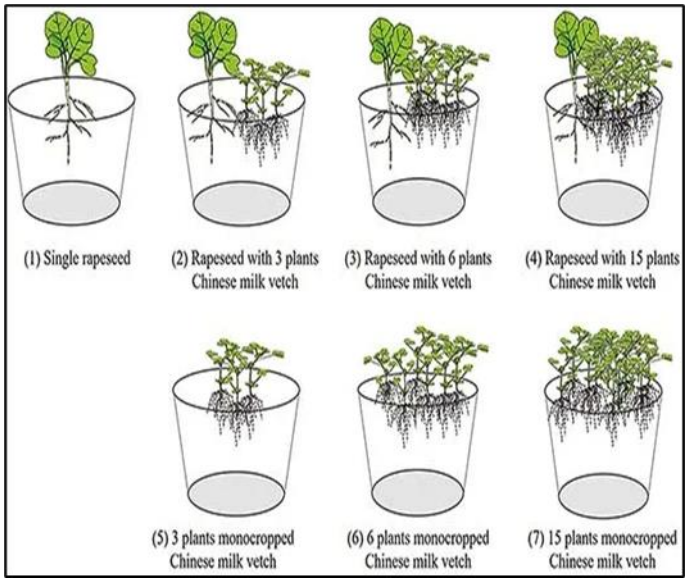
- **Ethrel** can be used for breaking the dormancy of cotton seed. The dormancy in cotton seed is due to the presence of ABA in pericarp of seed.
- Nitrogenous compounds like **Thiourea, Hydroxylamine, Nitric acid, Nitrate**, can also be used for breaking dormancy.
- Sulphidral compounds like 2 mercapto ethanol and 2,3 dimercapto ehtanol can also be used.
- Plant products like strigol (root exudation from striga parasite host plant) can also be used for breaking the seed dormancy.





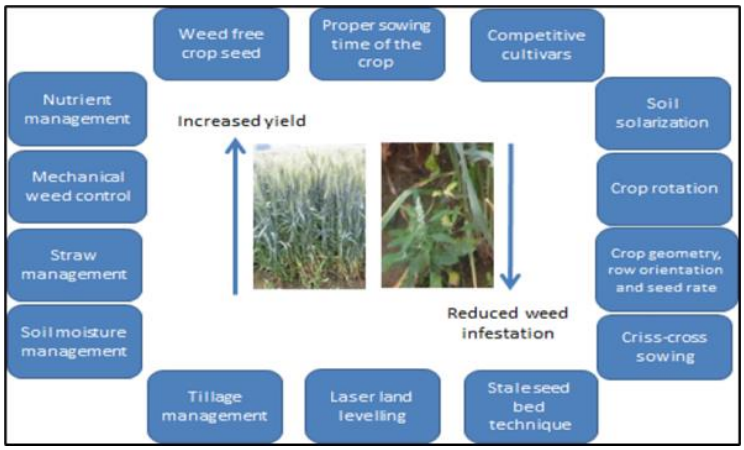
Planting Density

- Density of the plant in the field directly influences the quality of the seeds.
- More densely populated planting leads to the incidence of diseases, whereas less populated planting acquires more weed infestation with uneven ripening.
- Hence it is necessary to maintain the optimum plant density pertaining to each crop variety.



Weed Management

- Land selected for seed production should be maintained free from weeds.
- Weed seeds will remain dormant for a long period and grow faster than the main crop and produce seeds, which will reduce the purity of the seed crop.
- Removal of weeds at all stages in the seed production field is essential for maintaining the 1purity of the seeds



Crop	Objectionable weeds
Berseem	Chicory(*Chicorum intybus*)
Cucurbits	Wild Cucurbita sp.
Kasuri methi	Melilous sp.
Lettuce	Wild lettuce(*Lactuca sativa*)
Bhendi	Wild Abelmoschus sp
Rape &Mustard	*Argemone mexicona*
Wheat	*Convolvulus arvensis* (Hiran kuri)
Paddy	Wild paddy (*Oryza sativa* var. Fatua)

12.Other Factors Influencing Production

12.1 Seed Multiplication Ratio (SMR)

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

$$\text{SMR} = \text{Seed Yield} / \text{Seed Rate}$$

- **Seed rate** is the quantity of seed of a crop that is required to sow a unit area of land for optimum crop production.

Classes of seed	Seed rate (kg/ac)	Production (kg/ac)	Ratio	SMR
Breeder seed	10 kg	1700	170	1:170
Foundation Seed	10 kg	1700	170	1:170
Certified seed	15	1500	150	1:150
Average	**12.5**	**1600**	**128**	**1:128**

12.2 Seed Rate:

- It is the number of seeds planted per hectare (ha) to ensure normal density of crops and a
- maximum yield.
- It is expressed by the number of germinating seeds (millions) and the weight of the seeds (kg).

- The seed rate depends on germination of the seed, size of the seed, growing habit of the crop, etc.
- Extremes from the recommended seed rate (i.e. too high or too low) affect the plant population & then yield of crop.

Usually, the seed rate is calculated using the following formula:

$$\text{Seed Rate (kg/ha)} = (\text{Target plants/ m}^2 \text{ x Seed weight (mg)})/\text{Germination percentage (\%)}$$

GP = seeds germinated/total seeds x 100. Usually for every crop and variety there are certain values that are calculated using various methods

Crop	Seed rate (Kg/ha)
Rice transplanting	**30-50 (For Bold type : 40-50 ; medium to fine grain : 30-40)**
Rice Broadcasting	**100-120**
Rice drilling	**60-80**
Rice Hybrid	**12-15**
Rice SRI	**6-8**
Wheat	**100**
Wheat late sown	**125**
Maize	**20**
Maize Fodder **sorghum**	**50** **8-10 kg**

Crops	Seed rate (kg/ha)
1 Rice	
a. Transplanting	50-60
b. Broadcasting	80-100
c. Dibbling and Drilling	25-30
d. Hybrid rice	15
e. SRI method	6-8
2 Wheat	100-125
a. Wheat Late sowing	125
b. Wheat hybrid	67

Crop	Seed Multiplication Ratio	Crop	Seed Multiplication Ratio
Wheat	1:20	Lucerne	1:25
Paddy	1:80 (Varieties)	Oats	1:15
	1:100 (Hybrids)	Bhendi	1:100
Maize	1:80 (Varieties)	Tomato	1:400
	1:100 (Hybrids)	Brinjal	1:450
Sorghum	1:100	Chillies	1:240
Bajra	1:200	Watermelon	1:100
Ragi	1:80	Pumpkin	1:160
Gram	1:10	Bittergourd	1:41
Blackgram	1:40	Bottlegourd	1:99
Greengram	1:40	Ridgegourd	1:83
Cowpea	1:40	Cucumber	1:200
Horsegram	1:40	French bean	1:9
Moth bean	1:40	Clusterbean	1:50
Red gram	1:100	Peas	1:19
Cole crops	1: 433	Onion	1:171
Potato	1:4	Radish	1:100
Groundnut	1:8	Carrot	1:83
Linseed	1:50	Mustard and rape	1:100
Cotton	1:50	Soybean	1:16
Jute	1:100	Sunflower	1:50
Mestha	1:40	Sesame	1:250
Sunhemp	1:30	Safflower and castor	1:60
Berseem	1;10	Lucerne	1:25

12.3 Seed Replacement Rate (SRR)

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

- SRR = X / Y x 100
- Where, X = Quantity of farmer saved seed Y = Quantity of quality seeds

S. No.	Name of the crop	SRR
1	Paddy	17
2	Bajra (Pearl millet)	8
3	Maize	6
4	Redgram	6.1
5	Blackgram	17.7
6	Greengram	11.7
7	Cowpea	14.2
8	Groundnut	5
9	Sunflower	50
10	Sesame	15

13. Various seed sowing methods

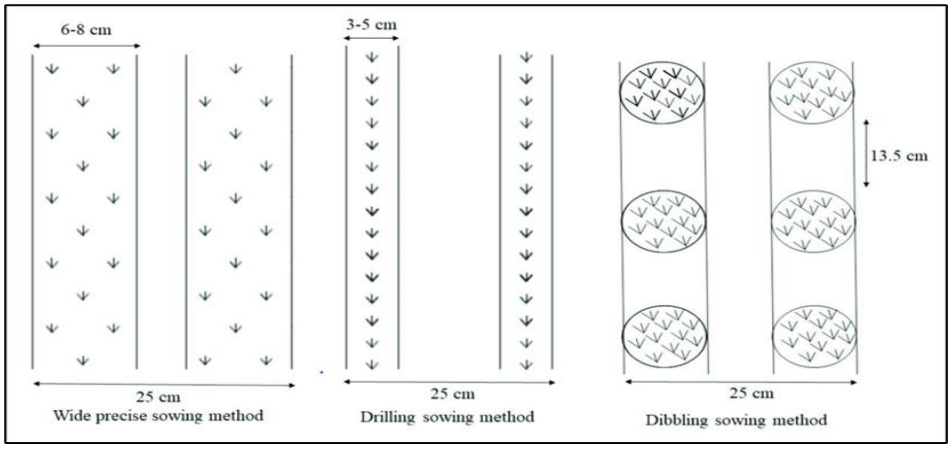
There are various seed sowing methods which are as follow:

Broadcasting method:

- Broadcasting is otherwise called as random sowing. Literally means ‘scattering the seeds’.
- Broadcasting is mostly followed for small sized to medium sized crops.
- This is the largest method of sowing followed in India, since; it is the easiest and cheapest and requires minimum laborers.
- The seeds are broadcasted in a narrow strip and the sowing is completed strip by strip.
- To ensure a good and uniform population, it is better to broadcast on either direction. This is called criss-cross sowing.
- If the seed is too small, it is mixed with sand to make a bulky one and for easy handling. Example: Seasame seeds are mixed with sand at 1:15 or 1:10 ratio and sown.
- In certain cases, the person sowing will be beating the seeds against the basket for uniform scattering. Ex. Sorghum, pearl millet.

Dibbling:

- This is actually line sowing. Dibbling is the process of placing seeds at cross marks made in the field with the help of dibbler as
- per the requirement of the crop in both the directions.
- Through this method seeds can be dibbled at desired depth in the moisture zone and spacing
- between rows and plants can be maintained.
- Dibbling is practiced on plain surface and ridges and furrows or beds and channels.
- Rice fallow cotton is dibbled on a plain surface.
- The seeds are dibbled at 2/3rd from top or 1/3rd at bottom of the ridge.

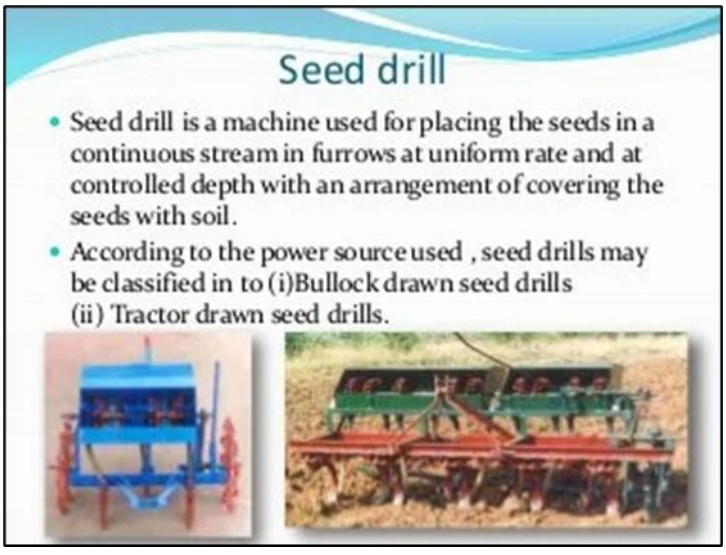


Dibbler

- A dibber or dibble or dibbler is a pointed wooden stick for making holes in the ground so that seeds, seedlings or small bulbs can be planted.
- Dibbers come in a variety of designs including the straight dibber, T-handled dibber, trowel dibber, and L-shaped dibber.

Seed Drilling:

- Drilling is the practice of dropping seeds in a definite depth covered with soil and compacted. In this method, sowing implements are used for placing the seeds into the soil.
- Both animal drawn, and power operated (seed drills) implements are available.
- In this method, depth of sowing can be maintained, and fertilizer can also be applied simultaneously. It is possible to take up sowing of inter crops also.



Transplanting:

- Seed are sown in small patch of land and later on transplanted from that patch to main field.

- Age of seedlings is 1/4th of the total duration of the crop.
- Thumb rule – 3 months crop – nursery duration 3 weeks, minimum 4 months – 4 weeks minimum period; 5 months – 5 weeks.
- After the nursery period, seedlings are pulled out and transplanted.

Note: AREA - 1/10th of the total area. If you want to sow seeds in 1ha land then your Nursery for transplanting the same should be 1000 sqm (since 1ha= 10000sqm).

Sowing behind the plough:

- Sowing behind the plough is done by manual or mechanical means. Seeds are dropped in the furrows opened by the plough and the same is closed or covered when the next furrow is opened.
- The seeds are sown at uniform distance. Manual method is a laborious and time-consuming process.
- Seeds like red gram, cowpea and groundnut are sown behind the country plough. Major sown crop is groundnut.

14. Seed Processing

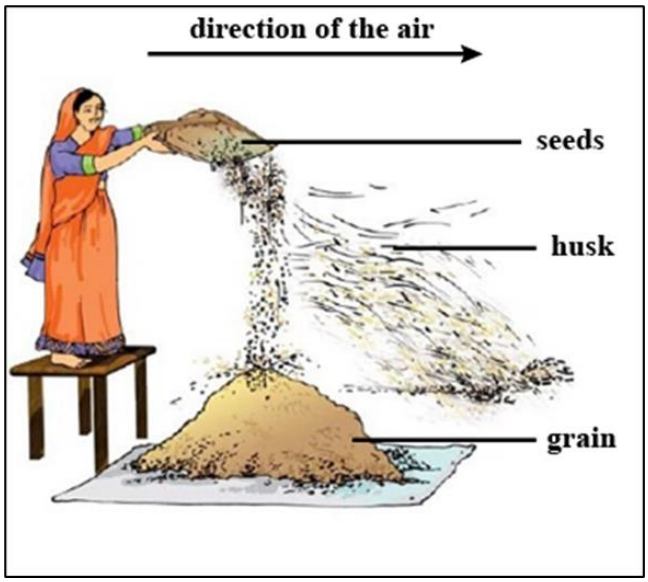
After harvest the seeds need to be processed by various methods in order to maintain the physical purity and also to increase the shelf life. This should be done before seeds are taken for storage.

Cleaning

- **Wet cleaning** - Plants which carry seeds in their moist flesh can be cleaned by this method. Seeds scooped from the flesh of a ripened fruit should be collected in a vessel and rubbed vigorously with coarse sand to remove flesh around the seeds. Then seeds are taken in a sieve and washed repeatedly under running water to remove the bits and pieces of flesh and mucilage. After such cleaning seeds should be dried for 10 days before storage. E.g. Cucumber, Tomato etc.
- **Dry cleaning** - This method is used for the matured seeds in a dry capsule / pod. Either the dry pods can be harvested individually or the whole plant with the pod is pulled out and shade dried, threshed for the collection of seeds. After threshing seeds are gently crushed or rolled and winnowed before storing. E.g. Paddy, Millets, Pulses, Oilseeds etc.

Winnowing

- It is an ancient method to remove the chaff from the seeds by tossing them in the air. Elongated flat baskets are used for winnowing.
- It helps to remove stem bits, old petals, husks and other parts of the flower and debris mixed with the seeds. There are also mechanical winnowers available.



Sieving

- Sieves with different gauge sizes are used for sieving in order to remove the debris and chaff from the seeds. Large debris retains in the larger sieve, whereas the dust materials smaller than the seeds is removed in the small size sieve.

Drying of Seeds

- Seed drying is the process of lowering the moisture content of the seed in order to improve the vigour and viability of the seed and thereby increasing the storage life.
- It helps to keep the seeds free from pest and disease incidence.
- Drying should be done at a lower temperature. During drying, first the moisture from the seed surface will be evaporated and the moisture from inner layers of the seed is transferred to the surface for further drying.

Natural drying / Sun drying

- It is a common method of drying followed in the field or threshing yard by using the radiant energy of the sun. Seeds should be spread in a thin layer to enhance the uniform drying of the seeds.
- Seeds with high moisture content should be shade dried and later exposed to sun drying.
- Sun drying is advisable only in the morning and evening hours. Drying in mid noon causes damage to seed quality.

Artificial / Mechanical drying by using forced natural / heated air

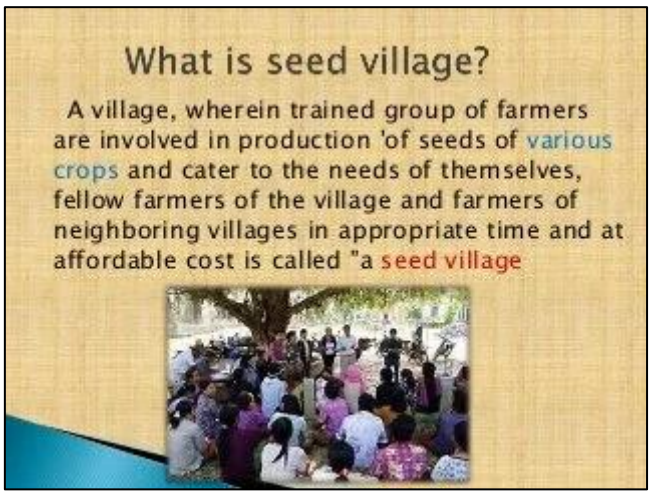
- This type of drying can be carried out inside the storage godown itself.
- It is possible only during the dry seasons. In some cases, drying is done by passing the heated outside air with the use of burner heater. This principle is followed in most of the present day dryers.
- Main advantage of this method is that drying is uniform and done within a short span of time. But the cost of the equipment and fuel requirement is very expensive.

Tests to ascertain the dryness of seeds

- Simple traditional methods are involved in order to ascertain whether the seeds are properly dried or not.
- Thin seeds are twisted between the fingers, thick seeds can be bitten by the front tooth and the small seeds can be squeezed between the fingernails. If they break with a cracking sound, it shows that the seeds are dried well.

15. Seed village

- The Seed Village Programme (SVP) is one of the most important components of the Sub-mission on Seeds and Planting Materials (SMSP) under Nation Mission on Agriculture Extension & Technology (NMAET) being implemented by Government of India from 2014-15 onwards.
- The following incentives will be provided to farmers under Seed Village Programme as per GOI norms.



Supply of Foundation seed:

- Financial assistance @ 50% subsidy is available for distribution of foundation /certified seeds-I of cereals for 1 acre area per farmer per crop each season.
- Financial assistance @ 60% subsidy is available for distribution of foundation/ certified seeds-I of pulses, oilseeds and green manure seeds for a maximum of one acre per farmer per crop each season.

Trainings:

- Three one day trainings will be conducted to the farmers on seed production technology.

- Financial assistance of Rs.15,000/- per group (50-150 farmers each group) will be provided for farmers.

Objectives:

1. Increasing the seed production
2. Increasing the seed replacement rate
3. Organizing seed production in cluster (or) compact area
4. replacing existing local varieties with new high yielding varieties
5. Self-sufficiency and self-reliance of the village
6. To meet the local demand, timely supply.

15.1 Seed village scheme is having two phases

Seed production of different crops:

The area which is suitable for raising a particular crop will be selected, and raised with single variety of a kind.

- **Selection of area**: The area with the following facilities will be selected:
  - Irrigation facilities
  - Suitability of climatic conditions to raise the crop for more than one season
  - Labour availability and Knowledge of local farmers on that particular crop
  - Occurrence or outbreak of pest and diseases
  - Past history of the area for suitability to raise seed crop
  - Average rainfall and distribution
  - Closeness to a urban area for easy movement of seed and other inputs

- **Seed Supply:**
  - The foundation/ certified seeds or University labelled seeds will be supplied by the University through Krishi Vigyan Kendras (KVKs) and Research Stations at 50% subsidy cost to the identified farmers in the area.
  - The farmers will use these quality seeds and take up their own seed production in a small area (1 acre) for their own use. The crops are Rice, Pulses and Oilseeds.

- **Capacity building**

A training on seed production and seed technology will be given to the identified farmers for technology empowerment of farmers.

Duration of the training	3 days
First one day training	**At the time of sowing**
Training on	**Isolation distance, sowing practices, seed treatment, and other agronomic practices.**
Second one day training	**During flowering**
Training on	**Identifying off types and removal, maintenance of seed plots, plant protection measures, maturity status and harvesting methods.**
Third one day training	**After harvest**
Training on	**Seed cleaning, grading, seed treating, bagging and storage aspects, seed sampling and sending to seed testing laboratory for analysis.**
A seed grower forum will be organized for further empowerment of technology and marketing	**-**

15.2 Establishing seed processing unit

- If the seeds are not processed and handled properly, all the past efforts in production may be lost. Thus, seed processing and packaging is very important aspect in seed production.
- The location of seed processing centres is based on the available infrastructure and convenience.
- Such a place will be well connected with roads and transportation facilities.
- Each seed processing centre will have the following infrastructure.
- Seed garden cum clearer
- Bag closer, trolleys, scales and furniture

- Building to house equipment
- Seed storage structure
- Seed threshing and drying yard
- Information centre

Benefits

- Seed is available at the doorsteps of farms at an appropriate time.
- Seed availability at affordable cost even lesser than market price.
- Increased confidence among the farmers about the quality because of known source of production.
- Producer and consumer are mutually benefited.
- Facilitates fast spread of new cultivars of different kinds.

16. Seed Organizations

- NATIONAL SEED RESEARCH AND TRAINING CENTRE, VARANASI (Responsible for Quality Seeds Availability , Testing & Quality Control At National Level)

- STATE FARMS CORPORATION OF INDIA LTD. (SFCI), (Responsible for Quality Seeds Availability by the seed production programme on various states)

- NATIONAL SEEDS CORPORATION LIMITED (Responsible for seed production of certified & foundation class)

- PROTECTION OF PLANT VARIETY AND FARMER RIGHTS AUTHORITY (PPV&FR Authority) It 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

- CENTRAL SEED TESTING LABORATORY (CSTL) IARI NEW DELHI
  C.G. Rajya Beej Evam Krishi Vikas Nigam (CGS SC) State seed corporation , responsible for seed production and distribution in the state.

Seed Certification Agencies:

- Chhattisgarh State Seed Certification Agency, Indira Gandhi Agri. University Campus, Krishak Nagar, Raipur-492006 (C.G.) (involved in seed certification, inspection, seed sampling etc)
- State Seed Testing Laboratory, Krishak Nagar, Raipur.(Role in seed testing around the state)

Cooperatives involved on seed

- Krishak Bharati Cooperative Limited (KRIBHCO)
- National Cooperative Development Corporation (NCDC)
- National Horticultural Research and Development Foundation (NHRDF) • Indian Farmers Fertiliser Cooperative Limited (IFFCO)
- National Agricultural Cooperative Marketing Federation of India Ltd. (NAFED)

International organizations

1.2 The International Seed Testing Association (ISTA)

- Founded in 1924 during the 4th International Seed Testing Congress held in Cambridge, United Kingdom.

Objectives of the Association

- To develop, adopt and publish standard procedures for sampling and testing seeds, and to promote uniform application of these procedures for evaluation of seeds moving in international trade.
- To promote research in all areas of seed science and technology, including sampling, testing, storing, processing, and distributing seeds, to encourage variety (cultivar) certification, to participate in conferences and training courses aimed at furthering these objectives, and to establish and maintain liaison with other organisations having common or related interests in seed.

2.AOSCA:

- Association of Official Seed Certifying Agencies the organization of seed certification agencies of the United States and Canada. It is a global network providing seed certification and quality assurance services to the agricultural industry.

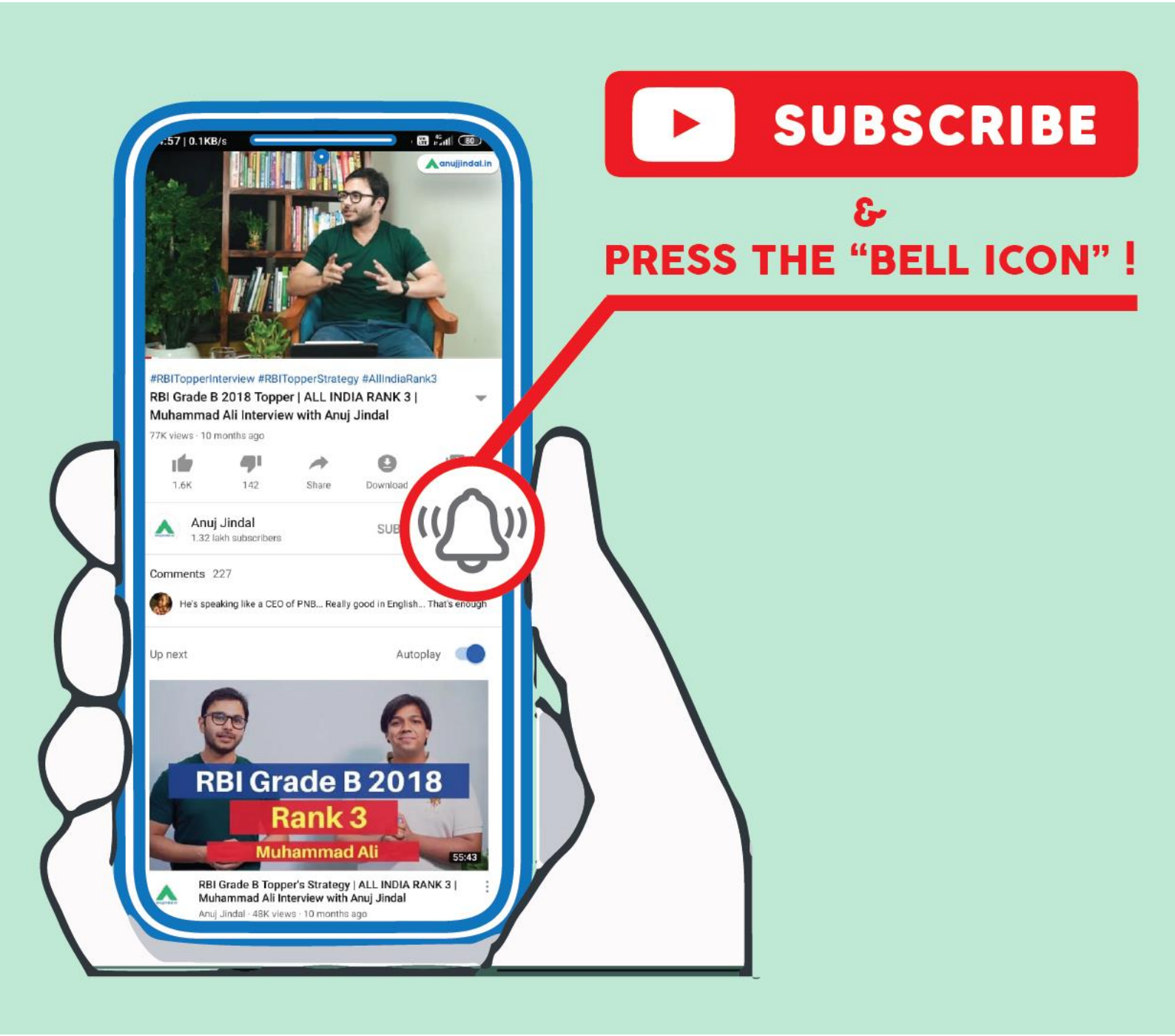
AOSA: Association of Official Seed Analysts, The organization seed analysts of the United States and Canada.

3.INTERNATIONAL SEED FEDERATION

- ISF works to enhance the contribution of the seed industry worldwide to meeting the growing global needs for food, feed, fiber, fuel, industrial, ornamental and amenity crop applications.

4.The Organization for Economic Co-operation and Development (OECD):

- It promote policies that will improve the economic and social well-being of people around the world. The OECD provides a forum in which governments can work together to share experiences and seek solutions to common problems. It work with governments to understand what drives economic, social and environmental change.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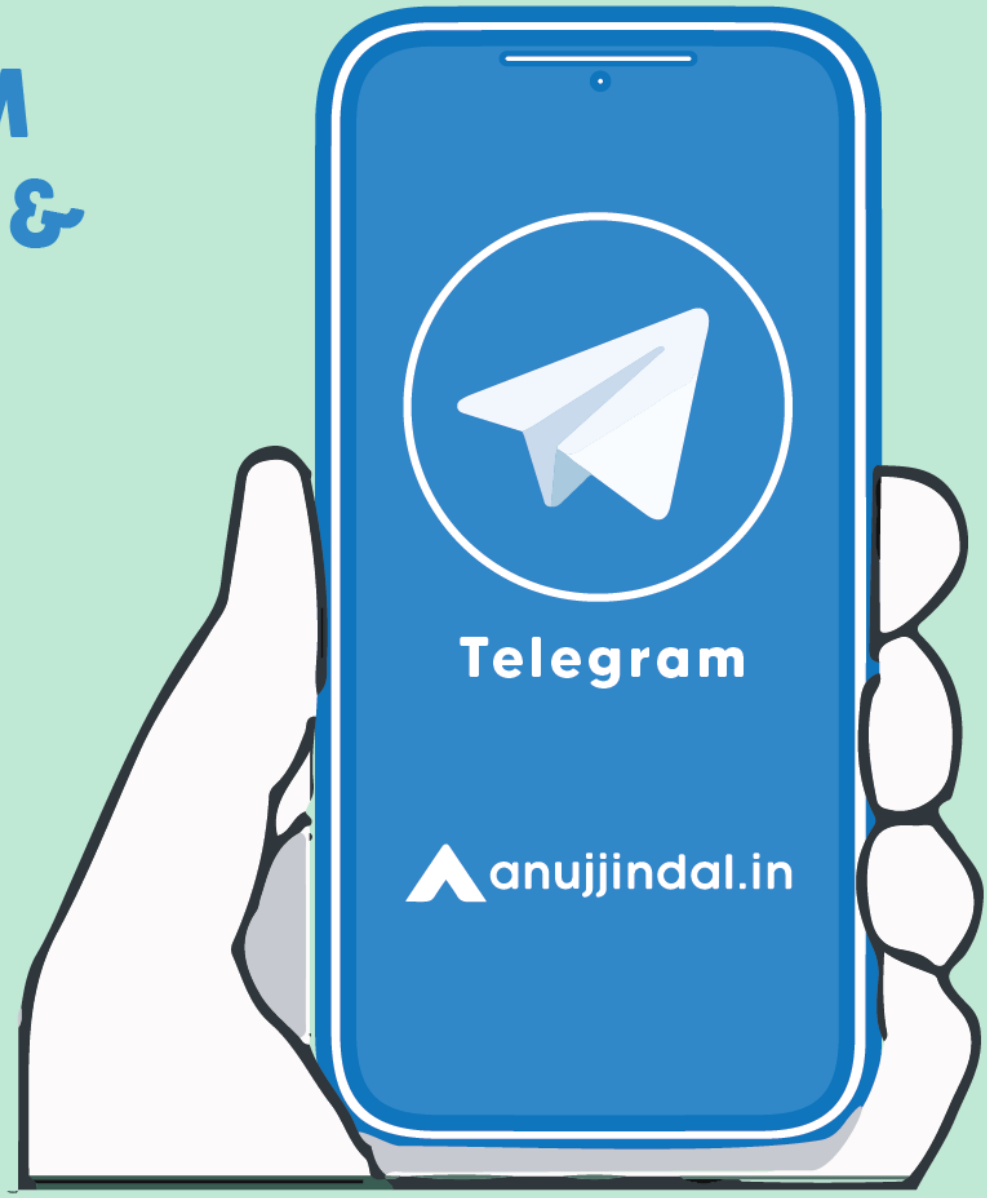

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Anshu Goel

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Atul Yadav

Cleared SEBI
Abhishek Kumar

Cleared SEBI
Vishwanidh Singh

Cleared SEBI
Gopika Jayan

Cleared SEBI
Vasant Kesari

Cleared SEBI
Swetha Bodagala

NET with 98 Percentile
Anushka Keshri

JRF with 96.92 Percentile
Vaishali Jadon

NET with 89.27 Percentile
Srishti Gupta

JRF with 72 Percentage
Abhishek Mohanty

NET with 68 Percentage
Dinesh Mohan

JRF with 64.66 Percentage
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