SEED PRODUCTION

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SEED

Any plant part used for raising the crop is seed. Seed include true seed seedling cutting, rhizome, grafts, roots etc used for propagation. Botanically seed is matured integument mega sporangium. Seed is also defined as matured ovule consisting or embryonic together with store of food surrounded by protective coat.

Parts of a typical dicotyledonous seed:

(i) *Seed coats*: seed coats consist of two layers of integument, united or free, the outer being called tests and the inner is called tegmen.The seed coats are provided with *hilum* which represents the point of attachment with the stalk, micropyle, minute pore above the hilum and raphe (a ridge formed by the funicle or stalk in many seeds.

(ii) *Embryo*: Embryos lying within the seeds is consisted of an axis and two cotyledons. The pointed end of the axis is the radicle and the feathery leaf end is called plumule. As the seed germinates the radicle gives rise to the root and plumule to the shoot.

(iii) *Endosperm:* Endosperm is the fleshy food storage tissue. In some seeds endosperm is present until maturity. Such seeds are called endospermic or *albuminous* seeds. In some seeds it is consumed in the young stage by the developing cotyledons and such seeds do not possess endosperm at maturity. Such seeds are called non endospermic or *exalbuminous* seeds.

Parts of a typical monocotyledonous seed:

(i) *Seed coat*: Seed coat is the brownish membranous layer adherent to the grain. This layer is made up of the seed coat and the wall of the fruit fused together.

(ii) *Endosperm*: It forms the main bulk of the grain and is the food storage tissue of it, being laden with reserve food material, particularly starch. In a longitudinal section of a grain, it is seen to be distinctly separated from the embryo by a definite layer known as the *epithelium*.

(iii) *Embryo*: It is very small and lies in a groove at one end of the endosperm. It consists of only (a) one shield shaped cotyledon known as scutellum (b) a short axis with the plumule and the radicle. The radicle is protected by a root cap. The plumule as a whole (growing point and foliage leaves) is surrounded by a protective sheath called *coleoptile*; similarly the radicle is surrounded and protected by a sheath called coleorhizae. The surface layer of the *scutellum* lying in contact with the endosperm is the *epithelium*, its function is to digest and absorb the food material stored in the endosperm.

In cereals (e.g. rice, wheat, maize, barley and oat), millets and other plants of the grass family the cotyledon is known as scutellum. It supplies the growing embryo with food material absorbed from the endosperm with the help of epithelium.

Difference between seed and grain

Sl. No	Seed	Grain
1	Any plant part used for propagation is seed. It includes seeds category , rhizome, grafts etc.	It is final produce of grain crops used for consumption.
2	It should be a viable and vigorous one	Grains need not be viable
3	It should be physically and genetically pure	Genetic purity is ignored in case of grains
4	Should satisfy minimum seed certification standards	No such requirements
5	It can be treated with pesticide /fungicide to protect seed against storage pests and fungi	It should never be treated with any chemicals, since used for consumption
6	Should be compulsorily certified	No such condition in grain production
7	Dormancy plays important role in quality of seed	Dormancy has no role grain quality
8	Physiological maturity considered for quality seed production	Physiological maturity has no importance in grains
9	It should satisfy all the quality norms	Not considered
10	Seed can be utilized as grain provided if it is not treated with poisonous chemicals	Grain never can be converted into seed.
11	Comes under preview of seed acts.	Comes under preview of food acts.

SEED DEVELOPMENT

Following pollination and fertilization, two major developmental steps occur in the life cycle of seed plants which do not occur in the mosses or ferns. One is the development of the seed and the other is the development of the fruit. The seed development consists of a conversion of the integument of the ovule into a resistant seed coat, the development of the endosperm, and the development of the embryo. All these events take place within the original ovary. After fertilization, the zygote divides mitotically. The product of this repeated nuclear division and cell multiplication is an embryo.

A section through a nearly mature seed will reveal an embryo consisting of two large cotyledons with a small epicotyl between them attached the hypocotyl. Most or all of the endosperm has been absorbed by the cotyledons and the integuments of the ovule have grown into a seed coat. The basal portion of the embryo is termed the radicle. The epicotyl develops into the above ground structures of the plant (stem, leaves, flowers).

The radicle develops into the true root system while the hypocotyl develops into the transition zone between root and stem.

Criteria of Quality Seed:

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

Significance of a good quality seed:

(i)good quality seeds of improved varieties ensure higher yield
(ii)ensures genetic and physical purity of the crops
(iii)gives desired plant population.
(iv)able to withstand the adverse conditions.
(v)will be free from pest and diseases.
(vi)seedlings will be more vigorous, fast growing and can resist pest and disease incidence to certain extent.
(vii)ensures uniform growth and maturity
(viii)development of root system will be more efficient that aids absorption of nutrients efficiently and result in higher yield.
(ix)it will respond well to added fertilizer and other inputs.

SEED QUALITY

Thompson (1979) defined seed quality as a multiple concept comprising several components and their relative importance in different circumstances and laid much emphasis on analytical purity or physical purity, species purity or genetic purity, freedom from weeds, germination percentage, seed vigour and health, seed moisture content and seed size, weight and specific gravity.

Seed quality characters: A good seed should have the following quality characters.

1. **Improved variety:** It should be superior to the existing variety i.e. the yield should be higher by 20-25% than the existing variety or it should have some desirable attributes like disease resistance, drought resistance, salt tolerance etc., with good yield potential.
2. **Genetic Purity:** The seed should be true to type. The seed should possess all the genetic qualities / characters, which the breeder has placed in the variety, genetic purity has direct effect on the yields. If there is any deterioration, there would be proportionate decrease in the yield or performance.
3. **Physical Purity:** Physical purity of a seed lot refers to the physical composition of the seed lots. A seed lot is composed of pure seed, inert mater, broken seeds, undersized seeds, soil and dust particles weed seeds, other crop seeds etc. Higher the content of pure seed better would be the seed quality. Pure seed together with germination gives the planting value of the seed lot.
4. **Seed germination and vigour:** Seed germination refers to the ability of a seed when planted under normal sowing conditions to give rise to a normal seedling. Seed vigour

refers to the sum total of all seed attributes that give effective plant stand in the field. Higher germination percentage and vigour gives adequate plant population and uniform growth, which have profound effect on, yield and determine the planting value of the seed.

5. **Freedom from weeds and other crop seeds:** This is an extension of physical purity described earlier. There are certain weed species, which are very harmful to the crop and once established they are difficult to eradicate. An absolute freedom from seed of such species is highly desirable and is one of the important criteria for determining the planning quality of seeds.
6. **Seed health:** Seed health refers to the presence or absence of disease organisms or insect pests on the seed. The quality of a seed lot depends on its health, hence the seed should be free from seed borne disease and insect pests.
7. **Seed moisture:** The seed moisture is the most important factor in determining the seed germination and viability during storage. At high seed moisture content there is high incidence of pest attack and at moisture content above16% seed get heated and the viability is lost. Hence the seed should be stored at safe moisture levels of 11-13%.
8. **Seed size, weight and specific gravity:** Seed size, weight and specific gravity has been found to have positive correlation with seed germination and vigour in many crops. Therefore the seed should be bold with high specific gravity.
9. **Seed Colour:** The colour of the seed often reflects the condition during seed maturation. The farmers from ancient times have regarded good normal shine as invariable quality guides. The colour and shine deteriorates only when the weather conditions are adverse during maturation or when insects infest the crop or when it is handled badly. The seed lots having high genetic purity, high germination and with a minimum amount of inert matter, weed seeds and other crop seeds and are free from diseases is said to be of high quality and if it is lacking of these it is said to be of low quality.

Classes or Types of Seed

(i) Nucleus seed: is the handful of original seed obtained from selected individual plants of a particular variety for maintenance and purification by the originating breeder. It is further multiplied and maintained under the supervision of qualified plant breeder to provide breeder seed. This forms the basis for all further seed production. It has the highest genetic purity and physical purity.

(ii) Breeder's seed: This is the progeny of the nucleus seed multiplied in large area under the supervision of plant breeder and monitored by a committee. It provides cent per cent physical and genetic pure seed for production of foundation class. Golden yellow coloured certificate is issued for this category by the producing agency.

(iii) Foundation seed: The foundation seed is the progeny of the breeder seed. Sometimes, it may be produced from the foundation seed which could be clearly traced to the breeder seed. The production of foundation seed shall be supervised and approved by the Certification Agency and should be so handled asto maintain specific genetic identity and genetic purity and shall be required to conform to the certification standards specified for the crop that is being certified. Seed Certification agency issues a white colour certification for foundation class seed.

(iv) Certified seed: It is the progeny of foundation seed and produced by registered seed growers under the supervision of Seed Certification Agency by maintaining the seed quality as per minimum seed certification standards.However, certified seed can also be produced from certified seed to maintain adequate seed supplies under the discretion of the Certification Agency (Section 14(2) of Seed Rules, 1968). Seed Certification Agency issues an azure blue colour (Shade ISI No. 104) certificate.

(v) Truthfully labeled Seed:

Truthfully labelled seed is that seed which meets the prescribed minimum limits of germination and purity and is labeled in accordance with the provision of section 6 of the seeds Act. It is the category of seed produced by cultivators, private seed companies and is sold under truthful labels. But field standard and seed standard should maintain as per seed act and certified seed stage. Under the seed act, the seed producer and seed seller are responsible for the seed.

Seed Standards for Truthfully labelled Seed

Kind	Minimum limits of germination	Minimum limits of purity
Rice	80	98
Wheat	85	98
Barley	85	98
Oat	85	98
Maize	80	98
Rapeseed and Mustard	85	97
Sesamum	80	97
Groundnut	70	97
Soyabean	70	97
Sunflower	60	98
Blackgram	75	98
Cauliflower	65	98
Cabbage	70	98
Brinjal	70	98
Tomato	70	98
Chilli	60	98

SEED VIABILITY

Seed viability is defined as the capacity of the seed to remain capable of germination for some specific period of time. Viability of different seeds may differ to a great extent. Some seeds loose viability even after a few weeks, whereas some seeds can remain viable for several years.

Life span of seeds

On the basis of longevity of seeds, the seeds are classified into three groups as follows:

(i) Macrobiotic seeds: These are also known as long lived seeds. The lifespan of these seeds ranges from 15 to more than 100 years. Examples: Lupine seeds buries in peat bog for 10,000 years(Canada), Indian lotus seeds over 1,000 years old, Silk tree seeds (*Albizia lebbek*) in 147 years, *Trifolium*seeds for several years.

(ii) Mesobiotic seeds: These seeds are also known as intermediate lived seeds. The life span of these seeds varies from 3 to 15 years. Examples: Barley, Flax, Tall fescue and Carrot seeds.

(iii) Microbiotic seeds: These seeds are also known as short lived seeds. The life span of these seeds does not exceed 3 years. Examples: Soybean, Onion, River Maple and wild rice

Orthodox and Recalcitrant seeds

All the seeds may be divided into two broad groups depending on the maintenance of viability under normal and specific environ mental conditions.

(i) Orthodox seeds: Seeds belonging to this group maintain viability for longer period when stored at low moisture level. The examples of this group of seeds include rice, wheat, maize, groundnut and tomato etc. For storage of orthodox seeds for longer period seeds are dried to low moisture level. For vegetable seeds the safe limit of moisture content is around 5%, for field crops is around 8%. Orthodox seeds may be stored in moisture impervious and aseptic condition to avoid seed infection and infestation.

(ii) Recalcitrant seeds: Seeds belonging to this group maintain viability for longer period, when stored at higher moisture level. e.g. lemon, grapes, apple, jack fruit, litchi etc.

Factors affecting longevity or period of viability of seeds:

1. Biotic factors

(a) Factors related to seed

(i) **Genetic makeup of the seed:** The longevity is influenced by the genetic constitution of the seed. Some seeds are naturally short lived e.g. onion, soybeans, ground nut etc. whereas some are naturally long lived e.g. Indian lotus, silk tree etc.

(ii) **Initial seed quality:** Barton (1941) found that the seeds of high initial viability are much more resistant to unfavourable storage environment conditions than low viable seed. Once seed start to deteriorate it proceeds rapidly. The mechanically injured seed suffered a lot and loses viability very quickly. Generally small seeds escape injury whereas large seeds are more likely to be extensively damaged e.g. bean, lima bean and soybean. Spherical seeds usually give more protection than flat or irregularly shaped seeds.

(iii) **Effect of provenance:** The place where the seed crop was produced greatly influences the longevity or storability *e.g.* the red clover seeds grown in Canada stored for four years with 80% germination whereas seeds grown in England and New Zealand stored only for 3 years with 80% germination. This is due to different climatic conditions and soil types prevailing in different places.

(iv) **Seed moisture content:** The moisture content of the seeds is the most important factor influencing longevity or viability. With increase in seed moisture content, the storage life decreases. If the seeds are kept at high moisture content, the loss of viability becomes very rapid due to mould growth and if the seeds are stored at very low moisture content below 4%, the seed is damaged due to extreme desiccation or occurrence of hard seeded ness in some crops. Before storage the seeds should be dried to the safe limits for storability suitable for the crop. The seed moisture content however depends on storage length, type of storage structure, kind or variety of seed, type of packing material used. For cereals in ordinary storage conditions for 12-18 months, seed drying up to 10% moisture content appears quite satisfactory.

However, for storage in sealed containers, drying upto 5-8% moisture content depending upon particular kind may be necessary.

(v) **Micro flora, Insects and Mites:** The activity of all these organisms can lead to damage resulting in loss of viability. The micro flora activity is controlled by relative humidity, temperature and moisture content of seeds. Treated seeds with fungicides can be stored for longer periods. Fumigation to control insects will also help in longer period storage. Fumigants like methyl bromide, hydrogen cyanide, ethylene dichloride, carbon tetrachloride, carbon disulphide and naphthalene and aluminium phosphine.

2. Abiotic factors:

(i) Relative humidity: Relative humidity is the amount of water present in the air at a given temperature in proportion to its maximum water holding capacity. Relative humidity and temperature are the most important factors determining the longevity of seeds during storage. Seed attain specific and characteristic moisture content when subjected to given levels of atmospheric humidity. This characteristic moisture content is called equilibrium moisture content. Equilibrium moisture content for a particular seed at a given relative humidity tends to increase as temperature decreases. Thus the maintenance of seed moisture content during storage is a function of relative humidity and to a lesser extent of temperature. At equilibrium moisture content there is no net gain or loss in seed moisture content.

(ii) **Interaction between moisture and temperature**: The temperature also plays an important role in life of seed. Insects and moulds increase as temperature increases. The higher the moisture content of the seeds, the more they are adversely affected by temperature. Decreasing temperature and seed moisture is an effective means of maintaining seed quality in storage.

Harrington's Thumb Rule: The following thumb rules by Harrington are useful measures for assessing the effect of moisture and temperature on seed storage. These rules are as follows:

(a) For every decrease of 1% seed moisture content the life of seed doubles. This rule is applicable between 5-14%.

(b) For every decrease of 5^oC in storage temperature, the life of the seed doubles. This rule applies between 0^o-50^o C.

Nomograph: Roberts (1972) developed formulae to describe the relationship between temperature, seed moisture content and period of viability. From these relationships it was possible to construct a seed viability nomograph. These nomographs are helpful in predicting the retention of seed viability in defined storage environment for a particular period or to determine combinations of temperature and moisture content which will ensure the retention of a desired level of seed viability for specific period.

(iii) Gas during storage: Increase in oxygen pressure decreases the period of viability, whereas N_2 and CO_2 atmosphere helps in increasing the storage life of seeds.

SEED DORMANCY

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

Cause of seed dormancy:

(a) Seed coat impermeable to water *i.e.*water does not entered into seed coat: The seeds of some plants especially those belonging to the families of Fabaceae, Malvaceae, Chenopodiaceae, Convolvulaceaea and Solanaceae have very hard seed coats whichare impermeable to water. The seeds remain dormant in the soil until the impermeable layer of testas decayed by the action of soil micro-organisms.

(b) Seed coat impermeable to oxygen (O_2 is not entering through seed coat): These seeds do not germinate because oxygen cannot enter inside the seed to facilitate respiration. Non availability of oxygen and increased concentration of CO_2 in the seed interior retards the respiration and hence germination. In many plants like cocklebur (*Xanthium*), apple, many grasses and some members of the compositae family dormancy is due to impermeability of seed coat to oxygen.

(c) Mechanically resistant seed coat: The seed coats of certain weeds like pigweed (*Amaranthus*), shepherds purse (*Capsella*), water plantain (*Alisma*) provide mechanical resistance to expansion and growth of embryo.

(d) Immaturity of embryo: In some plants like orchids, *Ginkgo biloba*, *Anemone nemorosa*, *Fraxinus excelsior* etc. the dormancy is due to immaturity of embryo. In this case the embryos of the seeds are not fully developed when the seeds are shed. The seeds of these plants can germinate after a period of rest during which the development of embryo is completed.

(e) Seeds needing after ripening: The seeds of barley, oat, wheat etc. though contain fully developed embryo, but they do not germinate immediately after harvesting. There is no requirement of any special treatments to overcome this dormancy. These seeds can only germinate if kept under dry storage condition at normal temperatures for about a few weeks to several months. During this period probably due to certain physiological changes in the embryo, the seeds develop the capacity to germinate which is called as after ripening.

(f) Presence of germination Inhibitors in seeds *i.e.* presence of inhibitors or release of inhibitors: Sometimes dormancy is caused due to the presence of some germination inhibitors in different parts of seed like tests, endosperm, and embryo or in structures surrounding them like juice or pulp of fruits like tomato and glumes like oats.

(g) Chilling or low temperature requirement: In certain plants such as apple, rose, peach etc., the seeds remain dormant harvest in autumn because they have a low temperature or chilling requirement for germination. The chilling requirement is met under natural conditions in winter season.

(h) Light sensitive seeds: The seeds of some plants like lettuce (*Lactuca sativa*), tobacco (*Nicotiana tobaccum*), tomato (*Lycopersicon esculentum*) and Shepherd's purse (*Capsella bursa pastoris*) require exposure to light to initiate germination. The light sensitive seeds are called photoblastic seeds.

(i) Seeds requiring high CO_2 concentration: The seeds of subterranean clover (*Trifolium subterraneum*) is known to germinate under higher concentration of CO_2, but remains dormant under ambient CO_2 concentration.

(j) High osmotic concentration: The seeds of the Artiplex sp. are known to have higher osmotic concentration, which prevents their germination. The seeds germinate only when the solutes are washed away by rainfall.

Methods of Breaking Seed Dormancy

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

(a) Scarification:

Any treatment that weakness the seed coat is known as scarification.Scarification method is applied, when dormancy is imposed by hard seen coat as in legumes or by impermeability of seed coats to water and oxygen or due to presence of growth inhibitors or mechanical resistance.

In this method there are various ways to break hard seed coat such as:

(i) Seeds are either rubbed on a sand paper manually. At the time of rubbing care should be taken that not to damage the axis of the seed e.g. Green gram and subabool.

(ii) When seed coat is too hard i.e. of woody nature, the seed coat has to be removing completely by breaking it. E.g. Rubber (*Havea* app) seed India teak wood seed.

(iii) Soaking hard seed coat in concentrated or diluted solution of sulphuric acid for 1 to 60 minutes can remove seed coat impermeability. *e. g.* cotton seeds, India teak wood seeds etc.

(b)Temperature Treatments:

(i) The seeds requiring exposure to chilling temperature for germination can be made to germinate by artificially providing low temperature(5-10^{o}C) in a moist medium for a few weeks. The dormancy of the seeds of apple, peach, plum, cherry and apricot can be broken through this method. The agricultural practices involving the placing of seeds in alternate layers of soil, sand or other suitable materials and keeping them in low temperature is called *stratification*.

(ii) Some seeds required a brief period of incubation (from a few hours to one to five days) at 40 to 50^{o}C before germinating at required temperature. (in this method care should be taken that moisture content of the seed is not more than 15% e.g. paddy (*Oryza sativa*).

(iii) Hot water treatment is also an effective method of breaking hard seed coat in legumes. In this method the seeds are soaked in water at 80^{o}C temperature for 1-5 minutes (depending up on the type of seed) before putting for germination.

(c) Light Treatments:

Exposure to red light helps in breaking the dormancy of the photoblastic seeds like lettuce (*Lactuca sativa*).

(d) Treatments with growth regulators and other chemicals:

Endogenous dormancy may be due to presence of germination inhibitors. Application of low level of growth regulators like Gibberellins, Cytokinins and Ethylene etc may break the seed dormancy.Most widely used growth regulators are gibberellins and kinetics *e.g.* presoaking the seeds of sorghum with 100 ppm GA_3helps breaking seed dormancy. Among other chemicals potassium nitrate (0.2%) and thiourea (0.5 to 3%) are

widely used for breaking seed dormancy in oat (*Avena sativa*), barley (*Hordeum vulgare*), and tomato (*Lycopersicon* spp).

SEED GERMINATION

ISTA (1985) defined germination as emergence and development from the seed embryo of those essential structures which, for the kind of seed in question, indicates its ability to produce a normal plant under favourable conditions.

Types of seed germination:

1. ***Epigeal germination***: Cotyledons emerges above the soil surface by elongation of hypocotyls*e.g.* castor, tamarind, cucumber, cotton, gourd etc.
2. ***Hypogeal germination***: (*Hypo*: bellow, *ge*: earth) In some seeds such as gram, pea, mango, litchi, broad-bean, groundnut etc. the cotyledons are seen to remain in the soil or just on its surface. Here the cotyledon do not emerge above the soil, epicotyl grow first.
3. ***Viviparous germination***: Many mangrove plants (plants growing in salt lakes and sea coasts) show a special type of germination of their seeds known as vivipary.The germinates inside the fruit while still attached to the parent tree and nourished by it. The radicle elongates, swells in the lower part and gets stouter. Ultimately the seedling separates from the parent plant due to its increasing weight, and falling vertically becomes embedded in the soft mud bellow. The radicle presses into the soil, and quickly lateral roots are formed for proper anchorage *e.g. Rhizophora* sp., *Heritiera* sp., *Sonneratia* sp. In this type of germination, the generation from development of embryo to young seedling is continuous, without any period of rest.

Physiology of seed germination:

1. Imbibition:
2. Hydration and activation:
3. Cell division and cell expansion:
4. Establishment of primary seedling:

***Phase I*: Imbibition**

Imbibition is a precondition for the metabolic process that ultimately lead to completion of the germination process. However, imbibition is a purely physical process which occurs whether the seed is dormant or non-dormant (except physical dormancy), viable or non-viable (Bewley and Black 1994, Mayer and Poljakoff-Mayber, 1982). Hence, dormant or dead seed may imbibe normally without leading to germination. Physically dormant seed will not imbibe unless their seed-coat has been made permeable by pretreatment or natural processes. Even where viable seeds have imbibed, germination may be impeded or delayed by the presence of other types of dormancy or by absence of appropriate germination temperature. Seeds in soil seed banks are often fully imbibed unless physically dormant.

***Phase II*: Hydration and activation**

The water uptake is very low during the lag phase which follows the imbibition. During this phase metabolic activity commences and the seed mobilizes stored food

reserves such as protein and starch and metabolic enzymes become active. When the seeds absorb water the organelles and macro-molecules present in the seeds are hydrated. Due to hydrolysis of different organelles both aerobic and anaerobic process are initiated. The anabolic process includes synthesis of carbohydrates, proteins,lipids,nucleic acid etc.The enzyme required for catabolic and anabolic process may either be synthesized or released from zymozen state(enzyme precursor).Aperticular enzyme is responsible for a particular biochemical process.The most conspicuous change during hydration is rise in the rate of respiration. The respiration pathways operating in the seeds are glycolysis, pentose phosphate pathway and citric acid cycle.The rate of respiration increases during the initiation of germination.During this period the rate of absorption of oxygen also increases. Initially there may be aerobic respiration but it is soon replaced byaerobic one due to availability of oxygen. Mobilization of reserve food material occurs during this phase by the activity of hydrolytic enzymes like *amylase*, *protease*, *lipase*, *nuclease* etc. Carbohydrates are hydrolyzed into simple sugars like glucose and sucrose. Proteins are hydrolyzed into amino acids.Lipids are hydrolyzed into fatty acids. Nucleic acids are hydrolyzed into nucleotides and nitrogenous bases. However new DNA and RNAs are synthesized from the existing nitrogen bases by the help of the enzymes like DNA polymerase and RNA polymerase. Growth regulators like Auxin, gibberellins and cytokinins present in conjugated states are released during hydration process. Due to the activity of growth regulating substances the germination process is initiated.

***Phase III*: Cell elongation and mitosis**

Cell division is facilitated by growth hormone cytokinin. The cell in the embryonic axis which are in the meristematic state start dividing when they are hydrated and properly conditioned through hydration of organelles, macromolecules and other component leading to various catabolic and anabolic activities. The meristematic tissue when divides prepare food materials or metabolites for completion of cell growth. These food materials are provided from stored food material in the cotyledon, endosperm and perisperm. Initially all the cells in the embryonic axis starts dividing but in the later stage they are differentiated. Cells stop mitotic division.The cells which are in the meristematic stage divide and redivide.The cell division is immediately followed by cell expansion.The cell expansion process is augmented by cell vacoulation. The cell expansion and vacoulation process is accelerated by the activity of phytohormone, Indole acetic acid. When the cells are expanded the radicle and the plumule come out of the seed coat by bursting the seed coat. No mechanical hindrance is created in coming out of the radicle and plumule. In case of dicots, the whole cotyledon comes out from the seed coat. The process of cell division and cell expansion ultimately results in the growth of young seedling. Following the lag phase seeds enter into a phase of cell elongation and mitosis resulting initially in protrusion of the radicle, later by the appearance of epicotyl, hypocotyls and cotyledons. Physiologically, seed germination is considered completed on protrusion of the radicle. In seed testing, germination is considered concluded only once a seed-ling has developed; in the hydrogen peroxide test germinant are evaluated after protrusion of the radicle, but this is considered a viability test, not a germination test.

***Phase IV*: Establishment of the primary seedling**

During the process of imbibition the seeds swell and some space is created in soil for accommodation of embroyonic root,the radicle.The plumule(in case of monocots) and cotyledons (in case of dicots) come out of the soil and grow towards the sunlight.The seedling in the initial stage is told to be in the hypertrophic stage because its initial growth and development depends upon the food materials stored in the cotyledons,endosperm and perisperm.However when the chlorophyll is synthesized either in the cotyledons or in the young leaves,the young plant starts photosynthesizing.Through the process of photosynthesis the young seedling manufactures food material for its growth.The radicle to a full root and absorbs water and minerals from the soil.The seedling enters into the autotrophic phase of growth. Germination is the beginning of growth of a seed. The seed must have the right level of warmth and moisture to begin to germinate. First, the seed leaves absorb moisture which allows the food reserves to become available to the new plant. It can then produce a root so that it can find its own water, followed by a shoot which develops from the plumule, which will allow it to absorb light. The plant needs both water and light to grow.

Factors influencing germination:

(i) *Moisture*: For germination of a seed, protoplasm must be saturated with water. In air dried seeds, the water content is usually 10-15%. No vital activity is possible at this low water content. Water is thus necessary to bring about the vital activity of the dormant embryo; to dissolve the various salts and to hydrolyse many organic substances stored in cotyledons or in the endosperm; to facilitate necessary chemical changes and to help the embryo to come out easily by softening the seed coat.

(ii) *Temperature*: A suitable temperature is necessary for germination of a seed. Protoplasm functions normally within a certain range of temperature. Within limits which vary accordingly to the nature of the seed, the higher the temperature the more rapid is the germination.

(iii) *Air*: Oxygen is necessary for respiration of a germinating seed. By this process a considerable amount of energy stored in the food material is liberated and made use of by the protoplasm. Respiration in the germinating seed is very vigorous as the active protoplasm requires a constant supply of oxygen, and hence the seed sown deeply in the soil shows very little or no sign of germination.

(iv) *Light*: Light is not essential for germination. Generally seeds germinate better in dark. However, some seeds like that of lettuce do not germinate in dark and light is indispensable for their germination.

SEED CERTIFICATION

Seed certification is system of maintaining the quality of seeds. The crops offered for certification are raised as per requirement for seed certification established by seed certification agency. Several inspections are made to ensure purity and quality of seeds.

Seed Certification Agency:

The certification agency established under section 8 or organized under section 18 of the Seeds Act 1966.Its major function is to certify seeds of any notified kind or varieties.

Steps of Seed Certification:

1. Verification of seed source
2. Field inspection to conform to the prescribed field standards
3. Supervision at harvesting and after harvesting
4. Seed sampling and testing in seed testing laboratory
5. Tagging and sealing

Field inspection

Field inspection is one of the most important steps in seed certification because many identifications including varietal identification are possible in the standing crops in the field. Field standards for some important crops are as follows:

Crops	**Minimum isolation distance(m)**		**Minimum number of field inspections and stages**	**Off types% (Max. permitted)**	
	Foundation	**Certified**			
Wheat, Rice, Oat, Barley	3	3	2: from flowering to harvesting	0.05% ear heads	0.20% ear heads
Cotton(varieties)	50	30	2: from flowering to harvesting	0.10%	0.20%
Groundnut	3	3	2: from flowering to harvesting	0.10%	0.20%

The seed crop is checked for proper isolation from other crops to prevent harvesting a mixture of seeds. Two to four field inspections are recommended to be done during seed production of different crops.

SEED TESTING

Seed testing is carried out to evaluate the planting value of seed. Different techniques are used to assess genetic purity, germination, viability, storability and field emergence of seed. In recent times, new seed technology applications are finding increasing use to deliver a complete value-added package to farmers.Seed testing technologies are mentionedbellow.

Seed sampling

Seed lot is a specific physically identifiable quantity of seed in respect of which a seed test certificate can be issued. Samples are obtained from the seed lot by taking small portions at random from different positions of the lot and combining them. From this composite sample, small samples are obtained in one or more stages. At each stage, thorough mixing is followed by progressive subdivision. Besides hand sampling, sampling can also be done with the help of samplers or trier, available for this purpose. The samples may be of the following kinds.

Primary Sample: it is a small portion taken from one point from theseed lot.

Composite sample: It is formed by combining and mixing all primary samples taken fromthe lot

Submitted sample: It is the sample submitted to seed testing laboratory. The size of the submitted sample is specified in Seed Testing Rules.
Working sample: It is a sample taken from submitted sample in the laboratory, on which one of the quality tests is made.
The sampling intensity depends upon the lot size-based on which the number of primary samples is prescribed. Sampling is carriedout only by qualified, trained and experiencedpersons.

Physical purity analysis

The physical purity analysis of a seed sample refers to the determination of the different components of the physical purity *viz.*, pure seed, other crop seeds, weed seeds and the inert matter by weight of sample on percent basis. All species of the seeds and each kind of inert matter are identified. Weight of the working sample for purity analysis depends on the crop or seed size and, for example, is 700g for French bean, 7g for tomato etc.

Seed germination testing

Germination testing is considered as the most important quality test in evaluating the planting value of a seed lot. Germination test is made on pure seed fraction of a physical purity test. Tests are made under controlled conditions of temperature and relative humidity. Examination of seedlings and also hard, fresh or dead seeds is done after a prescribed period. General requirements of seed germination are a suitable substratum, adequate moisture, and favourable temperature and light. Crop wise media or substrata, temperature and duration of testing have been prescribed.

Germination testing is done as follows:
Paper: Seeds may be tested for germination by placing them on (i) top of paper. (ii), between paper, and (iii) in pleated strips of paper. This is generally used for small and medium-sized seeds.
Sand: It is used as a substratum and seeds are tested for germination by placing them on the top of sand or in sand. This is generally used for large sized seeds.
Soil: Germination can be tested using soil also but it is, generally difficult to obtain consistent results in soil or artificial compost. For this reason, soil is not recommended as a primary substratum. However, this substratum is used to confirm the evaluation made by other methods or in doubtful cases.
The methods of germination testing should be based on Rules and Guidelines laid down by the International Seed Testing Association (ISTA).

Rapid methods of testing seed viability

It is often needed to ascertain viability of seeds in a short time. The following methods are generally used for this purpose.

Topographical tetrazolium test:

In this test, the living cells of the viable seed turn red by reacting with tetrazolium solution. The indicator dye used is Tetrazolium salt (2, 3, 5 triphenyl tetrazolium chloride). The method of tetrazolium test (TZ) was developed by the German scientist Lakon 1942. By the hydrogenation of 2, 3, 5-triphenyl tetrazolium chloride, a red, stable

and non-diffusible substance, triphenyl formazan is produced in living tissue or cells. The live parts of viable seeds are stained red, when incubated in the solution of this chemical, whereas dead ones are colourless. The colourless seed tissues become coloured due to reduction of tetrazolium by dehydrogenase enzyme activity in the living tissue of the seed.Besides completely stained viable seed, unstained non-viable seeds and partially stained seeds are also obtained. Varying proportions of necrotic tissues found in different zones of partially stained seeds. The position and the size of necrotic areas is then determined whether such seeds are viable or non-viable. For these reasons, the test is designated as the Topographical Tetrazolium Test.

Advantages of TZ-Test:

1. Through this test, the viability of the seed can be quickly and easily be estimated (within 12-20 hours)
2. For the dormant and slow germinating seeds, this test is highly useful to assess their viability, because these seeds will take longer time to produce results under germination
3. The chemical does not damage the seeds. Hence, they can also be used for germination purpose after the test is over.

Disadvantages

1. In this test, it is difficult to distinguish between normal and abnormal
2. It is also not possible to distinguish between dormant and non-dormant seeds, since the test does not involve the germination of seeds
3. Microorganisms affecting the germination are not detected in this test.

Embryo-excision method: In this method the embryos are excised from the soaked seeds and are incubated under normal conditions of light and moisture, generally at a constant temperature of 20°C for up to 14 days. Germinating embryos, those with one or more cotyledons showing growth or greening, and embryos remaining firm and slightly enlarged, are generally considered viable.

Ferric chloride test for mechanical damage

Mechanical injured areas of most of the legume seeds turn black when placed in a solution of ferric chloride. This practical method can be used for rapid assessmentof mechanical damage.

Seed vigour testing

Seed vigour is the sum total of those properties of the seed which determine the level of activity and performance of the seed or seed lot during germination and seedling emergence. Seed lots with similar germination may give varying results with regard to field emergence, seedling performance and field stand. Several tests, commonly known as vigour tests are capable of reliably predicting field-stand potential of the seeds. A vigorous seed lot is likely to succeed under a wide variety of field conditions. Nevertheless, a vigour test is nor a test for field emergence and field response *per se*. It may be direct test, viz. brick gravel test (The Hiltner Test), paper piercing test, conductivity test, accelerated aging test, the cold test for com etc. It may be indirect test

also, comprising measurements of seedling growth rate, dry weight of seedlings, speed of germination etc.

An accelerated ageing test was developed in early seventies. In this test, seeds are held at a high relative humidity (usually near 100%), with the result that their moisture content increase, and at 40^{o}-45^{o} C for varying lengths of time depending on the type of seed. This period of rapid ageing is followed by it germination lest. This test was initially developed as test of seed storage potential and is subsequently used as a vigour test as well.

Seed health tests

Seeds are the carriers of different microorganisms. Several micro-organisms like fungi, bacteria, viruses and nematodes are carried through seeds. For example, loose smut of barley and wheat are predominantly seed-borne. Detection and management of seed-borne pathogens is therefore an important aspect of seed technology.

Seed health tests may be done through (i) visual examination of dry seed, (ii) washing tests, (iii) seed soak method, (iv) examination after incubation using blotter, sand or compost or agar plate method, (v) examination of growing plants, (vi) other crop and disease-specific techniques, (vii) bioassay test, and (viii) other advanced tests including those using modem molecular techniques.

For a particular crop-specific disease, specific tests are available. For example, for Karnal bunt of wheat, the following specific test could be feasibly used.

Sodium hydroxide seed soak method Karnal bunt of wheat. Seeds, preferably 2000 in two replicates of 1000 each are soaked in a 0.2% sodium hydroxide solution (2 g NaOH/1,000 ml water) for 24 hr at 20^{o}-30^{o} C. Next day, the solution is decanted and seeds are spread over ablotting paper and examined visually. The portion of the seed infected with Karnal bunt (c.o. *Neovossia indica* fungus) infected exhibits a jet black shiny appearance contrasting to pale-yellow healthy portions of the seed. The Karnal bunt infection is then reported in percentage by number.The seed-soak method is also used to detect bunt of rice.

Moisture tests

Seed moisture tests are very important tests for determination of seed quality. The recommended method of moisture determination is based on oven drying, either for 1-4 hours at 130^{o}C or for 17 hours at 103 ± 2^{o}C (the latter is for seeds having high volatile oils in large proportion). However, there are alternative procedures, both destructive and non-destructive, which may also be used. These are (i) drying without heat, (ii) lyophilisation (freeze drying), (iii) reversibility method; and (iv) Karl Fisher titration method after extracting water from the fine ground seed with methyl alcohol and determining the moisture content by titration, air-oven method. The most commonly used moisture meter for seed moisture tests in India is Universal-OSAW moisture meter.

Varietal purity tests

These can be carried out by (i) grow out test and verifying the presence of distinguishing morphological and other characters. (ii) by using biochemical and molecular markers, which are quite prevalent presently, or (iii) DNAfingerprinting, if available and feasible.

Grow out test: The monitoring of genetic purity and freedom from seed-borne infection of seed lots is very important which can be done by post season control-plot testing or grow-out tests. In this test the plants are grown from the seeds to observe the varietal purity and seed borne infections. The crop is monitored throughout the growing period, and the off-type plants if any are tagged and counted at maturity to assess genetic purity. Grow-out test helps in the elimination of the sub-standard seed lots.

Recently different methods of varietal purity tests like electrophoresis and PCR-based technologies have been developed and standardized for different crops, but these are very costly tools.

Routine Test:

In a seed testing laboratory, germination test, purity test, test for other seeds and moisture test are known as Routine Test. Where the analysis for diseased seeds and other variety seeds is also desired on routine basis (as in case of certified seed samples for issuance of seed certification tags) these tests should also be included in the routine test.

Real value of seed:

The real value of the seed is the percentage of seed sample that would produce seedlings of variety under certification. It is also known as the utility percentage of the seeds and is a function of the purity and germination percent of the seed sample. The real value of a seed lot is determined by the following formula.

$$\text{Real value of seed (\%)} = \frac{\textit{Purity}\ (\%)\ x\ \textit{Germination}\ (\%)}{100}$$

When two or more seed lots are compared, both their purity and germination should be taken into account. This can be easily done by determining the real value of seed lots.

HYBRID SEED

Hybrids are the first generation (F_1) crosses between two pure lines, open pollinated varieties or clones that are genetically dissimilar. Most of the commercial hybrids are F_1s from two or more pure lines (tomato, rice, Jowar) or inbred lines (maize, sunflower, caster etc.).

Method of Hybrid-Seed Production in rice:

Hybrid rice can be produced in the following ways.

(i) Three-line system. The hybrid seed production involves multiplication of cytoplasmic-genetic male sterile line (A line), maintainer line (B line) and a restore line (R line) and production of F_1 hybrid seed (AxR).

(ii) Two-line system. The hybrid seed production involves the use of photo-period sensitive genetic male sterile (PSMS). Any normal line can serve as a restorer.

(iii) By using chemical emasculators. Chemicals that can sterilize the stamen, with little or no effect on the normal functioning of the pistil, can be used to emasculate female parents for hybrid rice production. The advantages are obvious, no special development of male sterile or restore lines is required and extensive varietal resources are available. In hybrid seed production, two-varieties are planted in alternate strips, and one is chemically sterilized and pollinated by the other.

SEED TREATMENT

Seed treatment refers to the application of fungicide, insecticide or both to the seeds to disinfect and disinfest them from seed borne or soil borne pathogenic organisms and storage insects. It also refers to subjecting the seed to solar energy exposure or immersion in conditional water. Seed treatment is also involves seed priming.

Benefits of seed treatment:

(i) Prevention of spread of plant diseases both systemic and non-systemic. Seed treatments is effective in controlling systemic diseases like smut of wheat, *Helminthosporium* blight of barley, loose and covered smuts of oats etc. Non systemic diseases that infect seed during harvest or storage period such as *Fusarium* with blight of barley oats, rice, sorghum etc. can be effectively controlled by appropriate seed treatment.

(ii) Seed treatment protects seed from seed rot and seedling blights. The protective coating around the seed, acts as a barrier against seed borne and soil borne organisms.

(iii) Seed treatment improves the germination through the control of surface moulds and flora, which are not pathogenic but may infect the seed during moist harvesting and storage condition. In the germination test thus may kill or cover the seed before it has germinated.

(iv) Provides protection from storage insects and pests

Types of seed treatment

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

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

(c) Seed protection: To protect the seed and young seedling from organisms in the soil,which might otherwise cause decay of the seed before germination.

Conditions under which seed must be treated:

(i) *Injured seeds*: Seeds suffer mechanical injury during threshing, drying or processing. Any break in the seed coat offers an excellent opportunity for the fungi to enter the seed and either kill it or weaken it.

(ii) *Diseased seeds*: Seed may be infected by disease organisms at the time of harvest or during processing in storage.

(iii) *Undesirable soil conditions*: Seeds are sometimes planted under unfavourable soil conditions such as cold and damp soils, which favours the growthand development of certain spores enabling them to attack and damage the seeds.

(iv) *Disease free seed*: Seed treatment provides a good insurable against diseases, soil borne organisms and thus protects weak seeds enabling them to germinate and provide seedlings.

Seed priming and pregerminated seed:

Seed priming is the most important physiological seed enhancement method. Seed priming is an hydration treatment that allows controlled imbibition and induction of the pregerminative metabolism (activation), but radicle emergence is prevented. The hydration treatment is stopped before dessication tolerance is lost. Priming solutions can be supplemented with plant hormones or beneficial microorganisms. The seeds can be dried back for storage, distribution and planting. Seed priming improves germination and seedling establishment through reducing dormancy, improving desiccation tolerance and enhancing seedling growth. This leads to better crop stands and higher yields. However, priming decreases the storability of the seed and the primed seeds need cool storage temperatures.

Commonly used methods of seed priming:

1. Osmopriming (osmo-conditioning) is the standard priming technique. Seeds are incubated in well aerated solutions with a low water potential, and afterwards washes and dried. The low water potential of the solutions can be achieved by adding osmotica like mannitol, polyethyleneglycol (PEG) or salts like KCl.
2. Hydropriming (drum priming) is achieved by continuous or successive addition of a limited amount of water to the seeds. A drum is used for this purpose and the water can also be applied by humid air. 'On-farm steeping' is the cheap and useful technique that is practized by incubating seeds (cereals, legumes) for a limited time in warm water.
3. Matrix priming (matriconditioning) is the incubation of seeds in a solid, insoluble matrix (vermiculite, diatomaceous earth, cross-linked highly water-absorbent polymers) with a limited amount of water. This method confers a slow imbibition.
4. Pregerminated seeds are only possible with a few species. In contrast to normal priming, seeds are allowed to have radicle protrusion. This is followed by sorting for specific stages, a treatment that reinduces dessication tolerance, and drying. The use of pregerminated seeds causes rapid and uniform seedling development.

SEED LEGISLATION IN INDIA

The basic purpose of seed legislation and its subsequent enforcement is to regulate the quality of seed sold to farmers The Indian Seeds Act was passed on 29th December 1966 and came into force from 1 October 1969 to regulate the quality of seeds offered for sale. The main features of the Act are voluntary certification and compulsory labeling. Therefore, seeds of notified kind or variety when offered for sale must either certified or truthfully labeled. The Seeds Act, 1966 *inter alia* provides for establishment of seed testing laboratories, notification of varieties, appointment of seed inspectors, minimum limits of germination and purity and, penalty for offenders.

The Seeds Act 1966 was followed by Seed (Control) Order 1983.The Seeds (control) order 1983 was promulgated under Essential Commodities Act of 1955 mainly with a view to evolve a mechanism for registration of seed dealers, get regular flow of information on seed production and sales and to ensure supply of seeds all over the country.

In the year 2001, another law in the name of *Protection of Plant varieties and Farmers' Rights Act,2001* was made. There is provision for an authority for protection of

plant varieties and farmers rights at national level *i.e.* Plant Varieties and Farmers Rights Authority and also provision for a registry, which facilitates registration of plant varieties. This legislation extends to all categories plants except micro organisms. Only new, distinct, uniform and stable varieties are eligible for being protected under the act. This legislation provides for compulsory licensing in the public interest. This law does not prevent the farmers, their traditional rights to save, use exchange, share and sell their produce of protected varieties. But they are restrained from selling branded seeds of the protected varieties for commercial purposes.

Seed Bill, 2004 is a recent initiative by the Indian government to regulate the seed industry and its stake holders in a changing scenario of global agriculture. This Bill *inter alia* provides for compulsory registration of varieties based on performance (to ensure quality of the seeds), accreditation of Indian Council of Agricultural Researchcentres, State Agricultural Universities (SAUs) and private organizations to conduct the performance trials, maintenance of national register of varieties, provision for self certification(accreditation of organizations for certification),accreditation of private seed testing laboratories, regulation of export and import of seeds, regulation of horticultural nurseries, exemption for farmers to save, use, exchange, share or sell their seeds without registration and brand names, increasing the penalties for major and minor infringement of the law, provisions for compensation to the farmers, and provisions to regulate the Genetically modified(GM) crops and ban on terminator seeds.

TERMINATOR SEEDS

Terminator seeds are genetically modified hybrid seeds carrying genes which prevent germination after one generation (Terminator gene technology). The term *Terminator technology* was coined by Mr. Hope Shand, the erstwhile Research Director of Rural Advancement Foundation International (RAFI), 1998. The seed incorporating the terminator gene will grow normally after germination until the crop is mature. But during the late embryogenesis process, a toxin is produced in the developing seed which kills the entire next generation of seeds. Terminator technology is an extremely complex technology in which two systems are brought together to stop the normal process of germination. These gene systems are *gene system-I* consisting of a *gene A* which produces the *Ribosome Inactivating Protein (RIP),* which is lethal to the growing embryo, *gene A* is linked to a transiently active *LEA (Late Embryogenesis Abundant) promoter, PA* through a blocking sequence. A recombinase specific excision sequence (LOX sequence) flanks the blocking sequence on either side. *Gene A* will only be active when *LOX sequence* will be removed. *Gene system II* consists of a *gene B* linked to promoter, PB. The *gene B* encodes for an enzyme *recombinase*, which is specific to the LOX sequence of the *gene system-I*. A third *gene C* produces a repressor protein that binds to the *promoter PB* and prevents the expression of *gene B.* The *gene C* can be derepressed by exogenous application of tetracycline. The patent for the *terminator gene technology* is with Monsanto seed company, USA.

Flow chart for production of terminator seed

1. A male parent containing *gene A* and a female plant containing gene B and gene C crossed to produce a hybrid seed(F_1 seed) containing *gene A, gene B and gene C.*

2. The hybrid seeds are sown after a pre-sowing treatment with tetracycline
3. Gene B is expressed leading to production of recombinase enzyme (Tetracycline induces the gene B by derepressing gene C which otherwise inactivates the gene B by producing a repressor protein that binds to PB).
4. *Recombinase* enzyme removes the *intervening blocking sequence(LOX)* present between gene A and its promoter PA leading to expression of gene A. PA is Late Embryogenesis Abundant (LEA) promoter active during early stage of embryo development.
5. Gene A produces Ribosome Inhibitor Protein (RIP) as a result embryo gets aborted in the early embryo stage.
6. F_2 seed (terminator seed) thus produced does not germinate.

ORGANIZATIONS / INSTITUTIONS ASSOCIATED WITH SEED PRODUCTION:

National Seed Corporation:

The National Seed Corporation (NSC) was established in the year 1961 under the Indian Council of Agricultural Research. Later on 7th March 1963, it was registered as a limited company in the public sector. The NSC was established to serve two main objectives i.e. to promote the development of seed industry in India and to produce and supply of foundation seeds of various crops.

Functions of NSC:

(i) Production and supply of foundation seed
(ii) To maintain improved seed stocks of improved varieties
(iii) Interstate marketing of all classes of seed
(iv) Export and import of seed
(v) Production of certified seed when required
(vi) Planning and production of breeder seed in consultation with ICAR
(vii) Providing technical assistance to seed corporations and private agencies
(viii) Coordinating certified seed production of several state seed corporations
(ix) Conducting biennial surveys of seed demand
(x) Coordinating market research and sales promotion efforts
(xi) Providing training facility for the staff participating in seed industry development
(xii) Providing certification services to states lacking establishment and independent seed certification agencies

Seed Certification Agency

The seed certification agency is established under section 8 or reorganized under section 18 of seeds act 1966.Its major function is to certify seeds of any notified kind or varieties. The State seed certification agencies (SSCAs) are responsible for certification of seeds of the concerned states.

Functions of SSCA:

(i) Screening the applications from the seed growers for seed certification
(ii) Checking and verifying the authenticity of the source seed used for growing the seed crop under certification

(iii) Carrying out requisite field inspections
(iv) Conducting seed tests
(v) Certifying seeds found suitable and issuing appropriate tags for certified and foundation seeds
(vi) Conducting short courses on seed production,
(vii) Guiding the seed growers on production, processing and distribution of seeds
(viii) Participating in other activities conducive to the development of seed industry

Central Seed Testing Laboratory:

The Seed Testing Laboratory at the Indian Agricultural Research Institute (IARI), New Delhi has been notified as the Central Seed Testing Laboratory. Functions of the Seed Testing laboratory have been enshrined under section 4(1) of the Seeds Act.

Functions CSTL:

(i) Initiate testing programmes in collaboration with State Seed Laboratories designed to promote uniformity in test results between all Seed Testing Laboratories in India.
(ii) Collect data continuously on the quality of seeds found in the market and makes this data available to the Committee;
(iii) Carry out such other functions as may be assigned to it by the Central Government from time to time; and
(iv) Act as reference laboratory in testing seed samples for achieving uniformity in seed testing. The State Seed Testing Laboratories are required to send five percent samples to the Central Seed Testing Laboratory along with their analysis results.

State Seed Testing Laboratory:

The section 4(2) of the Seeds Act envisages for establishment of State Seed Testing Laboratory in all states. At present there are 107 seed testing laboratories and 4 ISTA accredited private seed testing laboratories in India. The Seed Testing Laboratory at Central Institute of Cotton Research (ICAR), Nagpur deals with testing of Bt. cotton seeds only. The State Government could appoint seed analysts through notification in the Official Gazette under section 12 of the Seeds Act defining his geographical area of jurisdiction.

Functions of SSTL:

(i) To carry out seed analysis work in the state in a prescribed manner.
(ii) Analysis of the samples received from Seed Certification Agencies set up under Section 8 of the Seeds Act.
(iii) Analysis of the service samples: Seed users and seed producers could get seed sample tested to obtain the result to be used as information for seeding, selling or labelling purpose.
(iv) Analysis of the samples received from Seed Inspector to determine the compliance of labelling requirements under Section 7 of the Seeds Act.

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