Principles of Seed Technology

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Lecture 01: SEED PRODUCTION

Availability of quality seeds of improved cultivars is considered crucial for realizing productivity and adoption of cultivars in different agro-climatic conditions. The quality of seed alone is known to account for at least 10-15% increase in the productivity (ICAR 1993). However, lack of quality seed continues to be one of the greatest impediments to bridging the vast yield gap. Therefore, to approach the potentially realizable yield of a cultivar, production and distribution of quality seed is essential. The good quality seed should have the following characters:

- Genetic purity, and uniformity and should conform to the standards of the particular cultivar.
- Disease free, viable seeds.
- Free from admixtures of other crop seeds, weeds and inert matter.
- Acceptable uniformity with respect to size, shape and color.

Seed Production

Systemized crop production is known as seed production. In seed production adequate care is given from the purchase of seeds upto harvest adopting proper seed and crop management techniques.

The benefits of seed production are

- Higher income
- Higher quality seed for next sowing

Difference between seed and crop production

Seed production	Crop production
Basic seed should be from an authentic source	Any seed material can be used
Seed plot should be selected carefully for better performance, as per edaphic and environmental requirement	Can be grown in any area
Needs isolation from other varieties	Isolation is not necessary
Needs technical skill for maintenance of quality	Special technical skill is not required
Maintenance of genetic purity is important	Genetic purity is not required

Roguing is compulsorily practiced	Roguing is not practiced
Harvesting should be done at physiological/ harvestable maturity	Harvested at field maturity
Resultant seed should be vigorous and viable	Question of viability does not arise
Importance is given to seed quality rather than the yield	Importance is given more to yield

There are two types (major) of seed production ie. Varietal and hybrid

Seed production based on the type of seed used for multiplication .The difference between varietal and hybrid seed production are as follows

Varietal seed production	**Hybrid seed production**
It is single parent multiplication	It needs two to many parents
Isolation distance requirement is less	Isolation distance requirement is more
Production is by open pollination	Production is by managed control pollination (Female)
Seed can be used continuously for 3/4/5 generations	Seed has to be changed every time
Production technique is uniform (multiplication)	Technique differ with crop
Production care is less	Production care is more
Yield will be lower	Yield will be higher
Profit is less	Profit is higher

SCOPE AND IMPORTANCE OF SEED PRODUCTION

Indian Agriculture has made enormous progress in the last 50 years. Food grains production has risen from 50 million tons in 1947 to 212 million tons in 2003-04. The country has advanced from a situation of food scarcity and imports to that of food security and exportable surpluses. The Green Revolution of India has been universally acclaimed as a successful enterprise of the farmers, the Scientists and the Government. The land mark achievements in agriculture in the 60s and 70s were the result of a combination of inputs like introduction of high yielding varieties, increased fertilizer use, expansion of irrigation facilities, massive extension efforts, improved farm practices and, above all, ingenuity and industry of the Indian farmers. However, the growth of agriculture sector has not kept pace with the growth of the population and has stagnated. The unsatisfactory growth of agriculture,

apart from serious implications for food security of the country, has been adversely impacting the growth rate of country's economy. The imperative of National food security, nutritional security and economic development demand a very focused and determined approach to raise productivity and production in agriculture. In view of the fact, that the area under cultivation is unlikely to increase significantly, thrust will have to be on raising productivity per unit of cultivated land.

Substantial increase in yield and quality of crops depends upon a number of factors viz., inputs like fertilizers, irrigation and plant protection measures and suitable agronomic practices. However, the use of high quality seed thus plays a pivotal role in the crop production. The use of poor quality seeds nullifies the utility of all agronomic practices and every other input applied to the crop no matter how lavishly they are applied. Economically, the cost of seed is a very small component of the total cost of production. Sindhur Sen (1974) summarizes the importance of seed quality thus "What are known as the seeds of hope may turn into seeds of frustration" if they are not of high quality. It is therefore, important to use the seed confirming to the prescribed standards in terms of high genetic purity, physical purity, physiological quality and health quality. Since ages, Indian farmers were mostly dependent on traditional varieties; therefore seed requirements were met through farm saved seeds. The use of traditional varieties coupled with farm saved seeds whose quality is not guaranteed, resulted in drastic reduction in production.

Seed is the critical determinant of agricultural production on which depends the performance and efficacy of other inputs. Quality seeds appropriate to different agro-climatic conditions and in sufficient quantity at affordable prices are required to raise productivity. Availability and use of quality seeds is not a onetime affair. Sustained increase in agriculture production and productivity necessarily requires continuous development of new and improved varieties of crops and efficient system of production and supply of seeds to farmers. The National Seeds Policy 2002 clearly emphasizes that "It has become evident that in order to achieve the food production targets of the future, a major effort will be required to enhance the seed replacement rates of various crops. This would require a major increase in the production of quality seeds……." According to the National seeds Policy 2002, the thrust areas have to be -

i) Varietal Development.
ii) Seed Production.
iii) Seed Replacement Rate Enhancement.
iv) Primary responsibility for production of breeder seed to be that of the ICAR/State Agriculture Universities.
v) An effective seed production programme.
vi) Popularization of new varieties.
vii) Availability of newly developed varieties to farmers with minimum time gap.

viii) Provision of incentives to domestic seed industry to enable it to produce seeds of high yielding varieties and hybrid seeds at a faster pace to meet the challenges of domestic requirements.

After the genesis of NSP, NSE & SSC and private seed companies, production of certified and foundation seeds have been undertaken by them.

Crop/Season-wise Requirement and Availability of Certified/Quality Seeds in India (2008-2009)(Indiastat.com)

Crop	Requirement	Availability
Cereals Total	13343953	16964189
Pulses Total	1749254	1829974
Oil Seed Total	4814665	5349716
Fibre Total	302279	361151
Patato	430000	430000

The Indian seed industry is the eighth largest in the world with an estimated value of INR 49 billion (USD 1.06 Billion) and with an annual growth rate of 12% to 13 %. The industry has shown a buoyant growth over the last two years on well supportive monsoons. The development of private seed industry is no more confined to just production and marketing of seed. It has well acquired technological strength to cater to the varietal needs of tomorrow. Along with industries Indian farmers have in recent years adopted intensive cultivation practices in order to meet the growing demand for agricultural produce.

India is bestowed with varied agro climatic conditions / zones, experienced and dedicated farmers, viable seed industry, legislations etc favouring the production of quality seeds. However, there is an urgent need for streamlining all our strengths to overpower the weaknesses.

Strengths

- A well developed and knitted seed multiplication and distribution systems linked with several ICAR institutes / SAUs / NSC / SFCI etc.
- A network of 20 seed certification agencies and more than 96 notified seed testing laboratories to legally assure the quality seeds moving in the seed market.
- A large number of varieties in different vegetable crops are available suited to varied agro climatic conditions. This makes the selection easier for taking up production in a particular area.

- Our county is bestowed with varied agro climatic conditions, which can be exploited for taking up seed production of vegetables at any time of the year in one or other past of the country.
- A very fast development of private seed companies which are helpful in bridging. The gap between demand and supply of vegetable seeds in the country.

Weaknesses

- Vegetable seed production in the country has been vulnerable to vagaries of weather resulting in production of poor quality seeds.
- Availability of realistic data on actual area under vegetable and requirements of vegetable seeds is inappropriate.
- Maintenance of isolation distance. Since in our system there is no restriction for planting any particular vegetable crops in any particular area, it becomes difficult many times to maintain the recommended isolation distance.
- Very low or no indents for new improved varieties due to ignorance about the performance of newly developed improved varieties.
- Non-availability of adequate nucleus and breeder seeds in the seed production chain.
- Problems in lifting produced seeds against indents.

Factors which affect demand

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

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

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

- Price
- Promotion

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

Demand Forecasting of seed

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

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

Seed Replacement Rate of Select Crops: 2005-06

Crop	SRR (%)
Paddy	17
Millets	7
Pulses	12.5
Cottton (Rainfed /Irrigated)	10/15
Groundnut	5
Gingelly	15
Sunflower	50
Castor	30
Soyabean	20

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

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

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

SCOPE FOR SEEDS EXPORT

There is lot of scope for marketing of seed by Indian seed companies in countries lying between 300 North and South latitudes, which are having similar agro-climatic situations and the varieties bred in India are suitable as well as comparable to varieties produced in European Union (EU), USA and Japan etc. In addition, wage rates and consumption pattern of those areas are comparable to Indian conditions. The seed can be exported from India to Indonesia, Bangladesh, China, Sri Lanka, African countries. Central and South America and markets in developed countries. The Indian cotton hybrids are suitable for African countries, where the wage rates are low for hand picking in indeterminate types. The hybrid seeds of paddy, cotton, maize, sorghum, pearl millet, sunflower, varietal seeds of paddy, vegetables (tomato, brinjal, gourds and bhendi) can be produced more economically in AP for export purposes.

Export opportunities

The export opportunities can be classified into two major categories.

- Custom production of vegetable seeds (including hybrid vegetables)
- Export of branded seeds

i. Custom production of vegetable seeds (including hybrid vegetables)

Hybrid vegetable seed production is highly labour intensive. As the competition is going up, most of the major global companies are outsourcing the seed production to the countries having labour cost advantage *viz.,* China, Thailand, Vietnam, Chile, India etc. several Indian companies have established good reputation over the past 10 years by supplying good quality seed under contract production. We also have experienced and skilled manpower to take up this activity on large scale. If we look at the production capacity 70% of India's seeds' sales come from farmer bred seeds, 26% from those bred in publicly financed institutions, and only

4% from researched hybrids. The domestic hybrid seeds market is placed at INR 4.9 Billion and is annually growing at 10% a year, against the 5% global growth rate.

ii. Export of branded seeds

Over the last 15-20 years, Indian seed industry has emerged as a vibrant research based industry (in vegetable as well as field crops). Several innovative superior products have been developed for widely varying agro-climatic conditions in the Indian agriculture. It is reported that Indian germplasm / seeds can adopt very well in the countries failing in the region 300 North and South on the equator. This would cover markets of several developing countries from Central / South America, Africa and Asia. Incidentally, both Africa and Asia are presently the fastest growing markets. Indian seed sector with its vast germplasm base and trained man power would become a strong technology source for such countries.

Agri –export zones

India has her own inherent strength in agriculture and agriculture exports. Now these have been strengthened with the liberalization, privatization polices of the government and the positive clauses in the World Trade Agreement with which India can poise to double its agro exports to Rs.200 billion by 2007.

With a view to promoting agricultural exports from the country and remunerative returns to the farming community in a sustained manner, the concept of Agri Export Zones (AEZ) was floated. These zones have been set up for end-to-end development for export of specific products from a geographically contiguous area.

Lecture 02:
SEED POLICY

National Seed Policy, 2002

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

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

The important constraints were

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

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

Thrust Areas

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

1. Varietal Development and PVP

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

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

2. Seed Production

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

Public seed sector will be restructured and will continue to have free access to breeder seed, while Private Seed Sector will have conditional access. Seed village scheme will be facilitated to upgrade the quality of farmers saved seeds.
Seed Replacement will be raised progressively, National Seed Map will be prepared to identify potential areas of seed production, seed banks will be established with cold storage facilities, seed mini kits will be supplied for popularizing new varieties and will Seed Crop Insurance will be encouraged.

3. Quality Assurance

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

4. Seed Distribution and Marketing.

- Seed Distribution and Marketing of any variety will be subject to registry

in NSB.

- National Seed Grid will be established as a data base on seed

requirement, production, distribution and farmers preference.

- Access to finance from commercial banks will be facilitated.
- Availability of high quality seed will be ensured through improved

distribution system and efficient marketing set up.

5. Infrastructure facilities

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

6. Transgenic Plant Varieties

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

- **Import of seeds and planting material**

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

- **Export of seeds**

Long term policy will be evolved to exploit varied agro climatic condition of India and strong seed production system, to raise seed export from present level of less than 1% to 10% by 2020.

1. Seed export promotion zones will be established and strengthened.
2. Data Bank on International Market will be created.

- **Promotion of Domestic Seed Industry**

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

- **Strengthening of monitoring system**

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

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

Lecture 03:
SEED DEMAND FORECASTING AND PLANNING FOR CERTIFIED, FOUNDATION AND BREEDER SEED PRODUCTION

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Demand forecasting techniques

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

Target setting: This method is commonly used in developing countries where government is directly involved in planning and seed supply. In a centrally managed economy, targets are likely to be set at a national level and production plans fixed for each region.
India is an example of a more open economy where both the public and private sectors coexist in a well-developed seed industry, but where the government retains a coordinating function and has the ultimate responsibility for the security of seed supply. The Ministry of Agriculture sets the targets and organizes meetings to establish the supply situation and production plans of the various organizations involved.
Companies may opt to set a target for an ideal sales level while, at the same time, recognizing that this is unlikely to be achieved and budgeting for a more achievable situation.

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

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

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

SEED PRODUCTION

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

- Nucleus seed is the seed produced by the breeder to develop the particular variety and is directly used for multiplication as breeder seed.

- Breeder seed is the seed material directly controlled by the originating or the sponsoring breeder or Institution for the initial and recurring production of foundation seed.

- Foundation seed is the progeny of breeder seed. Foundation seed may also be produced from foundation seed. Production of foundation seed stage-I and stage-II may thus be permitted, if supervised and approved by the Certification Agency and if the production process is so handled as to maintain specific genetic purity and identity.

- Certified seed is the progeny of foundation seed or the progeny of certified seed. If the certified seed is the progeny of certified seed, then this reproduction will not exceed three generations beyond foundation stage-I and it will be ascertained by the Certification Agency that genetic identity and genetic purity has not been significantly altered.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Recommended System of Breeder Seed Indent and Supply:

1. Every State shall provide the agro-climatic zone-wise, district-wise and variety-wise quantity of certified/quality seeds sold and area covered in the previous Kharif/Rabi season

along with SRR, productivity data to ICAR, DAC and SAUs by ***1st December for Kharif crops and 1st May for Rabi crops.***

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

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

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

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

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

7. DAC shall compile all the Breeder Seed Indents of States and private seed companies and furnish them to ICAR/ concerned PDs/PCs for production of the breeder seeds.
8. The breeder seed will be allotted to all States and private seed companies for lifting from institutes of ICAR, SAUs to produce foundation and certified seed.

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

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

11. In case of hybrids of important food crops such as paddy hybrids the State Agriculture Universities shall take the responsibility in large scale production of Pure high quality parental

lines (A Lines, R Lines) (Breeder and foundation seed). It would be ensured that NSC, SFCI, State Seeds Corporations will procure the foundation seeds on priority.

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

Lecture 04:
DETERIORATION OF CROP VARIETIES – CAUSES AND MAINTENANCE

Deterioration of Genetic Purity

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

- Developmental variations
- Mechanical mixtures
- Mutations
- Natural crossing
- Minor genetic variations
- Selected influence of pest and diseases
- The techniques of the plant breeder

1. Developmental Variations

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

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

2. Mechanical Mixtures

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

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

3. Mutations

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

4. Natural Crossing

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

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

5. Minor Genetic Variations

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

6. Selected Influence of Pest and Diseases

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

7. The Techniques of the Plant Breeder:

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

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

Maintenance of Genetic Purity during seed Production

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

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

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

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

Genetic Purity Maintenance in Hybrid Seeds
Maintenance of the genetic purity of hybrid seeds is a complicated one requiring elaborate procedures.

Nucleus Seed of Inbred Lines

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

- It is rather important to ensure that the crop is well isolated, with the requirement varying from crop to crop and depending upon the nature of the material to be protected by isolation, the nature of the contaminant, and the direction of the prevailing wind.
- The isolation can be achieved either by distance or by time (maize). The inbred line may be composited for bulk planting in the next season.
- Maintenance of genetic purity in inbred lines through hand pollination and adequate isolation alone is not enough to achieve perfection.
- The isolated fields must be critically rogued for off types and other impure types prior to the shedding of pollen.
- The nucleus seed crop is harvested after physiological maturity if artificial drying facilities exist.
- Ear to harvest lines are harvested separately and piled; These are again critically examined for ear characteristics, sorting out of all off-coloured, diseased, or otherwise undesirable ears.
- If the overall percentage of off types exceeds 0.1%, hand pollination should be repeated to produce the second year's breeders seed.
- The uniform ears are bulked, dried in a clean dry bin at temperatures not exceeding 430C, shelled, cleaned, treated with pesticides, and stored under ideal storage conditions as breeder stock seed. This seed may be increased during the following season by paying adequate attention to isolation, roguing, etc., to maintain high genetic purity of the seed.

Nucleus Seed of Non-Inbred Lines

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

    - Other practices of seeding sibbed nucleus seeds are similar to those described earlier for inbred lines.
    - Roguing however, needs to be observed more critically by individuals with good knowledge of the material.
    - The breeder's stock seed thus produced from the nucleus seed can be utilized to increase the breeder's stock of non-inbred lines, paying adequate attention to

land requirements, isolation, roguing, harvesting and handling of seed to achieve maximum genetic purity.

- The breeder's seed of the established varieties of cross-pollinated crops can be maintained by raising breeder's seed crop in isolation and roguing the crop thoroughly at various stages.
- It is often purified by mass selection.
- The crop is grown in isolation and rogued carefully as described earlier.
- At maturity about 20,000 - 25000 true to type plants are selected, harvested separately, and bulked after careful examination.
- This constitutes the breeder's stock seed. The seed may be carried over to ensure against possible failures or unforeseen shortages

Lecture 05:
SEED QUALITY

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

Seed is defined as

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

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

As per Seed Act (1966) seed includes

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

Differences between seed and grain

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

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

A carrier of new technologies

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

A basic tool for secured food supply

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

The principal means to secure crop yields in less favorable production areas

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

A medium for rapid rehabilitation of agriculture in cases of natural disaster

- Widespread floods and droughts in various parts of the country and elsewhere have focused attention on these recurrent crises and the accompanying threats of famine and starvation. The establishment of National Seed Reserve Stocks should receive high priority for meeting such natural calamities.

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

SEED QUALITY

Seed quality is the possession of seed with required genetic and physical purity that is accompanied with physiological soundness and health status.
The major seed quality characters are summarized as below.

1. Physical Quality:

It is the cleanliness of seed from other seeds, debris, inert matter, diseased seed and insect damaged seed. The seed with physical quality should have uniform size, weight, and colour and should be free from stones, debris, and dust, leafs, twigs, stems, flowers, fruit well without other crop seeds and inert material. It also should be devoid of shriveled, diseased mottled, molded, discolored, damaged and empty seeds. The seed should be easily identifiable as a species of specific category of specific species. Lack of this quality character will indirectly influence the field establishment and planting value of seed.
This quality character could be obtained with seed lots by proper cleaning and grading of seed (processing) after collection and before sowing / storage.

2. Genetic purity:

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

3. Physiological Quality:

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

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

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

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

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

4. Seed Health

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

Hence the quality seed should have

- High genetic purity
- High pure seed percentage (physical purity)
- High germinability
- High vigour
- Higher field establishment
- Free from pest and disease

- Good shape, size, colour etc., according to the specification of variety
- High longevity / shelf life.
- Optimum moisture content for storage
- High market value

Characteristics of good quality seed

- **Higher genetically purity:**

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

- **Higher physical purity for certification**

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

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

Crop	**Designated inseparable other crop seeds**
Barley	Wheat ,oats & gram
Oats	Wheat ,gram & barley
Wheat	Oats, gram & barley

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

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

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

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

Objectionable Weeds of Seed Crop Plants

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)

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

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

Crop	Designated disease	Causal organism
Wheat	Loose smut	*Ustilago tritici*
Sorghum	Grain smut Kernel smut	*Sphacelotheca sorghii*
Mustard	Alternaria blight	*Alternaria sp*
Pearl millet	Grain smut Green ear Ergot	*Tolyposporium penicillariae* *Sclerospora graminicola* *Claviceps microcephala*
Sesame	Leaf spot	*Alternaria* sp
Brinjal	Little leaf	Datura virus 2
Chilies	Anthracnose leaf blight Leaf blight	*Gloesporium piperatum* *Alternaria solani*

Cucurbits	Mosaic	*Cucumis virus*
Cowpea	Anthracnose	*Colletotricum* sp
Bhendi	Yellow vein mosaic	Hibiscus virus 1
Potato	Brown rot Root knot nematode	*Pseudomonas solanacearum* *Meloidogyne incognita*
Tomato	Early blight Leaf spot	*Alternaria solani* *Xanthomonas vesicatoria*

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

Long term storage - 6 - 8 %
Short term storage - 10-13%

- **It should have high market value**

Role of good quality seed

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

Significance of quality seed

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

SEED AND ITS MULTIPLICATION

Seed multiplication ratio

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

Seed renewal period

Seeds undergo genetic deterioration on continuous usage for reproduction, due to the

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

Seed replacement rate

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

SRR = x / y x 100

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

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

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

Generation system

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

Multiplication ratios and seed multiplication stages

S.No	Seed crop	Multiplication ratio	Seed renewal period (times)	Seed multiplication stages		
				BS	FS	CS
1.	Paddy	152	4	1	1	2
2.	Wheat	49	4	1	1	2
3.	Barley	26	4	1	1	2
4.	Maize hybrid	248	1	1	1	1
5.	Maize variety	115	3	1	1	1
6.	Jowar hybrid	179	1	1	1	1
7.	Jowar variety	94	3	1	1	1
8.	Bajra hybrid	380	1	1	1	1

9.	Bajra variety	175	3	1	1	1
10.	Ragi	420	4	1	1	2
11.	Gram & Peas	24	3	1	1	2
12.	Pigeon peas	150	3	1	1	1
13.	Other pulses	125	3	1	1	1
14.	Groundnut	18	5	1	2	2
15.	Brassicas	200	3	1	1	1
16.	Sesamum	200	3	1	1	1
17.	Linseed	42	4	1	1	2
18.	Other oil crops	(73-100)	3	1	1	1
19.	Cotton	46	3	1	1	1
20.	Jute	120	3	1	1	1
21.	Fodder	75	3	1	1	1

Lecture 06: CLASSES OF SEED

The four generally recognized classes of seeds are: Breeder's seed, Foundation seed, Registered seed and Certified seed. The Association of Official Seed Certifying Agencies (AOSCA) has defined these seed classes as follows:

Breeder seed

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

Foundation seed

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

Registered seed

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

Certified seed

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

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

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

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

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

Certification of certified seed produced from certified seed is not permitted for crops other than those listed above.
Differences between certified seed and truthful labelled seed

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

GENERATION SYSTEM OF SEED MULTIPLICATION

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

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

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

- **Three - Generation model**

Breeder seed - Foundation seed - Certified seed

b. Four - Generation model

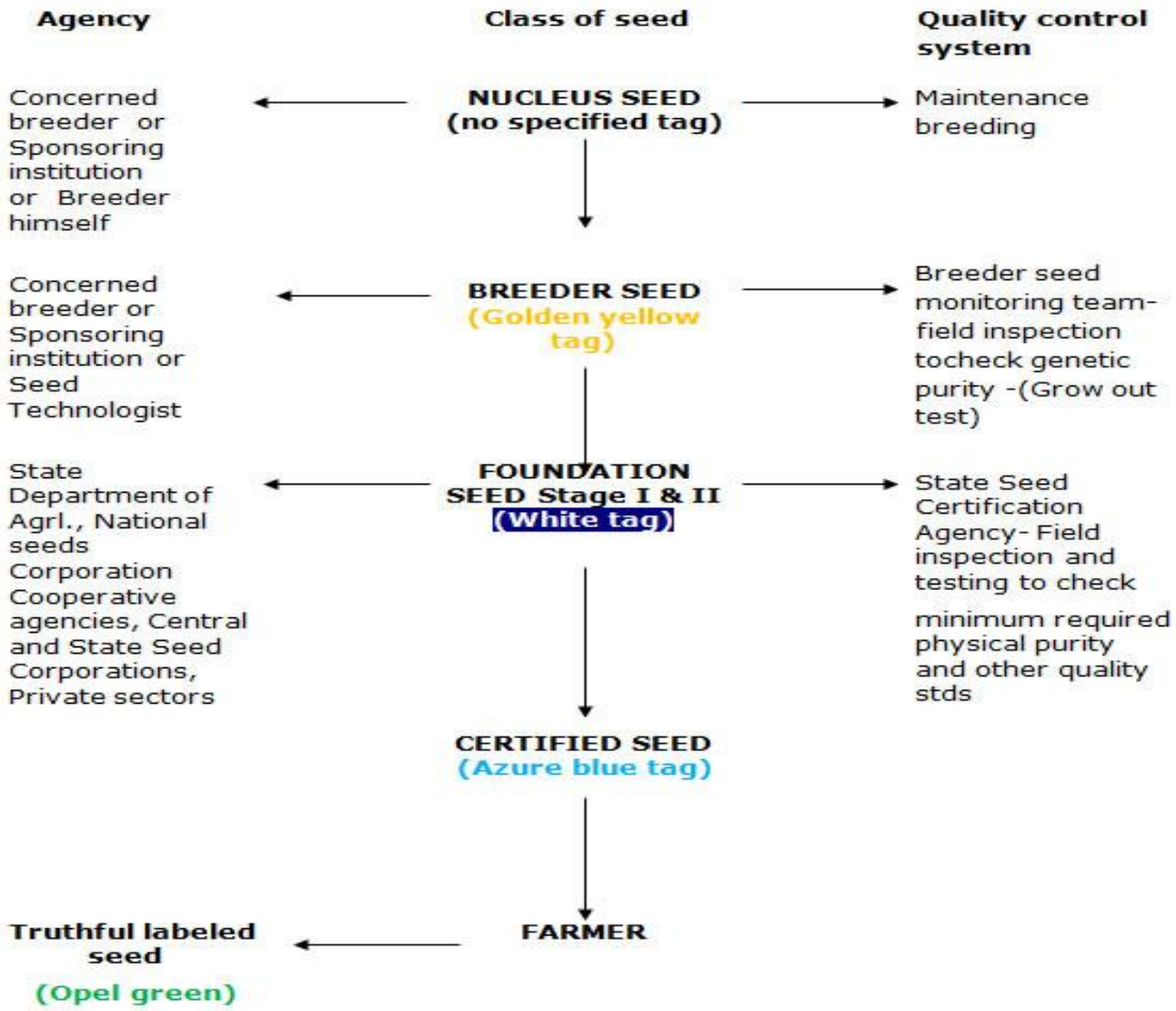
Breeder seed - Foundation seed (I) Foundation seed (II) - Certified seed

c. Five - Generation model

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

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

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



Nucleus and Breeders seed production

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

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

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

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

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

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

a. Sampling of the variety to obtain nucleus seed. New numbers, lines or selection which are highly promising, on the basis of performance in breeding nurseries and yield trials, should be sampled for seed purification. These samples provide a beginning for purifying new varieties and for possible increase and distribution to farmers. Not more than fifteen new varieties in any one crop at a station should be sampled in one year.
b. Table examination of samples: The two hundred plants of each sample should be threshed separately and the seed should be examined in piles on the table. Discard any pile appearing obviously off type, diseased or otherwise unacceptable. The seeds of each two hundred plant samples or less is now ready to be sown in a variety purification nursery called as nucleus.
c. Locating and seeding of nucleus: Each nucleus seed should be grown on clean fertile land at an experiment station in the region or in area in which this new variety could be grown, in the event of its release. The land must not have had a crop of the same kind in the previous year.
d. Inspection of nucleus two-row plots and removal of off types: Throughout the season of growth, from the seedling stage until maturity, the nucleus plot should be examined critically. Differences in the habit of early plant growth, leaf colour, rate of growth, time

of heading, height head characteristics and diseases reactions should be looked for. If a plot differs distinctly from the average in the preheading stages of growth, it should be removed before heading.

e. Harvesting and threshing of nucleus; each remaining plot, of which there should be at least 180 out of the original 200. Should be harvested individually with a sickle and tied in a bundle. The total bundles of each nucleus should be labelled and stored until the current years yield rests for trials are obtained. The nucleus bundles of any new variety should be discarded, if it is found unworthy of being continued.

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

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

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

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

is ready now for increase of foundation seed. A portion of this breeder's seed should be retained by the breeders to sown a continuation breeders seed of the variety.

Maintenance of breeder's seed of established varieties

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

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

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

Carry-over Seed

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

Lecture 07:
SEED PRODUCTION IN MAIZE

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

Floral biology

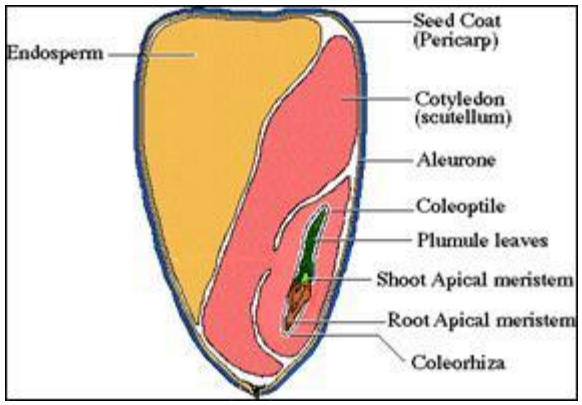
Botanical name	*: Zea mays*
Chromosome number	: 2n=20
Botanical Family	: Poaceae
Inflorescence	: Panicle cob, as the crop is monoceious in nature
Type of flowers	: Female : Cob (axillary inflorescence in the middle portion of plants) Male : Tassel (terminal inflorescence)
Husk	: Enlarged leaf sheaths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

Tassel

Cob

Husk

Silk



Seed

Types and Methods of seed production in maize

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

1. Open pollinated varieties

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

1. Synthetics

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

1. Composite varieties

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

d. Inbreds

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

Varietal seed production technique

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

Stages of seed multiplication

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

Popular varieties

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

Season

The best season for production is June - July, November- December and
January – February and the flowering should not coincide either with rain or high RH and the maturation should coincide with dry weather. The temperature of 37°C is favourable for better seed setting.

Land requirement

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

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

Differential blooming dates are permitted for modifying isolation distance provided 5.0% or more of the plants in the seed parent do not have receptive silks when more than 0.50% of

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

Selection of Seed

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

Pre sowing seed treatment

The seeds are given with any one of the seed treatment or in combination. Seeds are soaked in 2% KH2PO4 for 16h with a seed to solution ratio of 1:0.06 and are dried back to their original moisture content of 8-9% .This management could be used both for dryland agriculture as well as gardenland.

Seeds are also treated with 5% carbofuran 3G to protect the seed from shoofly infection. Seed treatment with chlorpyriphos @4 ml /kg is also recommended against the attack by shootfly. Seeds are dry dressed with bavistin @2g/kg of seed to protect against seed borne pathogens and soil borne pathogen.

Seeds are also treated with azospirillum @50g/kg of seed to fix atmospheric N. Any one of these treatment or combination of treatment is adopted for better productivity.
Seeds are also treated with polycoat @ 3g/kg of seed diluted in 5ml of water to invigourate the seed towards better marketability and production. Pink coloured polycoat performed better than other colour polymers. On adoption of sequence of treatment physiological should be followed with physical seed treatment.

Sowing

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

Plant spacing

Row spacing

Seed rate
Varieties : 20 kg /ha

Nutrient application
At last ploughing apply 12.5 tonnes of compost per hectare

Fertilizers(varieties) 150:75:75

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

Micronutrients
2% DAP is sprayed at 50% flowering stage to enhance uniform flowering and increased seed set
If Zn deficiency is found apply 20 kg of zinc sulphate / ha.
If Fe deficiency is found apply 12.5 kg /ha micronutrient mixture

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

Weeding

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

Irrigation

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

Pest and disease management

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

Roguing

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

Seed Certification

Number of Inspections

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

Field Standards

General: Maize field should be isolated from contaminants as follows

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

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

Specific standard: These are verified at the final inspection

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

Preharvest sanitation spray

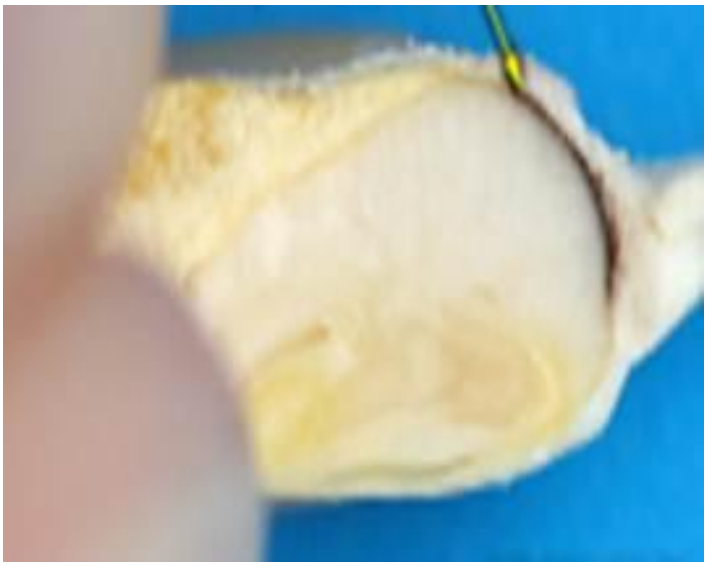
Spraying of endosulphan @ 0.07% and bavistin@10g /lit 10 days prior to harvest prevent the seed weevil (Sitophilus oryzae) infestation at storage.

Seed maturation

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

Symptom of Physiological maturation

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



Matured cob

Dunken layer

Harvesting

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

Dehusking

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

Cob sorting

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

Zenia and metazenia

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

Shelling

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

Drying

The seeds are dried to 8 to10 % moisture content either under sun or adopting mechanical driers for long term storage as the seeds is orthodox in nature.

Processing

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

Seed treatment

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

Seed packing

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

Storage

The treated seed can be stored up to 12 months provided the seeds are not infected with storage pests. Seed can be stored up to 3 years if the seeds are packed in moisture containers and are stored at low temperature .The godown should be kept clean as the possibility of secondary infestation with Trifolium (red flour weevil) is much in these crop. The major problem in storage is incidence of grain weevil which will powder the seed material in a short period.

Seed yield: 3 to 4.0 tones

Seed standard

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

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

B. Shelling

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

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

Mid storage correction

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

Lecture 08:
HYBRID SEED PRODUCTION IN MAIZE

Crossing technique : Manual emasculation by detasseling

Detasseling : Removal of male inflorescence from the monoecious crop

Time for detasseling : The time taken for shedding of pollen from the tassel in 1-2 days after emergence. Hence the tassel should be removed before the shedding of pollen.

Detasseling

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

Method

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

Precautions to be adopted during detasseling

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

System of Hybrid seed production

- Detasseling (Manual creation of male sterility)

Types of hybrids

Single cross hybrid

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

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

Double cross

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

Example
Ganga 2 : (CM 109 x CM 110) x (CM 202 x CM 111)
Ganga 101 : (CM 103 x CM 104) x (CM 201 x CM 206)
COH3 : (UMI 101 x UMI 130) x (UMI 90 x UMI 285)

Three way cross

- It is a cross between a single cross and an inbred.
- It is first generation resulting from the crossing of on approved inbred line and a certified open pollinated variety A x variety)
- A will be detasseled and allowed for crossing in the variety.

Example Ganga -5 (CM 202 x CM 111) x CM 500.
COH (M) 4 : (UMI 90 x UMI 285) x UMI 112

Double top crosses : The first generation resulting from the controlled crossing of a certified single cross and a certified open pollinated variety. : (A x B) x variety : (Ax B) will be detasseled and crossed with a variety

Seed production technology

Season - November- December, Mid July, Jan. Feb and Sep. Oct

Isolation distance

	Foundation seed (m)	Certified seed (m)
1. Inbreds	400	-
2. Single cross hybrid	400	-

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

	Foundation stage	Certified stage
• Same kernal color	400	200
• Different kernal colour	600	300
• Field of single cross / inbreds not confirming to varietal purity	400	200
• Single cross with same male parent confirming to varietal purity	5	5
• Single cross with other male parent not confirming to varietal purity	400	200

- Differential blooming dates are permitted for modifying isolation distance provided 5.0% or more of the plants in the seed parent do not have receptive silk when more than 0.20% of the plants in the adjacent field within the prescribed isolation distance are having shedding pollen.
- In hybrid seed production (certified seed stage) alone the isolation distance (less than 200 meter) can be modified by increasing the border rows of male parent, if the kernal colour and texture of the contaminant are the same as that of the seed parent.

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

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

Seed production stages and production of parental lines / hybrids

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

Spacing

Seeds are sown in ridges and furrows

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

Planting ratio:

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

Fertilizer

NPK kg / ha	:	200 : 100 : 100
Basal	:	100 : 100 : 50
1st Top	:	50 : 0 : 0 (20th days -vegetative phase)
2nd Top	:	50 : 0 : 50 (Boot leaf stage at 45 days)
Foliar	:	DAP 2% at 50% flowering
In Zn deficient soil	:	ZnSO4 @ 25 kg ha-1

Roguing

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

Field standard (%)

FS	CS	
Off types	0.2	0.5
Shedding tassel	0.5	1.0 (when receptive silk is 5% or more)
Inseparable other crop	:	Nil (both stage)
Objectionable weed	:	Nil (both stage)
Designated diseases	:	Nil (both stage)

Field standards –specific

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

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

Harvest

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

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

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

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

Shelling
Cob sorting should be the first operation it is a post harvest, evaluation for genetic purity. The sheath is removed and check for kernel colour, shank colour, diseased cobs, kernel arrangement. The cobs are shelled either mechanically or manually at 15-18% moisture content. Improper shelling leads to48% damage to kenel Growth of storage fungal Pericarp damage. Crack on pericarp can be identified by FeCl3 or Tz test. Shelling is done mechanically using cob sheller and manually by rubbing with stones.

Drying

Seeds are dried to 12% moisture content.

Grading

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

Seed treatment

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

Others: As in varietal seed production

Seed yield : 2.5 - 3.6 t/ha

Seed standard inbred, varieties and hybrids

Hybrids

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

Production of Synthetic cultivars

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

In pure-line theory of classic plant breeding, a pure line is defined as all the descendants of single homozygous individual by continued self-fertilization, resulting in a homogeneous cultivar. Hybridization, however, results in significant heterogenity. The multiplication of such heterogenous progeny in bulk to select homozygous individuals would be gigantic task. Most modern hybrid cultivars are, therefore, selected at an early stage (F2) as subsequent lines and probably released at the F8 and F12 generations. These are obviously not as homogeneous as a pure line.

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

Alternatively, the plant breeder can create a composite cross by bulking the F2 generations of several crosses. The composite is allowed to develop for several generations during which natural selection may occur. If the composite is grown at more than one location, a locally adapted cultivar may be developed in time. The composite constitutes a gene pool from which the plant breeder can select a cultivar with desirable characteristics for further multiplication.

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

A hybrid cultivar results from a controlled cross between a male and female parent, the seed being harvested from female parent only and used for crop production. In self fertilized crop species, it is easy to produce hybrid cultivars if male sterile lines are available that can be used as female parents. There are certain substsnces that act as a gametocides, destroying the pollen of desired female parent, or as inhibitors that prevent

pollen produced by the female parent from effecting fertilization. The advantage of the synthetic hybrid cultivar lies in heterosis. Special expensive measures are required to produce seed that is harvested from the female parent only. The resultant heterosis therefore must have a profitable effect to compensate for the cost of production of synthetic hybrid cultivars in the self pollinating crop species.

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

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

1) By emasculating the female parent, as is done in monoecious plants like maize, by removing the male flowers before the release of pollens.

2) By using male sterility in the female line, so as to avoid the physical removal of male flowers.

3) By using self incompatibility. In this system, the seed crop is harvested as a whole, since all plants are contributing and receiving pollen. The self incompatibility, however, is not always complete, and there may be production of some inbred plants. With the excessive production of such plants, the advantage of heterosis in the subsequent crop is diminished. The advantage of the synthetic hybrid cultivar in cross pollinated species is not restricted only to heterosis. Most hybrids are based upon inbred lines. Normally, cross fertilized plants require inbreeding for several generations to reduce heterozygosity and to include desirable genes in synthetic cultivars. A controlled cross between two such inbreds produces heterosis

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

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

Lecture 09:
SEED PRODUCTION TECHNIQUES IN PADDY VARIETIES

Phrenology:

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

Varietal seed production

Stages of seed production

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

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

Land requirement

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

Isolation

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

Selection of seed

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

Seasons practiced at Tamil Nadu

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

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

Selection of season

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

VARIETIES	SEASON	DURATION	POPULAR VARIETIES
Shout duration varieties	November- December (Karthikai –Margazhi)	Below 120 days	TKM9 ,CO 36, ADT 36
Medium duration varieties	November (Iyyppasi- Karthikai)	130-135 days	Bhavani ,CO43,
Long duration varieties	August (Adi-Avani)	More than 135 days	White Ponni,
Upland rice	July –August ---on receipt of showers .TKM9 and IR 50 should be sown Before 15th of July (direct seeding)	All durations but variety specific	MDU1,PKM1 Co 43,IR 20
Rainfed rice	June-July and September – October	Specific to location	ADT 38 ADT39 (Medium Duration Varieties)

Seed Rate

It varies with varieties and type of cultivation.

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

Seed Management Technique

Dormancy

Paddy exhibits dormancy which varies for duration of 0-30/45days depending on the variety. This could be broken by either soaking in KNO3 0.5 % for 16 hr or soaking in 0.1N HNO3 for 16 hrs. However the duration and concentration vary with varieties (e.g.) ADT36 exhibit 20-30 days of dormancy period from days to physiological maturity period which could be broken by soaking the seeds in 0.5%KNO3 for 16 hrs. Practically the intervening duration between the harvesting, and threshing, and further drying will remove the dormancy.

Seed Upgradation Technique (Egg Floatation Technique)

Either before processing or after storage or due to improper processing Paddy seed may have less vigorous seed such as immature, ill filled and insect damaged seed which may adversely affect the planting value of the seed. Removal of this seed will favour better establishment and higher production potential. These seed may be removed by adaptation of a simple water floatation technique based on specific gravity using salt water as a dissecting solution for separation of good quality seed from low quality seed, and egg is used as an indicator for specification of specific gravity measurement of 1.03 (120g of salt in 1000ml of water)

Methodology

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

Caution

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

Sprouting of seeds (pre germination)

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

Hardening and other seed management techniques

- In case of implementation of fortification treatment, seed could be soaked in equal volume of water to ensure that none of the solution is left unimbibied by the seed

- For dry land and upland paddy, seed hardening with KCl (1%) and pelleting with *Azospirillum* (600g /ha) could be adopted (e.g.) MDU 1, Paramagudi1.
- Seed colour variation occurs due to bacterial infection at later stages of maturation. Seed coloring with polycoat @3g kg-1of seed could improve the initial quality and marketability of such discolored seed.
- Polymer coating of Seed also will help to identify the brand name of seed and to identify the varietal variation among the cultivars by even the illiterate labours.

Nursery Management

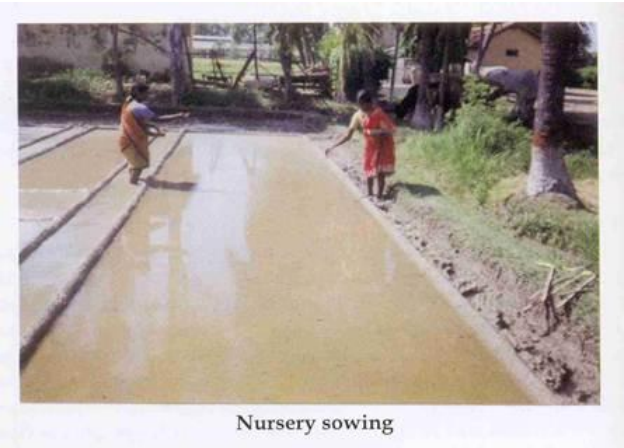
For raising one hectare of paddy, 20 cent (800m2) nursery is needed. The area should be prepared by floating the area one or two days before ploughing and allowed the water to soak in. The soil should be kept at shallow sub emergence. Before ploughing the water should be allowed to a depth of 2.5cm .Then the land is ploughed and brought to a puddling condition. The optimum size of the nursery bed will be 2.5 meters broad and with channels of 30cm width in between. In paddy, on raising more varieties in a same place **separate irrigation channels** are to be prepared for each variety to avoid the admixture of seeds and to maintain the genetic purity.

Nutrient Management

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

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

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



Nursery sowing

Sowing

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

Water Management

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

Weed Management

Apply any one of the pre emergence herbicides viz. butachlor 2l per ha,thiobencarb@2l/ ha, pendimithalin @ 2.5l/ha on 8th day after sowing to control weeds in the low land nursery. Keep a thin film of water and allow it to disappear. Avoid drainage of water. This will control germinating weeds.

Pest Management (NURSERY)

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

Age of transplanting

The age of transplanting vary with varieties as follows

DURATION OF VARIETIES	AGE OF TRANSPLANTING
Short duration varieties	18-22days
Medium duration varieties	25-30days
Long duration varieties	35-40days

Pulling out of seedling

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

Main field preparation

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

Fertilizer Requirement

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

Transplanting

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

Details on transplanting

Specifications	Duration of cultivars		
	Short	Medium	Long
No. of seedling per hill	2-3	2	2
Depth of planting (cm)	3	3	3
Spacing (cm)	20 x10	20 x15	20 x20
No. of hills/m2	50	33	25
Breeder seed multiplication	Adopt double row planting with a spacing of 15 x 10 cm for easy roughing		

- Adjust the sowing in such a way that harvesting does not coincide with rain

Weed Management
Pre emergence herbicide

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

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

Pest and disease management

Insects	Control measures
Stem borer	Fenthion100EC @ 500ml
Thrips Brown plant hopper Leaf folder Stemborer (white ear 2 %)	Phosphamidon85 WSC @ 300ml MonocrotophosWSC @ 500ml Endosulfan 35EC @ 60ml Quinalphos 25EC @ 1000ml
Mealy bug Earhead bug	Phosphamidon85 WSC @ 300ml Quinalphos 25EC @1000ml
Rice root nematode	Carbofuran3g 16.25kgin standing water
Diseases	
Blast	Carbendazim @ 250g/ha
Brown plant hopper	Mancozeb @ 1000g/ha
Sheath rot	Carbendazim @ 250g/ha
Sheath blight	Difolatan @ 200
Bacterial leaf blight	Streptomycine Sulphate+Tetracycline@300g+Copper Oxychloride @ 1250g/Ha
Grain discolouration	Mancozeb@1000g/ha

Water Maintenance of Paddy

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

Top Dressing

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

Foliar Spray

- Spray FeSO4 0.5% to prevent yellowing of plants in calcarious soils.
- Spray DAP 2% to enhance seed set in paddy cultivars (BEST).
- Spray GA3 three times at panicle initiation stage for complete exertion of panicle (hybrids).
- Spray panchakavya 1% for organic seed production to enhance seed set.
- Spray 0.5 % zinc sulphate thrice during crop growth on 20th 30th and 40th day of planting for short duration varieties or 30th 40th and 50th day for medium and long duration varieties in case of zinc deficient soils.

Rouging

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

Physiological maturity

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

Pre-harvest Sanitation Spray

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

Harvesting

- Lodged plants should not be selected for seed purpose.
- Withhold irrigation one week before harvest.
- Delayed harvest may lead to heavy shattering
- Bundled plants should be stacked as ear heads facing outside to avoid heat damage.

- Threshed produce should be clean and free of admixture in cracks and crevices.
- Birds scaring are also practiced in places of requirement.

Threshing

- Thresh the seed by beating the plants on a hard surface ,but take care that the seeds are not mechanically damaged.
- In tractor and machine threshing avoid mechanical damage by proper adjustment of speed/machine setting.
- Thresh at proper moisture content to avoid crushing / cracking (16-17 per cent).
- Clean the floor, equipment, containers to avoid genetic and physical mixture.

Winnowing and Drying

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

Grading

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

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

Seed Treatment

Normally paddy seeds are not treated with chemicals owing to their economic utility. But for long term storage, treat it with captan or thiram or bavistin @ 2-4g / kg of seed, Halogen mixture treatment (Chlorine based halogen mixture @3 g /kg of seed) is a eco-friendly treatment. As a prophylactic measure seed can be fumigated with celphos @ 3-6g/m3. But the moisture
content of the seed should not be above 10-12% which may interfere with the seed quality in terms of germination.

Seed Yield

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

Storage

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

Mid storage Correction

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

Seed Certification

Land Requirement

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

Number of Inspections

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

Field Standards

General: Paddy field should be isolated from contaminants as follows

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

Specific standard: These are verified at the final inspection

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

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

Seed Standard

Factor	Standards for each class	
	FOUNDATION	CERTIFIED
Pure seed (maximum)	98.0%	98.0%
Inert matter (maximum)	2.0%	2.0%
Huskless seed (maximum)	2.0%	2.0%
Other crop seed (maximum)	10/kg	10/kg
Other distinguishable varieties (maximum)	10/kg	10/kg
Total weed seed (maximum)	10/kg	10/kg
Objectionable weed seed (maximum)	2/kg	2/kg
Seeds infected with paddy bunt (Neovossia horrida (Tak.) (maximum)	0.10% (By number)	0.50% (By number)
Germination (Minimum)	80%	80%
Moisture (maximum)	13.0%	13.0%
For vapour proof containers (maximum)	8.0%	8.05%

Paddy Bunt

Lecture 10:
HYBRID SEED PRODUCTION IN PADDY

Breeding technique for commercial

Hybrid seed production : *Cytoplasmic geneic male sterility system*

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

Seed Multiplication work at different Stages

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

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

Systems of hybrid seed production

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

Popular hybrids

CORH1 : (IR 62829A x IR 10198- 66–2R)
CORH2 : IR 58025A x C 20R
CORH3 : TNAU CMS 2A X CB 87 R (110-115 days)
ADTRH1 : IR 58025A x IR 66R

Genes involved in EGMS

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

Advantages of EGMS system

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

Genes for fertility restoration in CGMS system : Rf1 and Rf2

COMMERCIAL SEED PRODUCTION TECHNIQUE

Land requirement : similar to variety

Isolation

Space isolation : Foundation seed stage : 20 Certified seed stage : 100 m
Time isolation : 20 days either earlier or later for other varieties compared with MS line.
Barrier isolation : • 30m of wood lot / tall crops
• plastic sheets of 2m height

Season

Kharif (May- June sowing)
Rabi (December- January sowing)
Rabi is more suitable than kharif.

Favourable climatic conditions during flowering for higher seed set.

- Daily mean temperature 24 - 30°C
- Relative Humidity 70 - 80 %
- The difference between day and night temperature should be 8-10°C.
- Sufficient sunshine and moderate wind velocity of 2-3 m / second.
- Free from continuous rain for above 10 days during peak flowering season.

Seed set and seed yield will be affected if temperature is below 20oC and above 35oC during the time of flowering. In Tamil Nadu, ideal time for sowing during kharif is 2nd fortnight of May and during rabi 2nd fortnight of December.

- CORH 1 -. 110-115 days (May-June, Dec - Jan)
- CORH 2 - 120-125 days (Rabi)
- ADTRH 1 - 110-115 days (kharif)

Seeds

Seed selection: Purchase from authenticated source with tag and Bill
For Foundation stage - (A & B lines)
For Certified stage - (A & R lines)

Seed rate

Female : 20 kg /ha
Male : 10 kg /ha

Nursery Management

- Keep irrigation channels separately for the parental line
- For Dec-Jan sowing take up staggered sowing for male twice or thrice with the interval of 10-15 days (3,10,15daysfor effective seed setting)
- Keep the nursery area free of weeds.
- Apply DAP @ 2 kg / cent as basal to get vigorous seedlings.
- For April-May sowing sow the male 5 and 10 days after female line
- Even split application of fertilizer N is favourable for production of vigorous seedlings.

Main field Transplanting

Spacing

Between A line - (15 x 15cm) Between A and R line - (20 x15cm)

Between R line - (30 x 15cm)

Age of transplanting

A line : 25 days

R line : 14,18,20 days

Fertilizer

Hybrids : 150:60:60

N & K applied in 3 splits

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

Staggered sowing of parents for synchronization

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

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

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

- Growth Duration Difference (GDD) method
- Leaf Number Difference (LND) method
- Effective Accumulated Temperature (EAT) method

Among these 3 methods though the LND method is more reliable one, the GDD method is mostly followed since it is rather simple and easy to adopt. In GDD method by checking the

previous data on the difference in duration from seedling to heading between male and female parents, the proper seeding date of both parents in current season can be determined. This method is suitable in seasons or regions where the temperature fluctuation is small.

Staggered seeding of R line for synchronization.

- Single seeding of R line
- Two seeding of R line
- 3 seeding of R line.

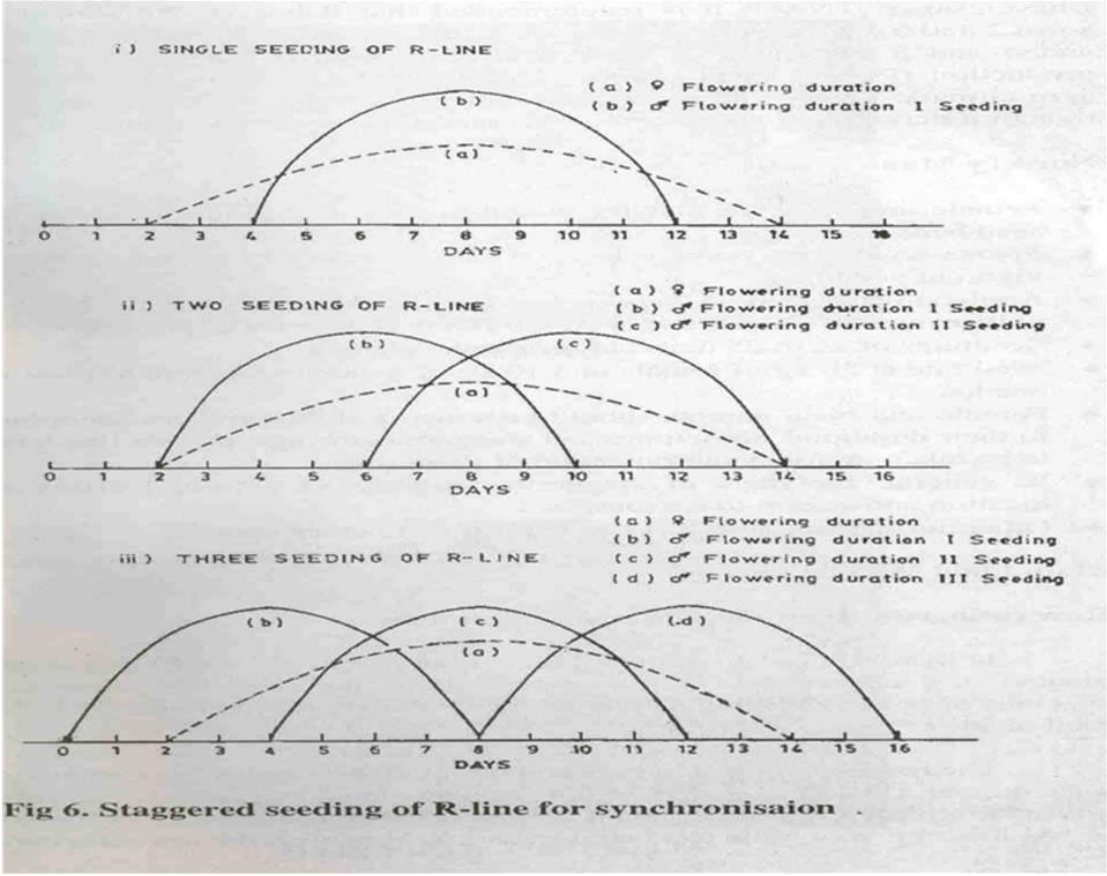


Fig 6. Staggered seeding of R-line for synchronisaion .

Row ratio: 8:2 or 10:2

Factors influencing row ratio

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

Layout for transplanting

To facilitate out crossing, the rows of male and female in the seed production plot should be perpendicular to the prevailing wind direction expected at flowering time of the parents. Practically a row ratio of 8:2 (A x R) is currently adopted for hybrid seed production and the transplanting sequence for 8:2 row ratio is as follows:

Transplanting of the 'R' line

Transplant the seedlings of ' R' line in paired rows of 30 cm apart.

In case of 2 staggered seedlings of R line, the first and second sown R line seedlings may be planted in two separate rows at 15 cm spacing or the 1st sown seedlings may be planted in both the rows with 30 cm spacing and 2nd sown seedlings may be planted in the middle of two seedlings in both rows. Whereas in three staggered seedlings of R line all the seedlings may be pulled out separately, mixed together thoroughly by spreading one over the other and planted in the two paired rows @ 2-3 seedlings per hill with 15 cm spacing within the rows. It is more convenient, easy and labour saving method incase of large scale seed production. By proper synchronization, higher seed set and yield have been recorded in 3 staggered seedlings of R line. Leave a 145 cm or 110 cm wide block between paired rows of R line seedlings for transplanting 8 rows blocks of A line seedlings.

Row ratio, row direction, spacing and planting pattern for hybrid rice seed production.

R	R	A	A	A	A	A	A	A	A	R	R
○	○	x	x	x	x	x	x	x	x	○	○
○	○	x	x	x	x	x	x	x	x	○	○
○	○	x	x	x	x	x	x	x	x	○	○
○	○	x	x	x	x	x	x	x	x	○	○
○	○	x	x	x	x	x	x	x	x	○	○
○	○	x	x	x	x	x	x	x	x	○	○
○	○	x	x	x	x	x	x	x	x	○	○
○	○	x	x	x	x	x	x	x	x	○	○

R	R	A	A	A	A	A	A	A	A	R	R

Female: Male ratio = 8:2 wind direction :

Transplanting of the 'A' line

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

Prediction of heading date

The method, which is widely used and found to be effective, is by examining the development of young panicles. Based on the morphological features, the young panicles are classified into 8 development stages. The synchronization in flowering can be predicted by using such criteria. In practice, about 30 days before heading, the male and female parents in the seed production field are sampled and their young panicles within the main clumps and tillers are carefully observed with a magnifying lens every three days. Usually female and male parent will take 27 and 32 days respectively from panicle initiation to heading in 8 stages.

Method of observing panicle initiation

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

Adjustment of flowering date

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

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

If the difference in flowering period between the two parents reaches 10 days or more it is necessary to remove the panicles from early developing parent and apply nitrogen fertilizer subsequently, thus making it late emerging tillers or unproductive tillers bear panicles and subsequently achieve synchronization of flowering.

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

Application of Gibberellin (GA3)

GA3 plays an important role in rice hybrid seed production. It can adjust physiological and biochemical metabolism of rice plant especially stimulating the elongation of young cells. About 25-30%. spikelets of a panicle are inside the flag leaf sheath in most of the indica CMS

lines than that of the Japonica CMS lines. GA3 has a definite role in exertion of panicle. In general, it is recommended that 50 g /ha with knapsack sprayer in two split doses, i.e. spray on 15-20% earhead emergence and 2nd spray in the next day for enhanced seed set.
GA3 will not dissolve in water and hence it should be dissolved in 75-90% alcohol (1g in 20-25 ml of alcohol) and make the required solution. Spraying should be done at 8 to 10 a.m. and 4-6 p.m.

Advantages of GA3 application

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

Supplementary pollination
Natural outcrossing was recorded less than 10% by Ramlingam et al. (1994). However, this depends upon the wind direction and its velocity.
Shaking the R line panicles by rope pulling at panicle level or rod driving during anthesis can make their anthers dehisce and spread the pollen widely and evenly thus the outcrossing rate could be increased. It is more effective especially on calm or breezy days.
Generally, supplementary pollination is carried out at 30 minutes interval for 5 times daily both morning and evening during peak anthesis (10-12 am and 2-4 p.m.) until no pollen remains on the R line. It is not needed when the wind is greater than moderate breeze.

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

- Short duration: Ist Spray on 60 DAS

  II nd " 80 "

- Medium duration: Ist Spray on 80 DAS

  II nd " 100 "

Roguing

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

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

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

Roguing in hybrids

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

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

Rogues / off types : Based on variation in phenotypic Characters

Harvesting, threshing & drying

- Turning of 90% green seeds to straw yellow colour is the stage of physiological maturity
- Moisture content will be 17-20%.
- Male parent should be harvested first .
- Care should be taken to avoid admixture of male line with female line while harvesting.
- The female parent should be threshed at 16-17% moisture content separately in a well cleaned threshing floor.
- The threshed seed should be winnowed and dried to reduce the seed moisture content to 12%
- The seed should not be dried under direct sun between 12 to 3.00 p.m. during hot sunny days.

Seed treatment

Seeds are treated with thiram / captan @ 4 g/kg. or with 5 gm halogen mixture. The halogen mixture is prepared by mixing CaOCl2 + CaCO3 for 1 week in air tight container.

Storage

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

Others - As in variety

Seed Yield

Hybrid yield (F1) : 800-1200 kg ha-1

General Tips

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

Seed renewal period: three times

Lecture 11:
SEED PRODUCTION IN SORGHUM

Sorghum is common millet of India with wider utility. It is used a feed, food and raw material for agri based industry. Botanically it is known as *Sorghum bicolor* L. and belongs to the family poaceae. It is an often cross pollinated crop, insects and wind are the pollinating agents.

Floral biology

Sorghum is an often cross-pollinated crop. The extent of out crossing is 6-45% and depends on nature of earhead. In loose panicles the cross-pollination is more and less in compact panicle. Spikelets occur in pairs on the lateral branches of the panicle. One is sessile while the other spikelet is pedicelled. Sessile is bisexual and pedicelled spikelet is male or sterile. Sessile spikelet is comparatively larger than staminate spikelet and each spikelet has two florets. Flower opening starts after 2 to 4 days of emergence of panicle from the boot leaf. Flowering starts from the tip of the panicle and proceeds downwards (basipetal). Flowering completes in 7 days. The pollen is viable for 10 to 20 minutes under field conditions. Fertile pollen will be lemon yellow in colour. Older pollen grains will normally turn to orange. Receptivity of stigma starts two days before opening and remains for several days (5 days). Flower opening and anthesis will be from 2.00 am to 8.00 am.

VARIETAL SEED PRODUCTION

Open pollination under isolation and selfing by bagging are the common methods of varietal seed production.

Stages of seed multiplication

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

Popular varieties

In Tamil Nadu , CO 25 CO26, CO 27 ,K5, K7, CO 19, CO 21, K9, BSR 1, CO 26, K4, K8, CO 25, APK 1, K 10, Paiyur 1 and 2 are the popular varieties for grain purpose ,while CO 20 and CO 28 is a fodder sorghum

Season

The best season for production is November- December and the flowering should not coincide either with rain or high RH as it will wash out the pollen and the maturation should coincide with dry weather. The temperature of 37oC is favourable for better seed setting.

Land requirement

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

Field Standards for isolation

Sorghum field should be isolated from contaminants as follows

Contaminants	Minimum distance(m)	
	FS	CS
Fields of other varieties of grain and dual purpose sorghum	200	100
Fields of same variety not confirming to varietal purity requirements for certification	200	100
Johnson grass (Sorghum halapense)	400	400
Forage sorghum with high tillering and grassy panicle	400	400

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

Seed and sowing

- For production of foundation seed, breeder seed is used as the base material, while for certified seed, foundation seed should be used as the base material. The seed used should be from authenticated source with tag and bill.
- The required seed rate will be 12kg /ha or 4-5kg/ acre.
- The seed are sown at a spacing of 45 x15 cm at a depth of 2-4cm as the plant has adventitious root system.
- In some places seeds are also raised in nursery and transplanted to the main field.
- In the main field seeds are sown either in ridges and furrows or under beds and channels.
- In some places seeds are also raised in nursery and transplanted to the main field at 27-30 days intervals.
- Rainfed - Direct sown 15.0 kg., Irrigated - Direct sown 10.0 kg / ha and transplanted 7.5 kg/ha

Presowing seed treatment

The seeds are given with any one of the seed treatment or in combination.

- Seeds are soaked in 2% KH2PO4 for 16h with a seed to solution ratio of 1:0.06 and are dried back to their original moisture content of 8-9% .This management could be used both for dry land agriculture as well as garden land.
- As an ecofriendly treatrment seeds are also fortified or hardened with 1% *prosopis* and pungam leaf extract for 16h with a seed to solution ratio of 1:0.06 and are dried back to their original moisture content of 8-9%.
- Seeds are also treated with 5% carbofuran 3G to protect the seed from shoofly infection. Seed treatment with chlorpyriphos @4 ml /kg is also recommended against the attack by shoot fly.
- Seeds are dry dressed with bavistin @2g/kg of seed to protect against seed borne pathogens and soil borne pathogen.
- Seeds are also treated with azospirillum @50g/kg of seed to fix atmospheric N. Any one of these treatment or combination of treatment is adopted for better productivity.
- On adoption of sequence of treatment physiological should be followed with physical seed treatment.
- Seed treatment with 10% prosopis leaf extract reduces the black mould attack, which can even be given as foliar spray at the time of maturation.

Nutrient application

- At last ploughing apply 12.5 tonnes of compost per hectare.
- The fertilizer requirement of seed crop is 150:50:50 kg of NPK, in which 100:50:50 kg / ha of NPK is applied as basal, while 25kg of N is applied after first weeding and the remaining 25 kg of N is applied after boot leaf stage.

- The seed crop is also sprayed with 2% DAP at primordial initiation stage and twice thereafter at 10 days interval.

- In calcarious soil and in problem soils FeSo4 0.5 % is sprayed thrice at 10 days interval from primordial initiation stage.

Weeding

- Application of atrazine @ 10ml per litre as pre-emergence herbicide control the growth of weeds upto 20-25 days.
- One hand weeding at the time of primordial initiation keep the field free of weeds. Weeding after boot leaf stage is not economical.
- On organic production, 2 hand weeding at seedling stage and other at boot leaf formation will keep the field weed free
- At 15-20 days after sowing furadon granules are placed at leaf whorls to avoid shootfly infection.

Irrigation

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

Pest and disease management

Common pests	Management techniques
Shootfly	Monocrotophos 0.03%
Stemborer	Rogar 0.3%
Gall midge	Endosulphan 0.07%
Earhead bugs	Endosulphan 0.07%
Black mould and sugary disease	Endosulphan 0.07% + Bavistin @10g /lit.
Kernal smut and head smut	Endosulphan 0.07% + Bavistin @10g /lit.

Kernal smut and head smut are known as designated diseases of sorghum.

Rouging

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

Specific standard: These are verified at the final inspection

Factor	Maximum permitted (%)	
	FS	CS
Off types at any one inspection and after flowering	0.050	0.020
Heads infected by kernel smut or grain smut (*Sphacelotheca sorghi*(Link) Clinton) and Head smut (*Sphacelotheca reiliana* (kuhn)Clinton) at final inspection	0.050	0.020

Seed fields can however be certified if diseased earheads are removed and burnt and the fields show on reinspection not more than maximum permissible level. Only one such re-inspection is permitted. Seed fields should be thoroughly roughed to remove plants infected by sugary disease (*Sphacelotheca sorghi* (Link) Clinton)/ergot (*Claviceps spp*.) so that the prescribed standards are met at seed stage. However, the seed fields shall not be rejected on account of the apresence of sugary/ ergot infected heads.

Smut

Ergot

Seed Certification

Number of Inspections

A minimum of three inspections shall be made as follows:

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

Preharvest sanitation spray

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

Harvesting

- The crop attains physiological maturity 40-45 days after 50% flowering and the seed moisture at this stage will be around 25-30%.
- This stage can be easily be identified by the formation of dunken layer at the place of attachment to the ear head.
- The earheads are harvested commercially when 80 % of the earheads are physiologically matured, where the moisture content will be around 20 %.
- The crop is harvested as once over harvest as uniformity will be maintained with earheads on maturity.

Threshing

The earheads are dried under sun and threshed with fliable stick for extraction of seeds. The moisture content of seed at the time of threshing will be 15-18%.

On large scale production LCT threshers are used, but care should be given to avoid mechanical damage, which in turn will reduce the seed quality and storability.

Drying

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

Processing

- Mechanical grading can be done with cleaner cum grader, which will remove the undersized immature and chaffy seeds
- The middle screen size should be 9/64" round perforated sieves. The size can vary depending on the type of seed
- For fodder sorghum 8/64"sieve is used

Seed treatment

The seeds are infested with several storage pests, to protect against these pests the seeds are given protective treatment with bavistin @2g/kg of seed with carbaryl @200mg/kg of seed as slurry treatment. Bifenthrin @5mg /kg of seed is also recommended for fodder sorghum.

Seed packing

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

Storage

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

Seed yield: 3000-4000kg/ha

Seed standard

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

Seed Standard

Factor	Standards for each class	
	Foundation	Certified
Pure seed (maximum)	98.0%	98.0%
Inertmatter(maximum)	2.0%	2.0%
Other crop seed (maximum) (by number)	5/kg	10/kg
Total weed seed (maximum) (by number)	5/kg	10/kg
Other distinguishable varieties (maximum)	10/kg	20/kg
Ergot, sclerotia, seed entirely or partially modified as sclerotia, broken or ergotted seed (maximum)	0.020%	0.040%
Germination (Minimum)	75%	75%
Moisture (maximum)	12.0%	12.0%
For vapour proof container (maximum)	8.0%	8.0%

Mid storage correction

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

Lecture 12:
HYBRID SEED PRODUCTION IN SORGHUM

Breeding technique for Commercial production

Cytoplasmic genetic male sterility (CGMS)

Seeds produced in different stages

Nucleus seed stage : Maintenance of basic source by seed to row progenies.

Breeder Stage : A (AxB), B and R line are multiplied

Foundation Stage : A (AxB) and R line are multiplied

Breeder and foundation seed stage: Multiplication of male sterile line or maintenance of A and B line

Certified seed stage : A x R – F1 hybrid produced.

Certified seed stage : Production of hybrid seed

Stages of Seed Production
Breeder seed ---> A x B - B - R

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

Certified seed ---> A x R

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

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

Stages of seed multiplication : Breeder seed – foundation seed – certified seed.

Foundation seed production : A and B line are raised in 4:2 ratio with 4 rows of B line as border row and allowed for cross pollination.

The seeds from A line will be collected as A line seeds (multiplied).

Certified seed production : Hybrid seed production

Commercial in Hybrid seed production techniques

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

Johnson grass

Forage sorghum

Seeds and sowing

Seed rate : A line : 8 kg ha-1
R line : 4 kg ha-1

Spacing : A line : 45 x 30cm
R line : 45 x solid row spacing.

Planting ratio: Foundation seed stage: 4:2 (A: B)
Certified seed stage : 5.2 (A:R)

Border rows : 4 rows of male (either B or R line) to, supply adequate pollen.

Live markers : •Live plants used for identification of male line live markers are used.
•It should have distinguishable morphological characters.
•Live markers can be sunflower, daincha etc.

Manures and Fertilizers

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

Synchronization technique

- Staggered sowing: Sowing of male parent and female parents are adjusted in such a way that both parents come to flowering at the same time.

- CSH-5, MS 2077 A must be sown 10-15 days earlier to the male CS 3541,
- CSH 6, the female parent MS 2219 A can be sown simultaneously with CS 3541
- CSH 9, the female parent MS 296 A must be sown 7-10 days earlier than male CS 3541 in November- December season.
- Spraying growth retardent MH 500 ppm at 45 DAS, delays flowering in advancing parent. MH wont dissolve in water and hence dissolve it in NaOH and then mix with water.
- Urea spraying 1% to the lagging parent.
- Withhold one irrigation to the advancing parent.
- Spraying CCC 300 ppm will delay flowering.

Roguing: Do it in both parents.

Off types

In female line remove : off types, wild types, pollen shedders, rogues, partials, volunteer plants, diseased plants, R line, mosaic plants, late Early flowering plant

In male line remove : Rogues, A line, Diseased plants, Late /early flowering plants, Wild types

Types of contamination

Presence of B line in A line called as pollen shedders
Presence of A line in Bline called as off type
Presence of R line in B line called as rogue
Presence of B line in B line called as rogue

Presence of B line in Rline called as rogue
Presence of B line in R line called as rogue
Pollen shedders and off type cause physical contamination, whereas, rogue cause physical and genetical contamination.

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

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

Field Standards

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

Designated disease

1. Kernel smut
2. Head smut
3. Sugary disease of sorghum

- It is specific to hybrid
- Occur due to low seed set
- Spray rogor 0.03% (or)
- Endosulfan 0.07%

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

- At the time of threshing the seed moisture content should be reduced around 15-18%. Threshing can be done by beating the earheads with bamboo sticks.

- While using the mechanical threshers, care should be taken to avoid mechanical damage.

Drying

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

Processing

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

Seed treatment and storage

- The seeds are treated with captan or thiram @ 2 g/kg of seed and pack it in cloth bag at 12% moisture content for short term storage and 8% moisture content in 700 gauge poly ethylene bag for long term storage (or)
- The seeds can also be treated with halogen mixture @ 3 g/kg of seeds. The halogen mixture is prepared by mixing CaOCl2 and CaCO3 +*Albizzia amara* at the rate of 5:4:1 and this mixture is kept in an air tight plastic container for 1 week. After one week the mixture is used for seed treatment.
- The treated seeds can be stored upto 12 months under open storage and upto 18 months in moisture vapour proof containers, provided it is not infested by the storage insects.

Seed yield : 3000 kg ha-1

Seed standards

	Foundation seed	**Certified seed**
Physical purity (%)	98	98
Inert matter (%)	2	2
Other crop seed	5 kg-1	10 kg-1
Weed seed	10 kg-1	20 kg-1
Other distinguishable variety	10 kg-1	20 kg-1
Ergot disease by number	0.020%	0.040%
Moisture content		
Moisture pervious container	12	12
Moisture vapour proof container	8	8

Others – as in varieties

Lecture 13:
SEED PRODUCTION IN PEARL MILLET

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

Floral biology

It is a highly cross-pollinated crop. The pollinating agent is wind. The flowers are protogynous. The spike emerges about 10 weeks after sowing, The styles begin to protrude 2-3 days later first at the top of the inflorescence and proceeds. They take two days to complete the entire spike. Exerted stigma remains receptive for 12-24 hours. Anthers usually emerge after the styles are dry. The anther emergence starts from middle of the spike and proceeds upwards and downwards. Anthesis occurs throughout the day and night with the peak between 8.00 p.m. to 2.00 a.m.

Protogynus Stigma Anther

Popular variety : CO7, CO8

Synthetics : If more than 5 parental lines are combined ,which are having general combining ability e.g. CO 7, ICMS 7703

Composite: 3-5 inbreds with no general combining ability are mixed and multiplied. WCC 75 (ICRISAT).

Land requirement

Seed field offered for certification should not have been grown with bajra in the previous season. However if it was grown, the field should be irrigated 3 weeks before sowing to destroy the germinating seeds.

Field Standards for isolation

Bajra field should be isolated from contaminants as follows

Contaminants	Minimum distance(m)	
	Foundation stage	Certified stage
Fields of other varieties	400	200
Fields of same variety not confirming to varietal purity requirements for certification	200	100

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

Selection of Seed

- For production of foundation seed, breeder seed is used as the base material while for certified seed, foundation seed should be used as the base material .
- The seed used should be from authenticated source with tag and bill.
- The required seed rate will be 18kg /ha or 3-4kg/ acre.

Presowing seed treatment

- The seeds are given with any one of the seed treatment or in combination.
- Seeds are soaked in 2% KH2PO4 or 0.5% brassinolide for 16h with a seed to solution ratio of 1:0.06 and are dried back to their original moisture content of 8-9% .This management could be used both for dry land agriculture as well as garden land.
- As an ecofriendly treatment seeds are also fortified or hardened with 1% *prosopis* and pungam leaf extract for 16h with a seed to solution ratio of 1:0.06 and are dried back to their original moisture content of 8-9%
- Seeds are treated with metalaxyl @6g/kg of seed to prevent the infestation by downy mildew.
- Seeds are also treated with 5% carbofuran 3G to protect the seed from shoofly infection. Seed treatment with chlorpyriphos @4 ml /kg is also recommended against the attack by shoofly.

- Seeds are dry dressed with bavistin @2g/kg of seed to protect against seed borne pathogens and soil borne pathogen.
- Seeds are also treated with azospirillum @50g/kg of seed to fix atmospheric N. Any one of these treatment or combination of treatment is adopted for better productivity.
- On adoption of sequence of treatment physiological should be followed with physical seed treatment.

Sowing

- The seed are sown at a spacing of 45 x 20 cm at a depth of 2-4cm as the plant has adventitious root system.
- In some places seeds are also raised in nursery and transplanted to the main field at an age of 20 -25 days.
- In the main field seeds are sown either in ridges and furrows or under beds and channels.
- The seedlings are thinned or transplanted at 20-25 days after sowing and gapfilling should be done 10-15 days after sowing.

Nutrient application

- At last ploughing apply 12.5 tonnes of compost per hectare. The fertilizer requirement of seed crop is 100:50:50 kg of NPK, in which 50:50:50 kg /ha of NPK is applied as basal, while 50kg of N is applied after 30-35 days after sowing at tillering phase .
- The seed crop is also sprayed with 2% DAP at primordial initiation stage and twice thereafter at 10 days interval to enhance uniform flowering and increased seed set.

Weeding

Application of atrazine @ 10ml per litre as pre-emergence herbicide controls the growth of weeds upto 20-25 days. One hand weeding at the time of primordial initiation keep the field free of weeds. Weeding after boot leaf stage is not economical and shade will also minimize the weed flora. On organic production, 2 hand weeding at seedling stage and other at boot leaf formation will keep the field weed free.

Irrigation

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

Pest and disease management

Common pests	Management techniques
Shootfly	Monocrotophos 0.03%
Stemborer	Rogar 0.3%
Downy mildew	Metalaxil @ 500gor ridonil MZ WP 2@2kg/ha or Mancozeb@ 1kg/ha.
Earhead bugs	Endosulphan 0.07%
Black mould	Endosulphan 0.07% + Bavistin @10g /lit.
Green ear /Smut/Ergot	Spray carbendazim @500g/ac in 2stages 10 and 50 % flowering
Rust	Spray with wettable sulphur @2.5g/ha on initiation of symptom and 10 days thereafter..

Green ear

Smut

Ergot

Roguing

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

Specific standard: These are verified at the final inspection

Factor	Maximum permitted (%)	
	FS	CS
Off types at any one inspection and after flowering	0.050	0.10
Plants infected by downy mildew/ green ear disease at any one inspection	0.050	0.10
Ergot earheads at final inspection **	0.020	0.040
Earheads infected with grain smut at final inspection	0.050	0.100

** Even if the infection is within the limit seeds are graded with brine solution to become eligible for certification.

Seed Certification

Number of Inspections

A minimum of three inspections shall be made as follows:

1. The first inspection shall be made before flowering preferably within 30 days after planting in order to verify isolation, volunteer plants, off types, downy mildew incidence and other relevant factors.
2. The second inspection shall be made during 50% flowering to check isolation, off types, downy mildew incidence /green ear and other relevant factors
3. The third inspection shall be made at maturity and prior to harvesting and in order to determine the incidence of downy mildew /green ear disease, ergot, grain smut and to verify true nature of plant and other relevant factors

Pre harvest sanitation spray

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

Harvesting

The crop attains physiological maturity 30-35 days after 50% flowering and the seed moisture at this stage will be around 25-30%. This stage can be easily be identified by the formation of dunken layer at the place of attachment to the ear head. The ear heads are harvested when 80 % of the ear heads are physiologically matured, where the moisture content will be around 20 %.The crop is commercially harvested as once over harvest but harvesting of ear heads as 2or 3 picking will preserve the seed quality as matured seeds are not over exposed to the changes in environmental conditions.

Special techniques

Selection of first formed 5-6 tillers for seed purpose ensures seeds quality. Ear heads also exhibit positional polymorphism where seeds of middle are better in seed quality. This type of selection will be useful in long term storage of seeds

Threshing

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

Drying

The seeds are dried to 8 to10 % moisture content either under sun or adopting mechanical driers for long term storage as the seeds is orthodox in nature.

Processing

Mechanical grading can be done with cleaner cum grader, which will remove the undersized immature and chaffy seeds .The middle screen size should be 4/64" round perforated sieves. The size can vary depending on the variety. (For WCC 75 5/64"sieve is used).

Seed yield: 3500- 4000 kg/ha

Seed treatment

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

Seed packing

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

Storage

The treated seed can be stored up to 12 months provided the seeds are not infected with storage pests. Seed can be stored up to 3 years if the seeds are packed in moisture containers and are stored at low temperature .The godown should be kept clean as the possibility of secondary infestation with Trifolium (red flour weevil) is much in these crop. The major problem in storage is incidence of grain weevil which will powder the seed material in a short period.

Seed standard

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

Seed Standard

Factor	Standards for each class	
	FOUNDATION	CERTIFIED
Pure seed (maximum)	98.0%	98.0%
Inert matter(maximum)	2.0%	2.0%
Other crop seed (maximum)	10/kg	20/kg
Weed seed	10/kg	20/kg
Ergot, sclerotia, seed entirely or partially modified as sclerotia, broken or ergotted seed (maximum)	0.020% (by number)	0.040% (by number)
Germination (Minimum)	75%	75%
Moisture (maximum)	12.0%	12.0%
For vapour proof container (maximum)	8.0%	8.0%

Mid storage correction

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

HYBRID SEED PRODUCTION

Breeding Technique for hybrid seed production : Cytoplasmic genetic male sterility system (CGMS)

History of bajra hybrid

Seed production : The first report on CGMS line was made by Burton and his co workers at Tifton Georgia USA. The line is Tift 23A.

Popular hybrid

Hybrid	Female	Male
KM 1	MS 5141 A	J 104
KM 2	MS 5141 A	K 560 -D-230
X4	MS 5141 A	PT 1921
X5	PB 111A	PT 1921
X6	732 A	PT 3095
X7	111A	PT 1890
H B1	Tift 23A(USA)	BIL -3B
HB 3	Tift 23A(USA)	J 104
HB 5	Tift 23A(USA)	K 559
UCH 11	732 A	PT 3075 (TNAU)
COH(cu) 8	732 A	PT 4450

Commercial Hybrid Seed Production

Isolation : Foundation seed : 1000 m

Certified seed : 200 m

Season : Irrigated : March – April, June – July, January – February

Rainfed : October – November

Seed rate : A line : 6 kg ha-1

B line : 2 kg ha-1

Main field preparation : Ridges and furrows

Planting ratio : Foundation Seed : 4:2

Certified Seed : 6:2

Pusa 23 : 8:2

Border rows : Foundation Seed : 8 (B line)

Certified Seed : 4 (R line)

Spacing : A line : 45 x 20 cm

B line : 45 x solid row.

Nursery : Seedling can also be raised in raised bed nursery and can transplanted to the main field at 20-25 days of aging.

Manures & Fertilizers

Nursery	:	750 kg / 7.5 cents for transplanting in one ha.
Mainfield	:	Compost : 12.t ton/ha NPK 100:50:50 kg ha-1
Basal	:	50:50:50 kg ha-1
Top	:	50:0:0 kg ha-1 (At tillering phase
Foliar spray	:	DAP 1% at peak flowering to enhance flowering and seed set.

Steps for synchronization of flowering

1. Withholding irrigation
2. Application DAP 1%
3. Staggered sowing
4. Jerking

Jerking

It is done 20-25 days after transplanting or 30-40 days after direct sowing. The early formed earheads of the first tillers are pulled out or removed which will result in uniform flowering of all the tillers.

Specialty with bajra in synchronization

The synchronization problem is less in bajra due to

1. Tillering habit
2. Supply of continuous pollen
3. Lesser pollen weight
4. Flight capacity of pollen
5. Pollen viability & stigma receptivity are longer.

Rouging : Done in both lines

- A line : seek for offtypes pollen shedder and partials
- R line : Seek for early flowering plants, rouges and diseased plants.

Character of offtypes : Variation in leaf colour, leaf waviness, grain colour earhead, shape, size, etc.

No. of field inspection : Three
- Seedling stage
- Tillering stage
- Grain formation stage.

Field standards

Standards	Maximum permitted (%)	
	FS	CS
Offtypes	0.05	0.10
Pollen shedders	0.05	0.10
Downy mildew diseased plants	0.05	0.10
Earheads affected by ergot	0.02	0.04

Harvesting Technique :

- Due to tillering habit, harvest the panicle / earhead in 2 picking (to avoid delayed harvest)
- Select 5-7 tillers for seed purpose.

Processing :

- Grade with 4/64" round perforated metal sieve as middle screen
- Use OSAW cleaner cum grader.

Seed Treatment : Thiram / Bavistin @3g kg-1 seed

Seed storage : • Cloth bag for short term storage (12 months)
• 700 gauge polyethylene bag – long term storage (> 24 months)

Mid storage correction : HDH with Na2PO4 10-4m for 4h.

Seed standards

Standards	Permitted (%)	
	FS	CS
Physical purity (Maximum)	98	98
Inert matter (Maximum)	2	2
Other crop seed (Maximum)	10 / kg	10 / kg
Weed seed (Maximum)	10 / kg	10 / kg
Ergot effected seeds (Maximum) by number	0.020 %	0.040%
Germination	75	75
Moisture content - Moisture pervious Moisture impervious	12 5	12 5

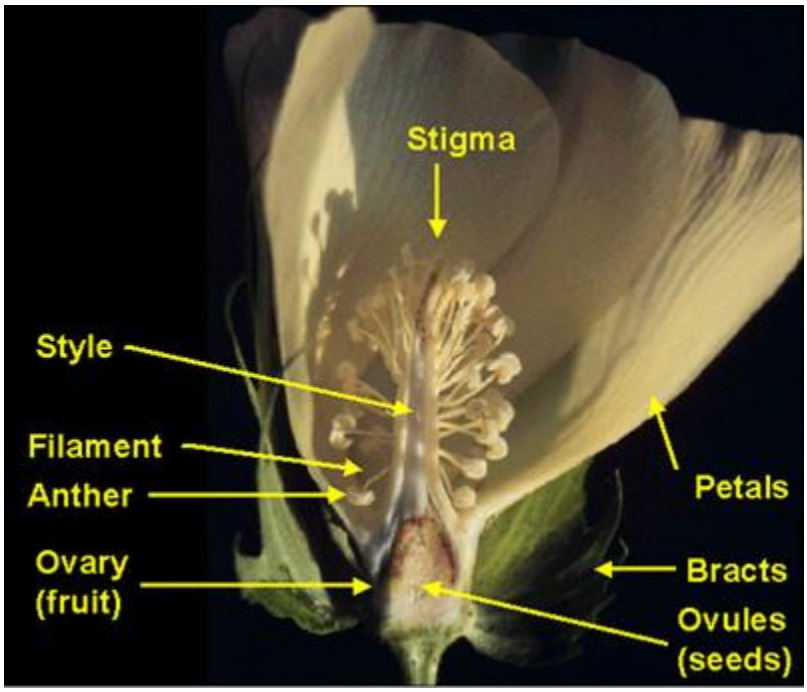
Seed yield : 3200 - 3250 kg / ha

Lecture 14:
SEED PRODUCTION IN COTTON VARIETIES AND HYBRIDS

Cotton botanically as *Gossypium sp.* is a fibre yielding crop. It is known as the queen of fiber crops. It serves as a cash crop to the farmer as the lint serves as the raw material for the textile industry .The seed is used both for multiplication and as animal feed.The success of commercial crop depends on the quality of the basic seed.

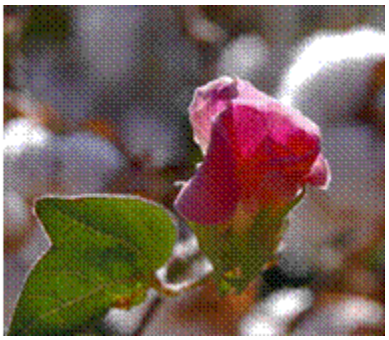
Floral biology

Simple, solitary, terminal, extra axillary, petals yellow to cream in colour, hermaphrodite, bracteoles called as epicalyx, three in number, free and deeply serrated and persistent at the base of the flower. Nectary gland is present on each bracteole. Calyx five, united, cup shaped corolla five, polypetalous, a purple spot is present on the inner side of the claw of the petal (petal spot) in some species. Androecium forming a staminal column (monadelphous) bearing numerous anthers. Ovary superior penta carpellary, style slender, passes through staminal column with three to five lobed stigma, ovules many in axile placentation.



There is much variation in case of flower opening. Asiatic cotton opens between 8 and 10. a.m. American cotton opens much earlier. Temperature affects the flower opening. After flower opening the cream yellow colour of corolla turns pink within a day and later changes to red. The receptivity of the stigma is 8 to 10 a.m.





Cotton is an often cross-pollinated crop where the extend of cross-pollination is > 60%. In cotton 4 different species are in popular usage, viz. *G. arboreum* (eg. K 10) *G. herbaceum* (e.g. Uppam) *G. hirsutum* (e.g. MCU varieties) and *G. barbadense* (e.g. Suvin and Suguna).

Method of Seed Production

Varieties: Under isolation, by open pollination, the varieties are multiplied. For nucleus seed production, selfing of flowers is done with cotton (lint) dipped in clay or red earth.

Hybrids: In cotton both inter and intraspecific hybrids are available.

Interspecific Hybrid :		
Varalakshmi	:	Lakshmi x SB298 E (*G. hirsutum x G. barbadense*)
DCH 32 / Jayalakshmi	:	DS 28 x SB 425 (*G. hirsutum x G. barbadense*)
TCHB213	:	TCH 1218 x TCB 209
Intraspecific hybrid	:	Suguna, Savitha (T7 x M12)

Tool employed for hybrid

The hybrid seed production in cotton is achieved through emasculation and dusting technique, which is the physical removal of male organ (staminal column) from the female parent.

1. **Emasculation and dusting**

At the time of flower initiation in female line, the flowers that are going to open next day are selected and the petals are removed between 3-6 pm. With the help of nail or needle, the total staminal (pollen + anther + anther tube) column are removed. Then the flowers are covered with a definite colour cover for easy identification of the emasculated flowers. In the morning

between 9 am -12 noon, which is the anthesis time, the flowers of selected male parent are plugged and dusted on the stigma of the emasculated flower on opening the cover. It is again covered with different coloured cover to avoid pollination with other pollen and to identify the emasculated and dusted flower from the rest. The pollen from a single flower is enough to dust 4-5 female flowers. The pollen receptivity of the stigma is for 46 hours.

For easy identification of selfed boll from emasculated and dusted boll the bract can be removed while emasculating owing to the little contribution of bract to seed set and seed yield.

Particulars of varieties/hybrids

Varieties	Parentage	Season	Irrigated / Rainfed	Seed yield (kg/ha)
Varieties				
MCU 5	Multiple cross	Aug- January	Irrigated	1850
MCU7	X ray irradiation of x L 1143 EE	Jan- Feb. to May - June(summer)	Irrigated (Rice fallows)	1330
MCU 11	MCU 5 x Egyptian hirsutum hybrid derivative	Aug - September	Irrigated	2200
LRA 5166	Laxmi x Reba B.50 x AC 122	Sep-October to Jan - February	Rainfed	725
K10	K9 x 11876 hybrid derivative	Sep-October to Jan - February	Rainfed	726
K11	(0794-1-DX 11876) x (0794-D x 11450) Multiple Hybrid derivative	Oct- March	Rainfed	1100
SVPR 1	MCU 7 x AC 129/2	February - July	Summer - Irrigated	15-16 Qtl. Of kapas /ha
Hybrids				
Suvin	Hyrbid derivative from the cross Sujatha x St.Vincent	Aug - February	Irrigated	1020
Jalyalaxmi	Interspecific hybird of DS 28 *G. hirsutum* x SB 425 (VF) *G. barbadense*	Aug-February	Irrigated	2880
TCHB 213	Interspecific hybird of TCH 1218 *G. hirsutum* x TCB 209 *G. barbadense*	Aug-February	Irrigated	2215
Savitha	T7 x M 12 (Intra hirsutum hybrid)	Aug-February	Irrigated	1800
HB 224	It is an interspecific hybrid involving *G. hirsutum x G. barbadense*	Aug-February	Irrigated	2000

Steps in hybridizing technique

- Emasculate and dust as far as possible buds appearing during the first six weeks of reproduction phase to ensure good setting and development of bolls.
- Restrict your emasculation each day evening from 3 pm to 6 pm and pollination in morning between 9-12 noon to ensure highest purity of hybrid seeds. Emasculation should be complete and perfect.
- Choose optimum size of bud and avoid young or too old buds for emasculation.
- Cover the male buds with paper bags, previous evening for their use next day.
- Emasculated buds may be covered preferably with butter papers.
- Do not forget to tie a thread to the pedicel of the bud immediately after pollination.
- Close your crossing programme after 9th week (from commencement of crossing) and remove all buds and flowers appearing subsequently to facilitate the development of crossed bolls.
- Nip the top and side shoots to stop further vertical and horizontal growth.
- Light irritations should be given as and when required. Excessive or scanty or inadequate irrigations should be avoided especially during crossing and boll development period.
- Continue irrigation till last picking of the crossed bolls. Frequency of irrigation depends on weather factors like rainfall, temperature and wind velocity.
- Pick up the ripe and completely opened bolls along with threads and collect in baskets for second sorting. Bolls without threads may be bulk harvested as female seed cotton.
- Crossed bolls collected in baskets may be sorted out for second time to verify that they are crossed bolls. Then collect the crossed seed cotton and store in gunny bags carefully marked as crossed bolls.
- Rain touch cotton or hard locks be picked and kept separately to avoid poor germination of hybrid seeds.
- Store the crossed seed cotton in a cool dry place till it is handed over to processing unit.

Use of Genetic male sterility

Hybrids are also produced by employing genetic male sterility system in cotton, where the female parent will segregate into 50:50 ratio of male sterile and male fertile plants. The male fertile plants are removed and the male sterile plants are crossed with concerned male line.
E.g. Suguna: Gregg x K 3400

Land requirement

The field should be fertile and formed into ridges and furrows. Black cotton soils are highly preferable than other soils. Land should be free from volunteer plants and designated diseases especially the wilt disease.

Season

Winter crop : Aug - Sep
Summer crop : Feb - March

Seeds and Sowing

Seeds should be obtained from an authenticated source with tag and bill.

Pre-sowing management

The seeds can be hardened with 1% prosopis and pungam leaf extract for rainfed/summer sowing to resist water stress problem.Use of delinted seed is better than fuzzy seed to avoid diseased and injured seed.

Seed rate

Varieties : 15 kg/ha (fuzzy seed) 7.5 kg/ha (delinted seed)
Hybrids : 3.75 kg/ha (Jayalakshmi), 1 kg (TCHB 213)
Male : 2 kg /ha and Female 4 kg /ha.

Seed treatment

Treat the seeds with azospirillum at 3 packets (600 g/ha) and 2 kg of azospirillum / ha mixed with 25 kg of FYM and 25 kg of soil and applied on the seed line. This saves 25 % nitrogen besides increasing yield.

Spacing – Varieties	**Hybrids**
1. Long duration :90 x 30 cm	♀ : 120 x 60 cm
2. Short duration :60 x 30 cm	♂ : 90 x 60 cm

Hybrids - Planting ratio

8:2 but here it is block system where flowers of 2 parts of male is sufficient to dust 8 parts of female parent.

Isolation (m)

	Foundation seed	**Certified seed**
Varieties	50	30
Hybrids	50	30

Manures and fertilizers

Compost : 12.5 tons/ha
Total : 100:50:25 NPK kg/ha
Basal : 50:50:25 NPK kg/ha
Top dressing : 25:0:0 NPK kg/ha

(40-45 days after sowing)
25:0:0 NPK kg/ha (70-75 days after sowing)

Foliar spray
Spray DAP 2% (for female parents, spray on 60,70,80 and 90th days after sowing. (Soak 5 kg of DAP in 25 liters of water over night and supernatant liquid should be taken and mixed with 475 liters of water for spraying 1 hectare).

Micronutrient application
Mix 12.5 kg of micronutrient mixture formulated by the Department of Agriculture Tamil Nadu with enough sand to make a total quantity of 50 kg for one hectare.

NAA application
Spray 40 ppm of NAA (40 mg of NAA dissolved in 1 liter of water) at 40 / 45th day using high volume spray liquid in 1125 liter /ha. Repeat the same dose after 15 days of first spray.

Topping
Topping arrests terminal growth by nipping the terminal 10-12th node for controlling excessive vegetative growth.

Rouging
The crop should be rouged for off types, selfed plants, from vegetative phase to harvest phase depending on plant stature, leaf size, leaf colour, hairiness, stem colour, flower colour, petal spot, pollen colour, number of sympodia, boll size, boll shape, pittedness etc. to maintain genetic purity.

Field standards
Maximum permitted (%)

	Foundation seed		**Certified seed**	
	Varieties	**Hybrids**	**Varieties**	**Hybrids**
Off types	0.1	0.1	0.2	0.5

Irrigation management
Once in 10 days. Critical periods are boll formation to boll maturation stages.

Specific problems
Boll shedding will occur either due to extreme dry climate or lesser frequency of irrigation or physiological disorder.
By spraying 40 ppm of NAA and cycocel at 20ppm, this can be minimized.

Harvesting

- The seed attains physiological maturation 45 days after anthesis.
- The initiations of hair line cracks on the dried bolls are the physical symptoms of physiological maturation.
- At that time, the moisture content will be 30-35%.
- The bolls are harvested as pickings in cotton.
- Due to continuous flowering habit once over harvest is not practiced.
- As and when the bolls burst with hairline cracks the bolls are collected and dried.
- Normally five to seven pickings can be practiced in a crop.
- But early 4-5 pickings are recommended for seed purpose.
- Harvest in the morning hours upto 10 to 11 a.m. only when there is moisture so that dry leaves and bracts do not stick to the kapas and lower the market value.

- Pick kapas from well burst bolls only.

- Remove only the kapas from the bolls and leave the bracts on the plants.
- As kapas is picked, sort out good puffy ones and keep separately.
- Keep stained, discoloured and insect attacked kapas separately.

Kapas sorting

Kapas is sorted manually to pick good quality seeds. Hard locks are to be removed (Kapas without proper bursting and lint is light yellow in colour), since these kapas mostly result in poor quality seeds, due to boll worm or other insect attack.

Skewed bolls or ill filled or nonviable seeds are formed if stigmatic lobes are not pollinated.

Ginning and certification

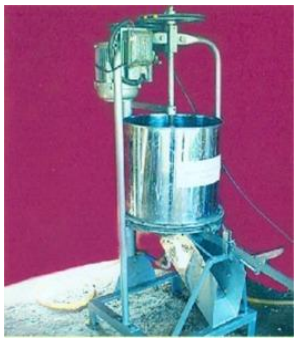
- Gin the crossed kapas in separate gins erected in authorized seed processing units or farm gins under the close supervision of the authorities concerned to ensure purity and avoid seed damage.
- Sieve the seed in two types of mesh to remove small, shrivelled seeds, broken seeds and clean perfectly from any dirt or dust.
- After ginning, the seeds should be dried well and cleaned by hand picking. After cleaning, certification agency will take sample for testing germination and genetic purity test. Minimum germination 65% and genetic purity 90% should be maintained.
- Certified seeds would be bagged in one kg bag, sealed and details regarding its origin, germination, physical purity per cent and genetical purity percent, besides season of production are passed on to sale agencies or respective producers for commercial sale.
- Uncertified seeds would be procured by the concerned Department or Agency at the market rate for the ordinary cotton seeds for further multiplication. This step is essential to avoid unauthorised sale of substandard uncertified seed.

Processing

The ginned seeds (or) the fuzzy seeds are graded by hand picking and by pressing on wire-mesh sieves to remove the under sized seeds and dust.

Acid delinting

- Fuzzy seeds will clog with one another. So for easy handling the seeds are delinted using H2SO4 @ 100 ml/kg of seed for 2-3 minutes.
- After acid treatment, the seed should be washed thoroughly for 3 to 4 times with fresh water.
- From the floaters, mature seeds without any visible damage can be picked and added to the sinkers.



Acid delinting machine

Procedure

Weighed quantity of fuzzy seeds is taken in a plastic container and required quantity of the acid is added. Stir well with wooden rod till a shiny black colour appears (Tar like) wash with more of water (5-6 times) and shade dry the seed to reduce the moisture content to 12% before further handling.

Processing of delinted seed

The free flowing delinted seeds can be graded using 10/64" round perforated metal sieve, which is recommended as standard sieve in OSAW cleaner cum grader for cotton.

The seed can also be graded by specific gravity method by using floatation technique using water. The seeds will separate into floaters and sinkers. The sinkers are good seeds. From floaters, reddish (immature) and damaged (seed with insect hole) are removed. The brownish seeds which are good seeds are handpicked and used for sowing.

Seed standards

Characters	Foundation seed	Certified seed
Physical purity % (min)	98	98
Inert Matter % (max)	2.0	2.0
Other crop seeds (max)	5 kg-1	10 kg-1
Weed seeds (max)	5 kg-1	10 kg-1
Genetic purity (%)	100	100
Germination (min) % (variety)	65	65
Germination (min) % (hybrid)	75	75
Moisture content (max) %		
a. Moisture pervious	10	10
b. Moisture vapour proof	6	6

Seed storage

The seeds can be stored upto 8-9 months in moisture pervious container and upto 12-15 months in moisture vapour proof containers.

The seed treatment with thiram @ 2.5 kg-1 or chlorine based halogen mixture @ 3g kg-1 will protect the seed from storage fungi *Aspergillus* spp and preserve the storability.

Mid storage correction

- The fuzzy and delinted seeds can be soaked in double the volume of 10-4 molar solution of Na2HPO4 for 2 and 1 hr respectively (3.59 g / 100 l of water.)
- Then the seeds are shade and sun dried to bring back to the moisture content of 10-12%. The mid storage correction improves the planting value of old seeds.
- Dead seeds may be removed by soaking acid delinted cotton seeds in monolayer for 3 h and drying back to original moisture content.

The seeds when put into potable water will separate into sinkers and floaters. Dead seeds become buoyant and float.

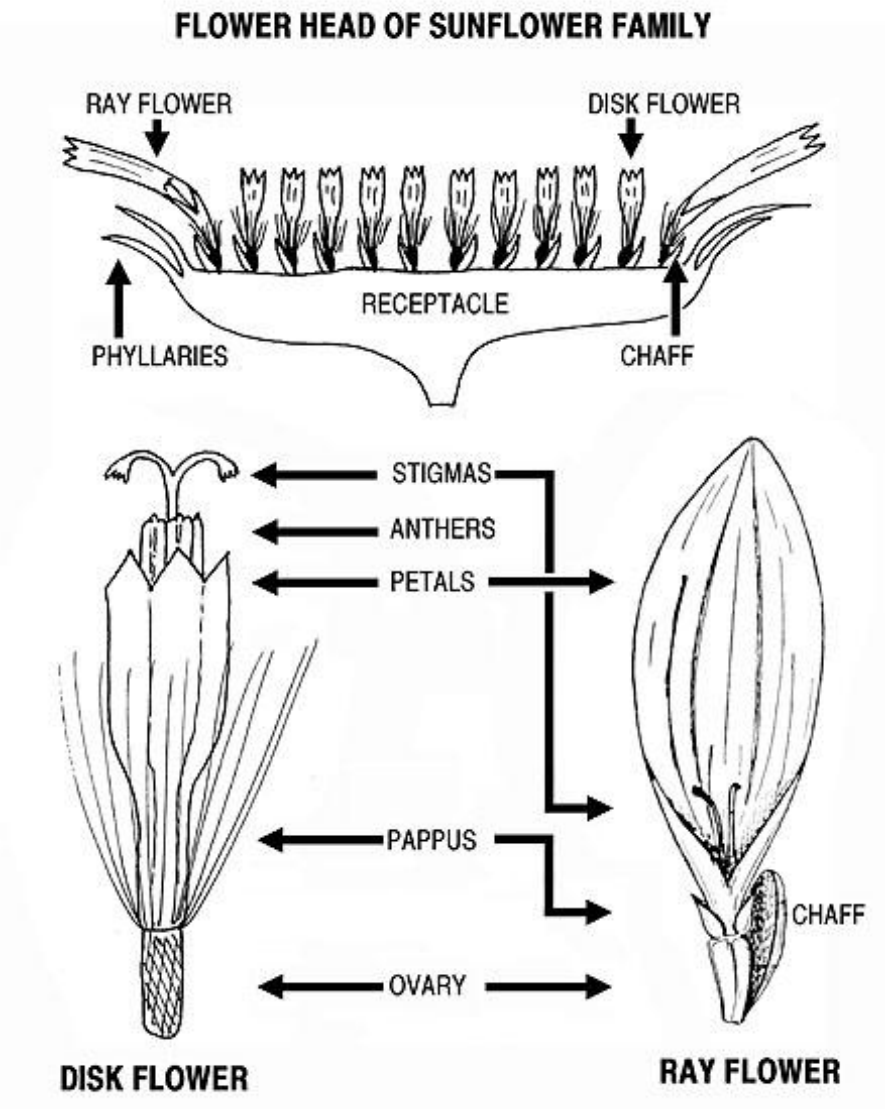
Lecture 15:
SEED PRODUCTION IN SUNFLOWER

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

Botany of flower

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

Anthesis and pollination



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

Varietal seed production technique

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

Varieties

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

Stages of seed multiplication

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

Varietal renovation method (Pustovit model)

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

Causes for ill filled seed

a) Pollination

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

b) Development of axillary flowers

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

d) Self incompatibility

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

Technology for increased seed set

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

Popular varieties

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

Season

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

Land requirement

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

Field Standards (Isolation)

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

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

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

Seed and sowing

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

Presowing seed treatment

- The seeds are given with any one of the seed treatment or in combination
- Fresh seeds of sunflower exhibit physiological dormancy which could be broken by soaking the seeds in 300ppm ethrel for 8h or 0.5% KNO3 for 16h. Moist hydration of seed with water for 24h followed by dry dressing with thiram @2g kg-1 of seed improved the productivity of the seed.
- Seeds are soaked in 2% ZnSO4 for 12h with a seed to solution ratio of 1:0.06 and are dried back to their original moisture content of 8-9% .This management could be used both for dryland agriculture as well as gardenland.

- As an ecofriendly treatrment seeds are also fortified or hardened with 1% moringa leaf extract for 16h with a seed to solution ratio of 1:0.06 and are dried back to their original moisture content of 8-9%.
- Seeds are dry dressed with bavistin @2g/kg of seed to protect against seed borne pathogens and soil borne pathogen. Seeds are also treated with azospirillum @50g/kg of seed to fix atmospheric N.
- Any one of these treatment or combination of treatment is adopted for better productivity. On adoption of sequence of treatment physiological should be followed with physical seed treatment.

Nutrient application

At last ploughing apply 12.5 tonnes of compost per hectare. The fertilizer requirement of seed crop is 80:40:40 kg of NPK, in which 40kg of N and full dose of P and K is applied as basal, while 40kg of N is applied at the time of earthing up i.e. 40-45 days after crop growth..The seed crop is also sprayed with 2% DAP or 20ppm NAA at 30and 60 days after sowing. In case of deficient soils the crop is sprayed with 0.5% Borax at button formation stage.

Micronutrients deficiency

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

Weeding

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

Supplementary pollination

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

Hand pollination

- Keeping of bee hives 5 ha-1

Foliar application

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

Irrigation

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

Pest and Disease management

Common pests and diseases	**Management techniques**
Cut worm	Chlorpyriphos (20EC) @ 3.75 l/ha
White fly	Imidacloprid @ 0.1ml/lit
Thrips	Phosphomidon 0.03%
Tobacco caterpillar (*Spodoptera litura*)	Endosulphan 0.07% or NSKE 5% or or Fenitrothion 0.05%
Capitulum borer (*Helicoverpa armigera*)	Endosulphan 0.07% or Helicoverpa NPV @ 250 LE/ha.
Alternaria blight and leaf spot	Mancozeb 0.3%
Rust	Zineb 0.2%
Downy mildew	Metalaxyl 25WP
Head rot	Copperoxychloride@0.4% or mancozeb 0.3% combined with endosulfan (0.05%)

Roguing

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


Field standards

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

Seed Certification

Number of Inspections

A minimum of three inspections shall be made as follows:

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

Bird scaring

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

Harvesting

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

Threshing

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

Drying

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

Processing

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

Seed treatment

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

Seed packing

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

Storage

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

Seed standard

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

Seed Standard

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

Mid storage correction

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

Hybrid seed production in sunflower

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

Hybrids

BSH -1 = CMS 234 A x RHA 274
KBSH 1 = " x 6 DI
MSFH 1 = MHS 71 x MHR 48
MSFH 8
MSFH -17
TCSH 1 = CMS 234 A x RHA 272
Season : June - July, October - November

Isolation distance

	Foundation seed	Certified seed
Hybrids	600 m	400 m

Seeds and sowing

Seeds are sown in ridges and furrows

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

Spacing

60 x 30 cm (hybrids)

Planting ratio : 8:1 or 4:1

Border row : two

Manures and fertilizers

Compost : 12.5 t/ha

NPK : 60:45:45 kg /ha

Supplementary pollination

- As in varieties

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

- Keeping of bee hives 5 ha-1.

Roguing

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

Field standards

Foundation seeds	Certified seeds
Off types 0.1 %	0.2%

Harvesting

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

Drying, processing and others – as in varieties

Seed standards

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

Parameter	FS	CS
Physical purity (min) %	98	98
Inert matter (max) %	2	2
Germination (min)%	60	60
Moisture content (max)%		
(a) Open storage	8	8
(b) Moisture vapour proof Storage	5	5

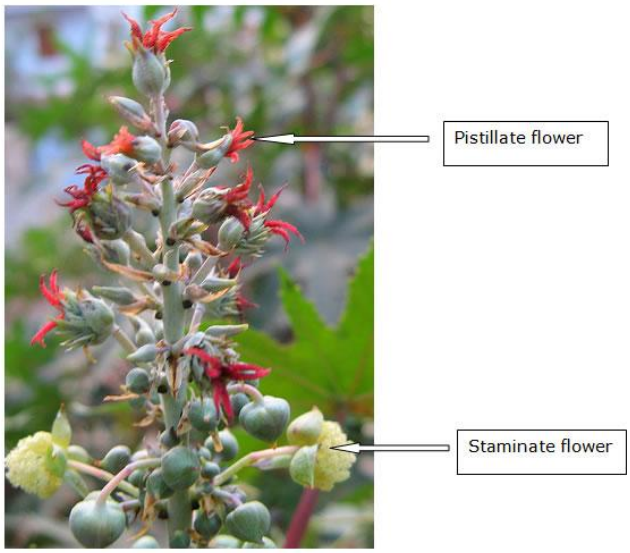
Lecture 16

SEED PRODUCTION IN VARIETIES AND HYBRIDS OF CASTOR

Castor and its speciality

- Castor is a cross pollinated crop, protogynous and wind pollinated. Inflorescences are borne terminally on the main and lateral branches.
- The main stem ends in raceme, which is the first or primary raceme. After the first raceme appears, 2 or 3 branches arise at the nodes immediately below it.
- Each of these branches terminates in racemes after 4 or more nodes have formed which are known as secondary racemes.
- Branches arise from the nodes just beneath secondary racemes, ultimately terminating in tertiary racemes. This sequence of development (indeterminate growth habit) continues.
- The racemes of castor are monoecious with the pistillate flowers on the upper 30-50% and staminate flowers on the lower part of the inflorescence.
- The proportion of pistillate and staminate flowers among the racemes varies a great deal both within and among genotypes. It is influenced by the environment of the plant, genotypes and nutrition.
- Female tendency is the highest in winter, while male tendency predominates in summer and rainy seasons.
- Also, the femaleness in young plants with high levels of nutrition is stronger than in old plants with low levels of nutrition.

Castor raceme



Pistillate mechanism

In addition to monoecism a sub form of dioecism exists in castor, which has led to the identification of 3 different pistillate mechanisms.

- **N type or conventional mechanism**
- It is governed by a recessive sex switching gene. This can be maintained by sibmating. The progeny from seed produced on pistillate plants segregates in 1: 1 ratio of pistillate and monoecious plants. In the production of F1 hybrid seed using the N pistillate line, the producer is required to rogue out normal monoecious plants before anthesis to obtain 100% production of pistillate plants in the female rows. This has proved difficult to do for 3 reasons.
- Uneven emergence
- Variation in time of flowering and
- Higher percentage of monoecious plants than expected 50 percent.
- **S type or non conventional mechanism**

It is derived from reversals, which start out as female and then revert to normal monoecism any time after the first raceme. Use of this pistillate line is beset with the problems of lack of stability of the expression of pistillate character as large number of revertants as well as monoecious plants was observed in the population. Eg. VP 1. This problem was successfully overcome with the exploitation of the NES system.

3. NES system

This line is normally pistillate under moderate temperature but produces interspersed staminate flowers under high temperature. In crossing fields (hybrid seed production plot) usually one or two roguing of the female line are sufficient to ensure that all flowering plants are pistillate to remove off types that appear.

E.g. The original population of VP 1 was thoroughly screened under high temperature to eliminate the monoecious plants as well as early revertants.

The seed setting in the selected totally pistillated lines is facilitated by the production of interspersed male flowers under the influence of environment sensitive genes.

India is the largest producer of castor in the world. In India, Gujarat is the leading state followed by Andhra Pradesh.

Varieties

SA 1, SA 2, TMV 4, 5, 6, CO 1, Aruna, Bhagya and Sowbaghya

Speciality with Hybrids in castor

- The development of N type pistillate line, N 145-4 has led to the exploitation of hybrid vigour in USA in 1950.
- A 100% pistillate line TSP 10 R (Texas S- pistillate 10) was released in 1962 in USA.
- Another stable pistillate line (NES 1) based on environmentally sensitive staminate flower character in combination with recessive sex switching gene released at Davis, California in 1964, is now used.
- In India, Gujarat first started hybrid seed production in mid sixties.
- First hybrid in India was released in 1968 in Gujarat as GCH3 (Gujarat castor hybrid) using TSP 10 R x JI 15.
- Indigenous pistillate line VP 1 was developed at Vijapur and using this GAUCH was released in 1973. But it is susceptible to wilt and root rot diseases.
- Hence another hybrid GCH 2 was released in 1985.
- Another hybrid GCH 4 was released in 1986 and is in cultivation.

Hybrids	Female	Male
GCH 3	TSP 10 R	JI 15
GAUCH 1	VP 1	V 19
GCH 2	VP 1	JI 35
GCH 4	VP 1	48-1
TMVCH 1	LRES 17	TMV 5

Land requirement

Well drained fertile soil should be selected. The crop cannot tolerate alkalinity and salinity. It performs well with medium to deep sandy loam and heavy loam soils are highly suited for seed production.

Isolation distance

	Foundation seed	certified seed
Varieties and Hybrids	600 m	300 m

Season

Rabi / Winter - Hybrid seed production. Summer and kharif provide ideal male promoting environment for undertaking seed production of the variety, male and female parents of hybrids. Kharif and summer encourages good expression of less productive plant which could be easily eliminated through timely roguing.

Female parents when raised in male promoting environment produce environmentally sensitive staminate flowers, which are very essential for self-production of the female parents.

Seed and sowing

Seed rate : 10 kg / ha (varieties)

2 kg / ha male and 5 kg/ ha female for hybrids.

Spacing

Varieties : 90 x 20 to 90 x 60 cm

Hybrids : 90 x 40 to 90 x 60 cm

Planting ratio

3:1 or 4 - 6:1

Fertilizer : Basal 40:60: 40 NPK / ha

Top: 1st 20 kg N/ha (40-50 DAS) , 20 kg N/ha. (After 1st picking)

Bloom: Presence of white waxy coating which protects from chilling and jassid attack.

4 types of bloom:

- No bloom
- Single bloom - Bloom only on stem
- Double bloom- On stem, petioles, and lower sides of leaves
- Triple bloom - On all parts.

Stages of inspection

- 10 days prior to flowering -Stem colour, inter-node length.
- During flowering - No. of nodes upto primary raceme
- Before 1st picking (Spike and capsule character, reversion to monoecious in second order raceme)
- After 1st picking - Reversion to monoecious or flower initiation in third order raceme.

Irrigation

Critical stages are primordial initiation and flowering stage in differential segmental order branches. Moisture stress in sensitive crop growth stages may lead to production of more male flowers in monoecious varieties.

Harvesting

Castor produces 4 or 5 sequential order spikes, which can be harvested in 3-4 pickings starting from 90-120 days at 25-30 days interval.

Premature harvesting leads to reduced seed weight, oil content and germination. If shattering is not a problem in a variety, harvesting can be delayed until all capsules are fully dried.

Grading

The seeds are size graded using round perforated metal sieve of 8/64".

Field standards

	Foundation seeds	Certified seeds
Off types (Varieties)	0.1	0.2%
Off types (Hybrids)	0.5	1.0%

Seed storage

Seed treatment with Thiram @ 2 g / kg

Storability in Pervious container - 1 year

Storability in Moisture vapour proof container - 2

Seed standards

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

Parameter	Foundation seed	Certified seed
Physical purity (min) %	98	98
Inert matter (max) %	2	2
Other crop seed &Weed Seed (max)	-	-
Other distinguishable variety seeds	5 / kg	10/kg
Germination (min)%	70	70
Moisture content (max)%		

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

Lecture 17

SEED PRODUCTION TECHNIQUES IN VEGETABLES

TOMATO (*Lycopersicum esculentus*)

Tomato is one of the most important vegetable crops grown extensively in the tropical and subtropical belts of the world. It is grown mainly fresh market and to a little extent for processing. Increased attention is now being bestowed to breeding and production of tomato. Production of tomato can further be increased if improved cultural practices are combined with good quality seeds. The quality seed production techniques in tomato comprises of the following steps.

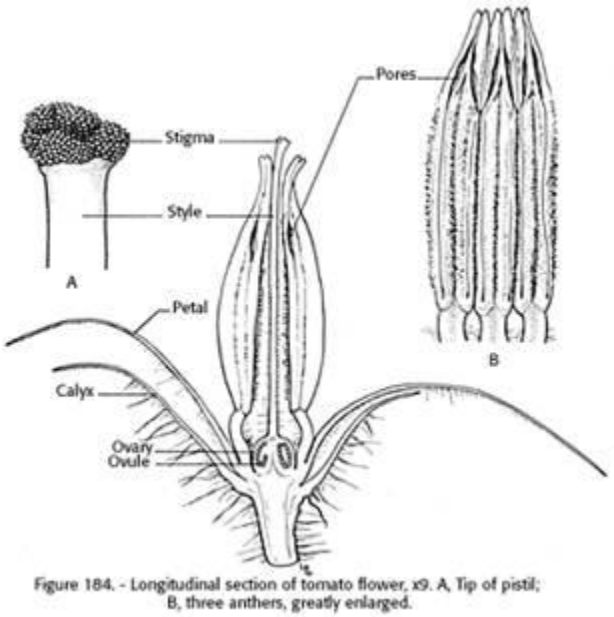


Figure 184. - Longitudinal section of tomato flower, x9. A, Tip of pistil; B, three anthers, greatly enlarged.

Botany

Tomato is a typical day neutral plant. It requires temperature of 15-20° C for fruit setting. Tomato is self pollinated crop. Self fertilization is favoured by the position of receptive stigma within the cone anthers and the normal pendant position of the flower.

Method of seed production : Seed to Seed.

Stages of seed production

Breeder seed - Foundation Seed I - Foundation Seed II - Certified Seed

Varieties :

Indeterminate varieties

Pusa Ruby, Solan Gola, Yaswant (A-2), Sioux, Marglobe, Naveen, Ptom-9301, Shalimar- 1, Shalimar-2. Angurlata, Solan Bajr, Solan Sagun, Arka Vikas. Arita Saurbh.

Determinate varieties

Roma (EC-13513), Rupali, MTH-15, Ptom-18, VL-1, VL-2, HS 101, HS 102, HS 110, Pusa Early

Dwarf, Pusa Sheetal, Floradade, Arka Meghli, Co.1, Co.2, Co.3 (Marutham), PKM.1, Py1,

Hybrids

COTH-1, Pant Hybrid-2, Pant Hybrid-10, Kt-4. Pusa Hybrid-l-4, Arka Shreshta, Arka Vardan, Arka Abhijit, Navell 1 &2 (Sandoz), Rupali, Sonali, MTH 6

Season : May - June and November - December

Land requirement

Selection of suitable land for tomato seed production is important where the previous crop should not be the same variety to avoid the contamination due to the volunteer plants.

Isolation requirement

For Seed production of tomato, varieties require minimum of 50 M for foundation seed and 25 M for certified seed. For hybrid seed production, it requires minimum of 200 M for foundation (parental line increase) and 100 M for certified hybrid seeds.

Seed rate

For i) Varieties - 300- 400 g/ha ii) For F1 hybrid - Male parent 25 g/ha; Female parent 100 g/ha.

Nursery

Sow the seeds in raised nursery bed of 20 cm height, in rows of 5 cm gap and covered with sand. Eight and ten nursery beds will be sufficient to transplant one acre. Apply 2 kg of DAP 10days before pulling out of seedling.

Transplanting

Transplanting should be done with the seedlings are 20-25 days old, preferably at evening time. Spacing is 60 x 45 cm (90 x 60 cm for female parent and 60 x 45 cm for male parent of hybrids).

Manuring

After thorough preparation of a field to fine tilth, apply 25 tons of FYM per ha. Apply 100 : 100: 100 Kg of NPK/ha of which, 50% of the N is applied as

Roguing

The roguing should be done based on the plant characters (determinate / indeterminate), leaf, branching and spreading characters and also based on fruit size, shape and color. The plants affected by early blight, leaf spot and mosaic (TMV) diseases should be removed from the seed production field.

Planting ratio

For hybrid seed production, the female and male parents are normally planted in the ratio of 12:1 or 12:2.

Pest and disease management

The major pests attacking tomato crop are leaf eating caterpillars and fruit borers, which can be controlled by spraying. The major diseases in tomato are **early blight and mosaic virus.** The early blight rot can be controlled by spraying Benlate or Dithane M-45.

Harvesting seed extraction and processing

The fruits are harvested after full maturity of the fruit when turn in to red color fruits from first and last one or two harvests should not be used for seed extraction.

Stages of maturation: Mature green, Breaker, Turning, Pink, Red, Dark red / over ripe

The fruits from in between 6-7 harvest should be used for seed extraction. The seed viability is depends on the method on which the seeds were extracted and hence, it is more important to choose proper methods of seed extraction. Before seed extraction, the fruits are to be graded for true to type and selection of medium to large size fruits for getting higher recovery of quality seeds.

The acid method of seed extraction is the best method for tomato seed extraction. In this method, the fruits are to be crushed into pulp and taken in a plastic containers (or) cement tank. And then add 30 ml of commercial Hydrochloric acid per kg of pulp, stir well and allow it for ½ hour. In between this duration the pulp may be stirred well for one or two times. This facilitates the separation of seed and pulp. After ½ hour, the seeds will settle down at the bottom and then the floating fraction is to be removed. The collected seeds should be washed with water for three or four times.

- While following acid method we must use only plastic or stainless steel containers or cement tank.
- Care must be taken to avoid the usage of iron or zinc containers, which will affect the viability potential of the seeds and as well damage to the containers due to chemical reaction with acid.
- For large scale seed extraction we can use the tomato seed extractor developed by Tamil Nadu Agricultural University.
- The seeds extracted by this machine may again be treated with commercial Hydrochloric acid @ 2-3 ml/kg seed with equal volume of water for 3-5 minutes with constant stirring. And then seed should be washed with water for to four times.
- It is easy to dry the seeds extracted by acid method and also remove the fungus growth over the seed coat, thus seeds possess golden yellow colour and high vigour.
- The seed extracted by fermentation method posses poor vigour and off colour due to fungal activity.

Comparison of different seed extraction methods

	Fermentation	**Acid**	**Alkali**
Method	Mix fruit pulp with water - 24 - 48 h	HCl @10ml / Kg of pulp - 20-30 minutes	Washing soda @ 900mg/4 l of water- equal volume – overnight soak
Salient features	• Low cost. • Unskilled labour. • More Time taken • Low Seed recovery (0.5 to 0.6 % • Dull seed colour. • Seed..borne.. pathogens	• Cost is more. • Skilled labour • Lesser Time • High seed recovery (0.8 to 1 %) • Bright colour market value higher. • Seed borne pathogen – removed • Improper washing leads to injury to seeds	• Recovery 0.7 to 0.8 per cent • Luster of the seeds will be lost. • Improper washing leads to injury to seeds

Fermentation method

Manual Crushing

Fermentation

Washing

Extracted seed

Acid seed extraction

Mechanical Crushing

Extracted seed

Acid treatment

Washing of seeds

Drying and grading

Seeds are to be dried in the shade. It should never be dried in hot sun. the safe moisture content of the seed for grading is 8 to 9 per cent. Seeds can be graded using 6/64'' round perforated sieve.

Storage

The seeds dried to safe moisture content after treating either with captan or thiram @ 2 g/kg can be stored for 15 months in moisture vapour pervious containers, while it can be stored in moisture vapour proof containers for 30 months.

Hybrid seed production:

In tomato the hybrid seed production is normally done by 'Emasculation and Hand Pollination'. However use of chemical hybridizing agents (MH-1000 ppm) or CMS lines are also practiced.

Emasculation and dusting

1. Emasculation is done before the anthers are mature and the stigma has become receptive to minimize accidental self pollination.

Selection of flower

1. Thus emasculation is generally done in the evening, between 4 PM and 6 PM one day before the anthers are expected to dehisce or mature and the stigma is likely to become fully receptive.
2. Emasculate the bud by hand with the help of needle and forceps. Remove the **calyx, corolla and staminal column or anthers**, leaving **gynoecium i.e., stigma and style** intact in the flower.

Removal of anther cone

Removal of corolla

1. Emasculated flowers should be covered immediately with red coloured paper cover to protect against contamination from foreign pollen and also for easy identification of emasculated bud during dusting.
2. Remove the red paper cover of the emasculated bud and dust the pollen gently over the stigmatic surface using cotton or camel brush, etc.,

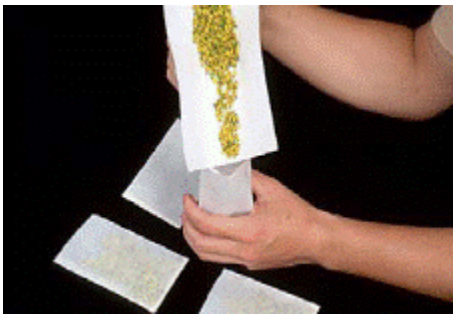
Emasculated flower

Dusting of pollen

- After dusting, the emasculated flowers are again covered with white or other coloured paper cover for two to three days.
- Pollen collected from one male flower can be used for dusting 5 to 7 emasculated flowers.

Pollen collection

Male flower



Collected flower

Drying of flower

Collection of pollen I

Collection of pollen II **Pollen for hybrid crosses**

Seed Yield : 100 -120 Kg/ha

Seed Certification

Number of Inspections

A minimum of three inspections shall be made as follows:

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

Specific requirements

Factors	Foundation	Certified
Off types - variety	0.1 %	0.2%
Hybrid	0.01%	0.05%
Plants affected by seed borne diseases	0.1 %	0.5%

Seed standard (variety and hybrid)

Factors	Foundation	Certified
Pure seed (mini)	98%	98%
Inert matter (maxi)	2%	2%
Other crop seeds (maxi) 5/kg	5/kg	10/kg
Weed seeds (maxi)	None	None
Germination (mini)	70%	70%
Moisture (maxi)	8%	8%
For VP container	6%	6%

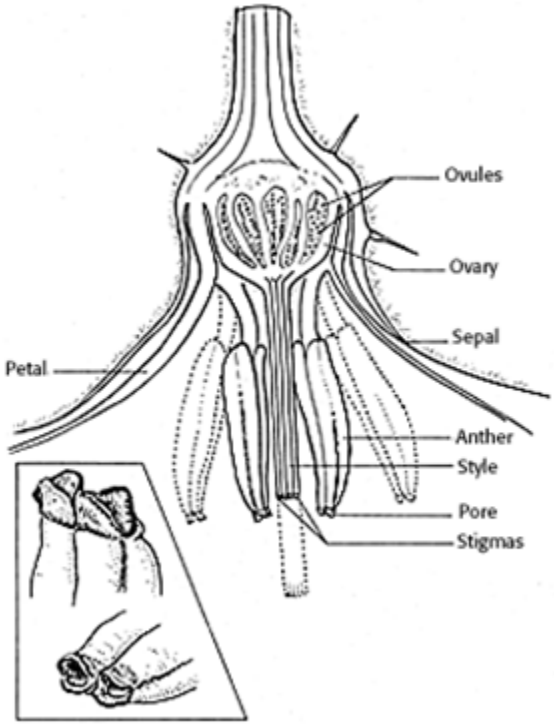
Lecture 18 :

BRINJAL (*Solanum melongena)*

Brinjal is one of the most important vegetable crops grown extensively in the tropical and subtropical belts of the world. It is grown mainly fresh market and to a little extent for processing. Increased attention is now being bestowed to breeding and production of Brinjal. Production of brinjal can further be increased if improved cultural practices are combined with good quality seeds. The quality seed production techniques of brinjal comprises of the following steps.

Botany

Brinjal is often cross pollinated crop. Brinjal flower opens mainly in morning. A few flower open at 16 hr. Anther dehiscence occurs 15-20 minutes after flowers have opened. The period of receptivity ranges from a day prior to flower opening to 4 days after opening. Brinjal produces 4 types of flowers with different style length. (Long style, short style, medium style and pseudo short style). For seed production and better yield, the long and medium style is desirable. To increase the production of long and medium style application of more nitrogen or spraying of growth regulators during pre-flowering and flowering stages may be followed.



Method of seed production : Seed to Seed.

Stages of seed production

Breeder seed à Foundation Seed à Foundation Seed II à Certified Seed.

Varieties

Co.1, Co.2. MDU.1, PKM.1, KKM.1, PLR. 1. AU1, Pusa purple long, Arka nidhi, Pant smart,

Arka neelkanth, Arka shrish.

Hybrids

CoBH1,Arka Navneet (IIHR 22-1 x supreme), Pusa H-5, Pusa H-6, MHB 10, MHB 39 (Mahyco), Azad Hybrid.

Season

The brinjal seed production can be taken up in the following 2 seasons. May-June and December- January.

Land requirement : The land should be free of volunteer plants.

Isolation

For varieties, 200 M or 100 M of isolation distance is required for foundation and certified seed, respectively. For hybrid seed production minimum of 200 M isolation distance should be maintained.

Seed rate

Varieties - 400 - 500 g/ha

Hybrids - 200 g/ha (Female) - 50 g/ha (Male)

Nursery

Sow the seeds in raised nursery bed of 20 cm height, in rows of 5 cm gap and covered with sand. Eight and ten nursery beds will be sufficient to transplant one acre. Apply 2 kg of OAP 10days before pulling out of seedling.

Transplanting

Seedlings are transplanted when they are 30-35 days old (12-15 cm height) preferably in the evening time. Spacing of 75 x 60 cm (non spreading) and 90 x 60 cm (spreading) varieties, 90 x 60 cm for female parent and 60 x 45 cm for male parent of hybrids.

Manuring

The field should be thoroughly ploughed for fine filth and apply 25 tons of FYM/ha. The other fertilizer requirement for brinjal variety and hybrid are same as followed for tomato seed production.

Roguing

The roguing should be done based on the plant characters, leaf, branching and spreading characters and also based on fruit size, shape and color. The plants affected by **Phomopsis blight, leaf spot and little leaf virus disease** should be removed from the seed production field.

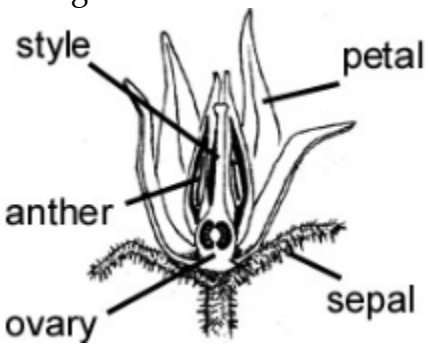
Pest and disease management

The pests like fruit borer, shoot borer, beetles, aphids, mealy bug and jassids can be controlled by spraying Nuvacron or Methyl parathion. The red spider mite can be controlled by spraying in Kelthane. The important diseases are **damping off and little leaf** which can be controlled by spraying fungicide and systemic insecticides, respectively. **Powdery mildew, leaf spot and anthracnose** diseases can be controlled by spraying Benlate.

Hybrid seed production

The planting ratio of female and male parents adopted for hybrid seed production is normally

5:1 or 6:1.For production of hybrid seeds, crossing programme is done using emasculation and dusting methods as followed in tomato.



Harvesting and processing

Harvesting is done when fruits are fully ripe (when the fruits turn into yellow colour) i.e., 405 days after flowering. The harvested fruits are to be graded for true to type and off type and fruit borer infested fruits are discarded. The graded fruits are cut in 2-3 pieces or whole fruits will be put in a cement tank with water and crushed manually and then allow it for fermentation for 1-2 days. Then the floating pulp portions are to be removed, the seeds settled at the bottom should be collected and washed with water and then the seeds with equal volume of water is treated with commercial Hydrochloric acid @ 3-5 ml/kg of seed. The mixture is kept for 10-15 minutes with frequent stirring. Then the treated seeds are to be washed with water for 3-4 times. Afterwards seeds are dried under shade for 2-3 days over a tarpaulin and followed by sun drying for 1-2 days to reduce the seed moisture content to 8 per cent. Then the seeds are cleaned and graded with BSS 12 sieve. The processed seeds are treated with fungicides or Halogen mixture @ 5g/kg of seed.

Storage

The seeds dried to safe moisture content after treating either with captan or thiram @ 2 g/kg can be stored for 15 months in moisture vapour pervious containers, while it can be stored in moisture vapour proof containers for 30 months.

Seed Yield : 100-200 Kg/ha

Seed Certification

Number of Inspections

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

Specific standards

Factors	Foundation	Certified
Off types – Variety	0.1%	0.25
Hybrid	0.1%	0.05%
Designated diseased plant	0.1%	0.5%

The designated diseases in brinjal are Phomopsis blight caused by *Phomopsis vexans* and little leaf caused by Datura virus -2.

Seed standards (Variety & Hybrid)

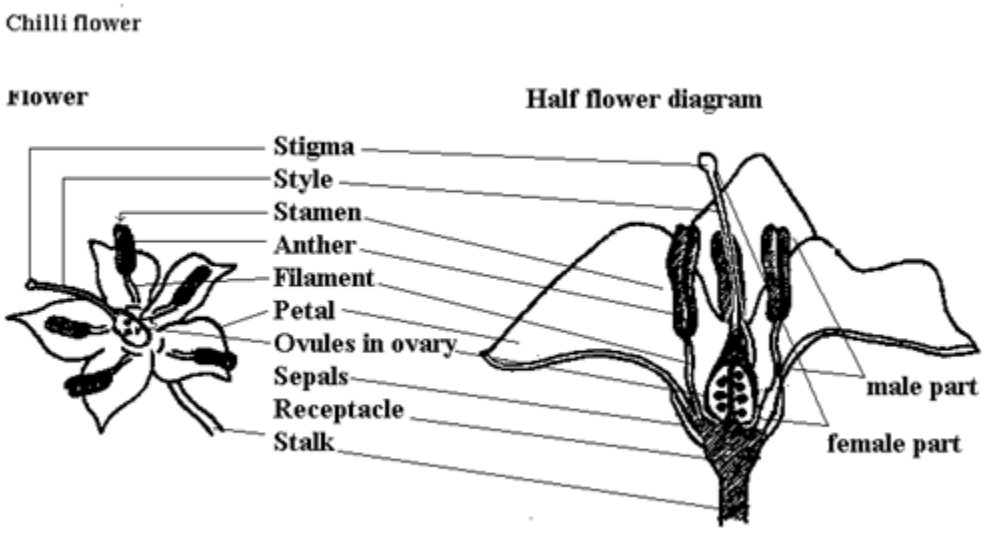
Factors	Foundation & Certified
Pure seed	98%
Inert matter	2%
Other crop seed	None
Weed seed	None
Germination	70%
Moisture content	8%
For VP Container	6%
Genetic purity - tomato & brinjal hybrids is	90%

Lecture 19

CHILLI (*Capsicum frutescense*)

Chillies widely used as vegetable and spice is an often cross pollinated crop, where the extend of cross pollination is upto 7 to 36 per cent. It belongs to the family solanaceae. It is also known as hot pepper and botanically it is known as *capsicum annuum***.** The quality seed production techniques of chillies comprises of the following steps.

Botany: Often Cross pollinated vegetable. The flower is protogynous. Anther dehisces only half to 5 ½ hr after stigma becomes receptive. Anthesis in chilli occurs between 6.00 and 9.00 hr. Flower remains open for 2 to 3 days, receptivity of stigma was the highest at the day of flower anthesis.



Method of seed production : Seed to seed

Stages of seed production : Breeder seedàFoundation seedàCertified seed.

Varieties: K.1, K.2, K.3, Co.1, Co.2, PKM.1, MDU.1, Bagyalakshmi.

Hybrids: KT.1, (Pusa Deepti), Solar Hybrid 1, Solar Hybrid 2. Early Bounty, Indira, Lario, Hira, Bharat.

Season : June-July, February-March, September- October.

Land requirement : There are no land requirement as of previous crops, but the land should be free from volunteer plants. Generally areas affected by wilt or root rot may be avoided. Crop rotation must be followed to avoid endemic Solanaceous pests.

Isolation requirement : Minimum isolation distance of 400 M for foundation and hybrid seed and 200 M for certified seed production are necessary.

Seed rate : Seed required for one hectare is 500 g to 1 kg for variety; for hybrids - Female = 200

g and male = 50 g

Nursery : Sow the seeds in raised nursery bed of 20 cm height, in rows of 5 cm gap and covered with sand. Eight and ten nursery beds will be sufficient to transplant one acre. Apply 2 kg of DAP 10 days before pulling out of seedling.

Transplanting: The seedlings of 30-35 days old are ready for transplanting. Transplanting may be done on the ridges in the evening.

Foliar spray: To arrest the flower drop, NAA (Planofix) can be sprayed @ 4ml/L. Very light irrigation is also done arrest the flower drop.

Manuring : Apply 50 tones of FYM/ha for irrigated crop. Basal 0:70:70 kg of NPK and 50 kg of N at 15 days after transplanting and 50 kg N at 45th days after transplanting.

Roguing: Field inspection and roughing should be done both for varieties and hybrid at different stages based on the plant height and its stature, flower colour and pod characters. The plants affected with leaf blight, anthracnose and viral diseases should be removed from the seed field.

Pest and disease management: The important pest attacking chilli and capsicum are thrips, aphids, pod or fruit borer and mites. The thrips and aphids can be controlled by spraying Dimecron (systemic pesticide), pod borer can be controlled by spraying Nuvacron and the mites can be controlled by spraying Kelthane. The major diseases affecting the plants are die back or fruit rot, powdery mildew and bacterial leaf spot. Spray Dithane M-45 for control of die back, Karathane for powdery mildew and Agromycin for leaf spot disease control.

Hybrid seed production: The crossing operation can be performed as per the methods outlined for tomato and brinjal hybrid seed production. However, hand emasculation and pollination is somewhat difficult since the flowers are minute. Hence use of male sterile lines can also be employed for hybrid seed production.

Harvesting and processing: Harvesting should be done in different pickings. First and last one or two pickings can be harvested for vegetable purpose. The well ripened fruits with deep, red colour alone should be collected in each picking. After harvest, fruit rot infected fruits are to be discarded. The harvested pods are to be dried under shade for one (or) two days and then under sun for another 2 or 3 days. Before drying pods are to be selected for true to type and graded for seed extraction. The seed are extracted from graded dried pods. The pods are taken in gunny bag and beaten with pliable bamboo sticks. The seeds are cleaned by winnowing and dried to 10% moisture content over tarpaulin. Then seeds are processed with BSS 8 wiremesh screens. For large scale seed extraction, the TNAU model chilli seed extractor may be used.

Seed Yield : 50-80 Kg/ha

Seed Certification

Number of Inspections

A minimum of three inspections shall be made as follows:

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

Specific standards:

Factors	Foundation	Certified
Off types	0.1%	0.2%
Designated diseased plant	0.1%	0.5%

The designated diseases are caused by *Collertotictum capsici* and leaf blight caused by *Alternaria solari.*

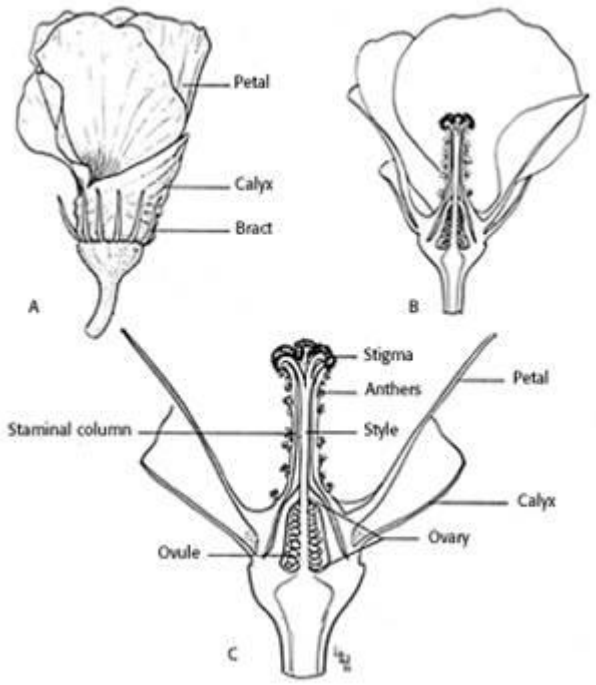
Seed standards (Variety & Hybrid)

Factors	Foundation	Certified
Pure seed	98%	98%
Inert matter	2%	2%
Other crop seeds	5/kg	10/kg
Weed seeds	5/kg	10/kg
Germination	60%	60%
Moisture content	8%	8%
For VP Container	6%	6%

Lecture 20

BHENDI (*Abelmoschus esculentus*)

Botany: Anthesis is between 9 and 10 hr and is preceded by maximum anther dehiscence between 8 and 9 hr. The stigma remains receptive on the day of anthesis. Bhendi is an often cross pollinated crop. Cross pollination to an extent of 12 per cent is due to **protogy nous**.



Method of seed production : Seed to seed

Stages of seed production : Breeder seed à Foundation seed à Certified seed.

Varieties : Co.1, MDU.1, Parbhani Kranti, Arka Anamika, Pusa A-4, Pusa Sawani

Hybrids:CO2,CO 3, Mahyco hybrid, Shoba

Season : June-July, September- October and February- March

Land requirement : Select field on which bhendi crop was not grown in the previous season, unless the crop was of the same variety and certified. Field should be free from wild bhendi (*Abelmoschus sp*.)

Isolation requirement: Seed field must be isolated from other varieties at least by 400 M for foundation and hybrid seed production and 200 M for certified seed production.

Seed rate : Varieties : 8-10 kg/ha

Hybrids : 4 kg/ha (Female); 1 kg/ha (Male)

Manuring: Apply 12.5 tons of FYM/ha before ploughing. Apply 150:75:75 kg NPK/ha, of which 50% of the N should be applied as top dressing in two split doses at flowering and 10 days later.

Planting ratio: For hybrid seed production, female and male parents are normally planted in the ratio of 4:1.

Roguing: Minimum of three inspections for varieties and 4 inspections for hybrids, one at vegetative, two at flowering and one at fruit maturity stages. The rouging should be based on the plant characters, hairiness, fruit character like fruit colour, number of ridges, fruit length etc., and the off type and mosaic attacked plants should be removed from the seed field. Wild bhendi if present should be removed before flowering.

Pest and disease management: The major pest attacking bhendi are jassids, aphids and white fly, which can be controlled by spraying Rogar or Dimecron or Endosulphon. The pod borer and red spider mites can be controlled by spraying Endosulphon and Kelthane, respectively. The diseases such as yellow vein mosaic and powdery mildew can be controlled by spraying systemic insecticides and Karathane, respectively.

Hybrid seed production: In bhendi, since the flowers are large in size, hand emasculation and pollination is the best suitable method for seed production. The emasculation and dusting can be done as per the methods outlined in tomato. The male and female parents are raised in blocks at the ratio of 9:1 (Female: Male).

Harvesting: Fruits should be harvested when they have dried (30-35 days after crossing). The pods which expose hairline crack and turn to brown colour on drying alone are cut using sickle manually.

Threshing:

The pods are dried and threshed using pliable sticks. Separated seeds are winnowed to remove plant debris and dried over a tarpaulin to 10% moisture content. Dried seeds are subject to water floatation in which, good seeds sink while poor seeds float. The floaters are removed, while sinkers are dried under shade followed by sun drying. Then the seed are cleaned, dried and treated with Captan/ Thiram.


Processing: Seeds are to be processed with BSS 7 wiremesh sieve.
Seed Yield: 1000-1200 Kg/ha

Specific standards:

Factors	Foundation	Certified
Off types	0.1%	0.2%
Objectionable weed	None	None
Disease affected plants	0.1%	0.5%

Objectionable weed: wild *Abelmoschus sp.*


A.moschatus ***A. manihot***

Designated diseases: Yellow Vein Clearing Mosaic (Hybiscus virus-1)

Seed standards

Factors	Foundation	Certified
Pure seed	99%	99%
Inert matter	1%	1%
Other crop seed	None	5/kg
Total weed seed	None	None
Objectionable weed	None	None
Other Distinguishable Varieties (ODV)	10/kg	20/kg
Germination	65%	65%
Moisture	10%	10%
For VP Container	8%	8%

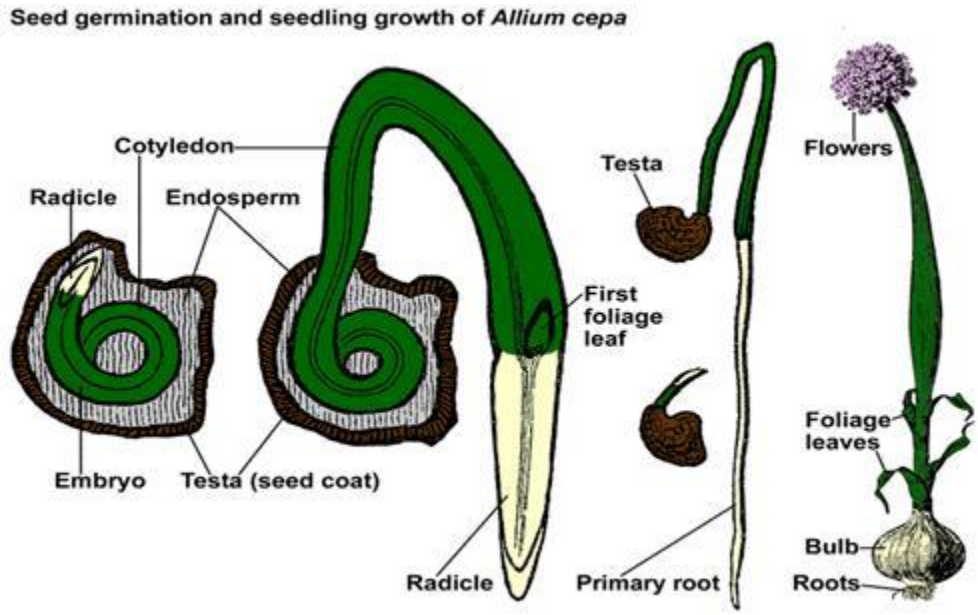
Lecture 21

ONION (*Allium cepa*)

Onion is one of the most important commercial vegetable crops in India. Maharastra, Gujarat, Uttra Pradesh, Orissa and Andhra Pradesh are the major onion growing states. The total annual area is estimated to be about 3 lakhs hectare and production is about 35.37 lakh tonnes. It is grown mainly in rabi season. Three crops *viz.*,Kharif, late Kharif and rabi are taken in Nasik division of Maharashtra whereas Gujarat, Andhra Pradesh, Rajasthan, Punjab, Harayana, Madhya Pradesh, Karnataka and Tamil Nadu take up two crops that is Kharif and rabi. Kharif onion is a recent introduction in Northern, Eastern and Central India.

Botany

Onion is the biennial crop and takes two full seasons to produce seeds. In the first year bulbs are formed and in the second year stalks develop and seed are produced. It is **a long-day plant**. The day length influences bulb onion, but has little effect on induction of seeding. It appears to be **day-neutral** for seed production. It requires cool conditions during early development of the bulb crop and again prior to and during early growth of seed stalk. Varieties bolt readily at 10 to 15 degree C. In the early stages of growth, a good supply of moisture is required and temperatures should be fairly cool. During bulbing, harvesting and **curing** of seed, fairly high temperatures and low humidity is desirable. Seed production is widely adapted to temperate and sub-tropical regions.



Stages of seed production : BS – FS - CS
Varieties

A.	**RED**	
1.	Punjab Selection	PAU, Ludhiana
2.	Pusa Ratna	NBPGR, New Delhi
3.	Pusa Red	IARI, New Delhi
4.	Pusa Madhavi	IARI, New Delhi
5.	N-2-4-1	MPAU, Rahuri
6.	Arka Niketan	IIHR, Bangalore
7.	Arka Kalyan	IIHR, Bangalore
8.	Agrifound Dark Red	NHRDF, Nasik
9.	Agrifound Light Red	NHRDF, Nasik
B.	**WHITE**	
1.	N-257-9-1	MPAU, Rahuri
2.	Pusa White Round	IARI, New Delhi
3.	Pusa White Flat	IARI, New Delhi
4.	Punjab-48	PAU, Ludhiana
C.	**Aggregatum Onion**	
1.	CO 5	TNAU, CBE

- Bellary Red, Rampur local, and Kalyanpur,

Season
The optimum sowing season is middle of June to Middle of July in the plains.
Isolation Requirements
Onion is largely cross-pollinated crop with up to 93 per cent natural crossing but some self-pollination does occur. It is chiefly pollinated by honey-bees. For pure seed production, the seed fields must be isolated from fields of other varieties of onion and fields of the same variety not conforming to varietal purity requirements for certification atleast by 1000 metres for foundation seed production and 500 metres for certified seed production.
Method of Seed Production

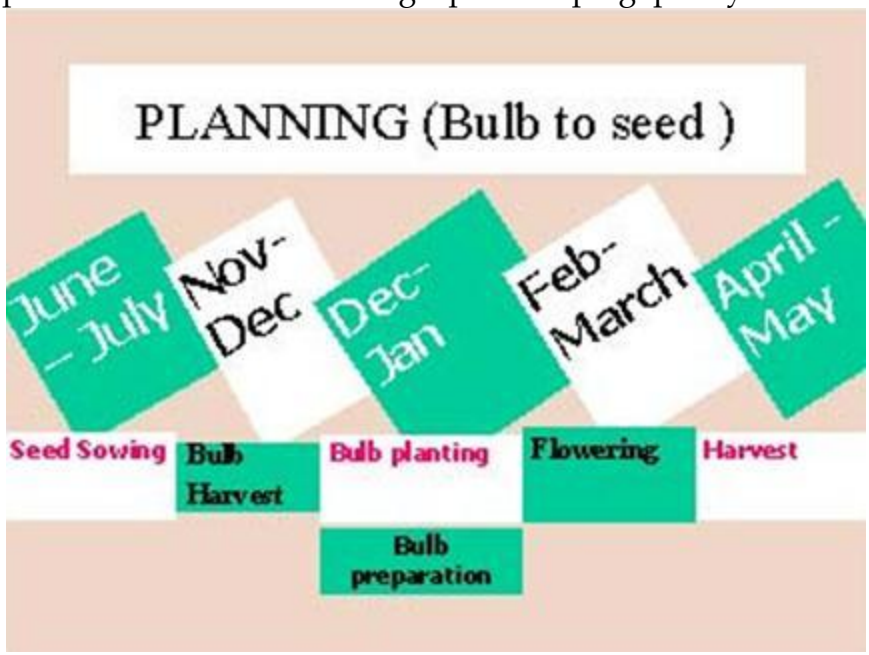
There are two methods of seed production

1. **Seed to seed method**: In this method, the first season bulb crop is left to over-winter in the field so as to produce seed in the following season.
2. **Bulb to seed method:** The bulbs produced in the previous season are lifted, selected, stored and replanted to produce seed in the second year.

Mostly the bulb to seed method is used for seed production because of the following advantages over the seed to seed method.

a) It permits selections of "true-to-type" and healthy bulbs for seed production.

b) Seed yields are comparatively very high. The seed to seed method, however, can be practiced for varieties having a poor keeping quality.



Bulb to seed method

A. Bulb Production stage

- **Climatic requirement**

Though it is possible to produce bulbs in different climatic conditions, mild climate is reported to be very good. For better bulb production a temperature of 15.5 to 210C and about 70% relative humidity required.

- **Land requirement**

Fields in which onion was grown should be selected unless it was of the same variety and was certified. The onion can be grown on various types but it grows best in soils which are able to

retain moisture for longer time. Heavy soils do not permit proper bulb development and many times bulbs are misshapen. 6-8 pH range are considered better for onion.

- **Isolation requirement**

Onion is highly cross pollinated crop with upto 93% natural crossing. It is mostly pollinated by honeybees. For pure seed production the seed fields must be isolated from field of other varieties of onion of the dame colour at least by 1000 meters for foundation seed and 500 m for certified seed. The isolation distance between colour particularly white and red colour must be much more which needs to be decided.

- **Seed rate**

8-10 Kg per hectare

- **Sowing and transplanting time**

Season	Sowing	Transplanting
Kharif	June-July	July-August
Rabi	Oct-Nov	Dec-Jan

In kharif 6-7 weeks old seedling and in rabi 8-9 weeks seedlings should be transplanted. Over aged **nursery** should not be planted otherwise premature bolting may be there.

- **Manures and fertilizers**

FYM	50 tonnes
CAN	400Kg
Or	
Urea	200kg
Super phosphate	300 Kg
Muriate of Potash	100 Kg

Nitrogen should be applied as basal and top dressing in two splits. Top dressing may not be delayed otherwise thick necks may be a problem.

- **Spacing**

15 x 10 cm. More spacing between plants results in thick necked plants.

- **Irrigation**

Irrigation should be given at fortnightly interval or weekly interval as the case may be. Field should not be left dry for long otherwise splitting problem is more.

- **Weeding**

2-3 weedings and hoeings are done. Stomp @ 3.51 / ha may be applied 3 days after transplanting to manage the weeds economically. One weeding by hand is, however, necessary.

- **Plant protection**

Malathion @ 0.1% along with tritone against thrips. 4-5 spraying may be necessary. Indofil M45 @ 0.25% along with tritone against purple blotch and stemphylium blight, 5-6 sprayings may be done.

k) Roguing

Remove off type plants on difference in colour of leaves or plant type. Remove resprouted plants or premature bolters.

l) Harvesting

Harvesting the crops one week after 50% of tops falling and keep in windrow upto 3-5 days for field curing. After that bulbs are cured in shade to remove fields heat before keeping in store. In kharif bulbs are ready for harvesting within 90-100 days after transplanting while tops are still erect. Bulbs are allowed for field curing upto 3-5 days then again cured were in shade or in field depending upon the temperature for 12-15 days. Tops are cut leaving 2.5 cm neck.

B. Seed Production Stage

1. **Selection of bulb**

True to type bulbs are selected based on colour, size and shape kept in ventilated storage in rabi crop and in kharif crop bulbs are planted after curing for 15 days. 4-6 cm size bulbs are selected for getting good crop.

1. **Climate**

Conditioning of plants / bulbs is necessary for seed stalks formation. Temperature of 4.50c to 140C are favourable for this conditioning. Longer this prevails, more stalks each plant will produce and more flowers will be in each umbel. Low humidity gives good seed development. While plants are in flowering clear bright sunny days are necessary for good insect activity.

1. **Bulb rate**

25 quintal / ha

1. **Spacing**

45 x 30 cm

1. **Fertilizer and manures**

200 kg urea / ha.50% as basal and rest as top dressing
300 Kg super phosphate (single) / ha
100 Kg muriate of potash / ha

1. **Irrigation**

Irrigation at an interval of 15 days in winter and 7-10 days in summer is necessary for proper seed development. Fields should not be kept saturated for long as this facilities development of diseases.

1. **Rouging**

Remove plants based on foliage, colour inflorescence and flower characters.

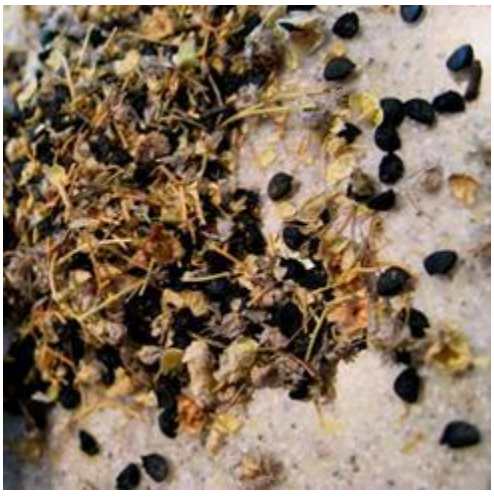
1. **Plant protection**
2. Spray Indofil M45 @ 0.25% against purple blotch and **stemphylium** blight.
3. Endosulfan @ 0.20% against thrips and head borer.

1. **Harvesting and curing**

When capsules become brown and seeds inside become black the umbels are then cured and dried.

1. **Threshing and cleaning**

Threshing is done manually. Pre-cleaning is done by brushing machine and scalper. Cleaning and grading are done by Air screen cleaner by using 1/14x1/2 as grading screen and then upgrading is done by gravity separators.



1. **Drying and Packing**

Seeds are dried upto 6-8% moisture depending upon packaging requirements. If seeds are required to be packed in Aluminium foil and other moisture proof containers, seed are dried upto 6% otherwise upto 8%.

l) Seed yield

5-7 q / ha

Certification Standards

I. Field Standards

1. **General requirements**

1. Isolation

Onion seed fields shall be isolated from the contaminants shown in column 1 of the Table below by the distance specified in columns 2,3,4 and 5 of the said Table:

Contaminants	**Minimum distance (meters)**			
	Mother bulb production stage		**Seed Production stage**	
	Foundation 2	Certified 3	Foundation 4	Certified 5
Fields of other varieties	5	5	1000	500
Fields of the same variety not conforming to varietal purity requirement for certification	5	5	1000	500

1. **Specific requirements**

Factors		**Maximum permitted**	
		Foundation	**Certified**
*	Bulbs not conforming to the varietal characteristics	0.10% (by number)	0.20% (by number)
**	Off types	0.10%	0.20%

* Maximum permitted at second inspection at mother bulb production stage.

** Maximum permitted at and after flowering at seed production stage.

II. Seed Standards

Factors	Standards for each class	
	Foundation	**Certified**
Pure seed (minimum)	98.0%	98.0%
Inert Matter (maximum)	2.0%	2.0%
Other crop seed (maximum)	5 / Kg	10 / Kg
Weed seeds (maximum)	5 / Kg	10 / Kg
Germination (minimum)	70%	70%
Moisture (maximum)	8.0%	8.0%
For vapour-proof containers (maximum)	6.0%	6.0%

Problems and Prospects of certification in onion seed production

Following are the problems and remedial measures in certification of onion seed:

1. **Unawareness about the notified varieties by the farmers**

Many improved and notified varieties have not been demonstrated fully with the farmers as such farmers still prefer old varieties. The extension agencies in the state may therefore take up demonstration so as to allow farmers to know about the new improved varieties.

1. **Unawareness about the advantage of certified seed over truthful seed**

In cereals and some other seeds the seed production and distribution programme are properly organized. Farmers have been demonstrated with the advantage of using certified seed. In vegetables particularly in small seed such demonstrations or extension education programmes have not been carried out. Farmers thus are not aware about the benefits of using certified seed in onion. Extension agencies should arrange state level demonstrations on use of certified seed in onion to make the farmer fully aware of advantages of the certified seed.

1. **No maintenance breeding for improved varieties**

Since varieties when developed by the Universities / institutes do not pass through maintenance breeding later, the varieties do not behave in different characters in the same way as these were at the time of development. The application of certification standards particularly for genetics purity therefore becomes impossible. The Universities / Institutes should continue maintenance breeding of their varieties for maintaining distinctiveness, uniformity and stability.

1. **Most of the parameters of the varieties are influenced by agro climatic conditions**

In onion there are many characters like colour, shape, bolting, neck thickness or doubles which are affected adversely by agro climatic conditions like soil, temperature, rainfall, cultural practices etc. Practical application of certification standards required to be seen at the time of certification where staff cannot have proper judgment. The staff should, therefore, know the details of characters and how and to what extent, they are influenced by adverse weather conditions. Based on that the staff should assess the situation and apply their mind in certifying a crop.

1. **Staff with certification agencies are neither adequate nor they have proper knowledge about the crop.**

Onion is highly cross-pollinated crop and it requires through inspection or check at different stages. If one stage is left it becomes difficult to meet the requirements. For example if inspection is not managed at the time of bulb selection, Similarly if isolation is not checked at the time of **bolting** it becomes a frutile exercise later as roughing has no meaning at the time of flowering. This is possible only when sufficient staff having good knowledge about onion is provided.

1. **Unawareness of farmers about pre harvest and post harvest practices of onion seed production.**

The extension agencies as also staff certification agencies are supposed to properly guide for production and post harvest practices for certified seed production initially. Certification staffs presently do not guide. Presently since staff themselves are not aware about pre harvest practices as also post harvest practices, programmes many times fail as such farmers hesitate in going for certified seed production. It is, therefore, necessary for certification staff to guide the farmers initially.

1. **Inadequate infrastructural facilities for storage of bulbs, cleaning, grading and drying**

Bulbs of rabi onion are required to be stored in ventilated godowns which are not available. Seed requires is must which is mostly not available. Similarly for enabling the seed producers to pack the seed in moisture proof containers for long term storage, seeds are required to be dried to 6% moisture where dehumidified driers are required. Such facilities are lacking at any places.

1. **Certification standards are not realistic**

Presently standards which have been fixed are not realistic. The standards need to be fixed based on the type of material being developed by the institutes. The effects of agro climatic conditions on different parameters need to be considered. Isolation distances are not adequate particularly between white and red varieties.

1. **Non availability of adequate quality breeder / foundation seed of a variety**

Even if everyone is ready for taking up certified seed production, adequate quality breeder seed foundation seed with the concerned institute is not available. Because of this problem in fact many good varieties in onion have been lost before going to farmers. The seed production programme, therefore, should be properly planned right from production of breeder seed to certified seed so as to make available quality seed in adequate quantities for improving production and quality.

1. **Low price of seed available in the market**

Many times onion seed price in the market are very low compared to quality seed / certified seed. This is mainly because farmers collect seed from premature bolters / takes up *in situ* method where though quality is poor quality is in abundance, Govt. should, therefore give some.

Lecture 22

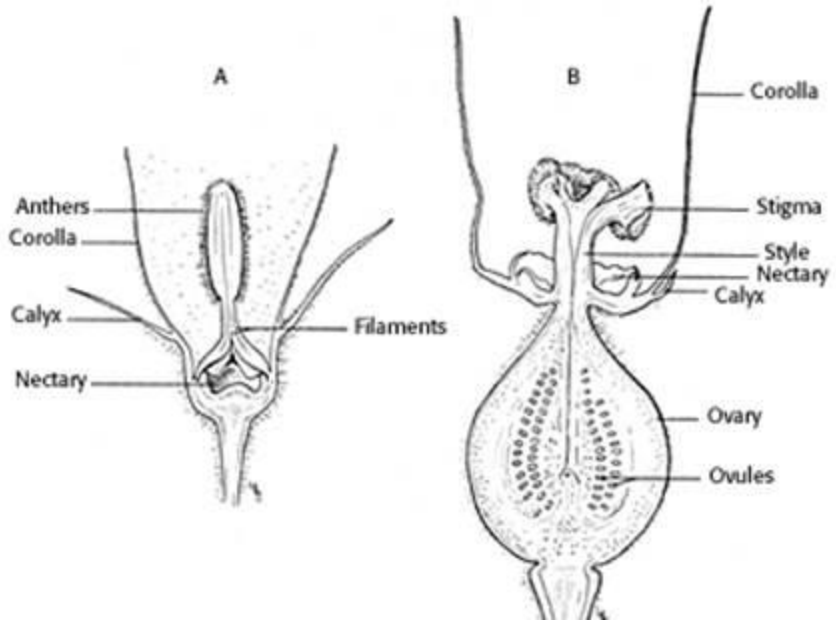
SEED PRODUCTION OF CUCURBITACEOUS VEGETABLES

Land Requirements: There are no land requirements as to previous crop, but the land should be free of volunteer plants. Generally the soil should be well drained and aerated.

Isolation Requirements: Most of the cucurbits are monoecious in character and a few are dioecious. A number of **hermaphrodite and andromonoecious** cultivars are also available in some crops. Pollination is largely done by insects. For pure seed production and isolation distance all around seed field is necessary to separate it from fields of other varieties, fields of the same variety not conforming to varietal purity requirements for certification, from wild cucurbit species, and to separate musk melon from long melon and vice versa, and pumpkin from summer and winter squashes and vice versa as follows

Class	Minimum distance (meters)
Foundation	1000
Certified	500

Flower structure in cucurbits



GENETIC PURITY AND SEED HEALTH STANDARDS FOR CUCURBITS

Factors	Minimum permitted level (%)	
	FS	CS
Open pollinated variety		
Off-type	0.10	0.2
Objectional weed plant	None	None
Hybrids		
Off-type in seed parent	0.01	0.05
Off-type in pollen parent	None	0.05
Pollen shedders in seed parent	-	0.10
Seed borne diseases ***		
Muskmelon *	0.1	0.20
Summer squash **	0.1	0.5

Cucumber mosaic virus ,** Cucumber mosaic virus, watermelon mosaic virus

SEED CERTIFICATION STANDARDS IN INDIA FOR CUCURBITS

Factors	Minimum permitted level (%)	
	Foundation seed	Certified seed
Pure seed (minimum)	98	95
Inert matter (maximum)	2	5
other crop seed (maximum)	None	None
Weed seed (maximum)	None	None
Other objectional varieties (only for hybrids)	5/kg	10/kg
Germination (minimum)	60	60
Moisture for ordinary pack (maximum)	7.0	7.0
Moisture for vapour proof pack (maximum)	6.0	6.0

Seed production details in Cucurbitaceous vegetables

Particulars	Bittergourd	Snakegourd	Ribbedgourd	Ashgourd / Pumpkin
Isolation	Foundation seed 1000 m and certified seed 500 m			
Season	June - July and Feb – March			
Varieties	CO1, MDU1, Coimbatore long green & long white	CO1, CO2, PKM1, MDU1	CO1, CO2, PKM 1	CO1, CO2
Seed rate / ha	2.5	2.5	2.5	2.5 / 1.0
female flower increased by	Spraying of Ethrel 200 - 250 ppm at two true leaf stage and after a week of 1st spray			
Spacing (cm)	Take pits of size 45x45x45 cm at 2.5x2.0 m distance			
Fertilizers / (NPK g/pit)	6:12:6	12:24:12	9:15:9	6:12:6
Physiological maturity	Change of fruit colour in any part or 1/3 of fruit tip to yellow to red		Complete drying of fruits	Change of fruit colour to orange brown in pumpkin and ashy coating and metallic sound in ashgourd

Processing	Hand picking	Hand picking	BSS 4 wire mesh sieve	16/64 round perforated sieve
Fruit to seed recovery (%)	30	15-16	13-14	1.0-1.3
Seed yield (kg/ha)	120-150	220-250	200-250	120-150

Techniques of Hybrid Seed Production in cucurbits

i. Hand emasculation and hand pollination

This technique is frequently used for melon seed production. In this species, andromonoecious lines are common and they must be emasculated and hand pollinated if used as the female parent for producing hybrid seed. This method has also been used for some watermelon and cucumber hybrids. This technique is applicable for limited scale production, since lot of trained labour are required in pinching, pollen collection and hand pollination.

ulation and pollination

ii. Hand emasc by insect

The male flowers from female lines are pinched off day before of anthesis regularly, which honeybees and other insects (voluntary) uses as a pollinating agents. The male and female are grown in alternate rows. The fruit set on female lines are of hybrid and harvested for seed extraction. The planting ratio varies within the crops e.g. summer squash 3:1 and 4:1 in muskmelon and cucumber but depend upon the population of bees in plot. This technique is also used in bottle gourd, pumpkin, muskmelon, cucumber, summer squash and bitter gourd for hybrid seed production.

iii. Use of genetic male sterility system

Genetic male sterility system has been utilized for commercial hybrid production in muskmelon. The genetic male sterility in muskmelon is controlled by single recessive gene (msms). For hybrid seen production, the male sterile line is used as female parent. Since genetic male sterile line is maintained in heterozygous forms, 50% fertile plants are to be removed at flowering. The other 50% having non-dehiscent empty anther are retained in female rows. The female and male are grown in 4:1 ratio. However, to maintain the good plant

population in female rows it is suggested that seed parent should be sown with double seed rate. It is also advised that female line seedling should be raised in polythene bags and transplanted at flower appearance in order to avoid the fertile plants in female rows. The pollination is done by honey bees and 1 to 2 medium sizes hives are good enough to ensure the good pollination and fruit set at female row.

The male sterile line is maintained in heterozygous form by crossing with maintainer line under adequate isolation distance or under cover.

iv. Use of gynoecious sex form

The gynoecious sex form has been commercially exploited in hybrid seed production of cucumber. For hybrid seed production female and male rows are planted in 4:1 ratio. The female (seed parent) bear only female flowers and pollination in done by insect (honeybee). To ensure the good fruit and seed recovery, the sufficient population of honeybee 1 to 1½ colony of medium size has to be kept at the boundary of seed production plot to boost the amount of crossing. The parental lines i.e. male parent maintained by selfing (mixed pollination) and rouge out undesirable plants before contamination take place. The female lines i.e. gynoecious lines maintained by inducing the staminate flower through the sprays of silver nitrate 200 ppm at two to four true leaf stage and then selfing is carried out. It was observed that 10-11 male flowers appear per 100 nodes.

The performance of gynoecious lines is unstable under high temperature and long photo period conditions because of their thermo-specific responses for gynoecious stability. That is why the gynoecious cucumber did not receive much attention in the tropical countries. However, few true breeding tropical gynoecious lines in cucumber and muskmelon have been developed at IARI. As a result of development of true breeding line, muskmelon hybrid Pusa Rasraj was developed. These homozygous gynoecious lines are maintained by using GA3, 1500ppm or silver nitrate 200-300 ppm or sodium thio sulphate 400 ppm to induce staminate flowers at two and four true leaf stage. Homozygous lines are planted in strict field isolation. The gynoecious lines are crossed with monoecious male parent to produce F1 hybrid.

v. Hybrid seed production through chemical sex expression

The hybrid seed can also be produce in cucurbits by the application of chemicals for attaining the sex of cucurbits. Specific chemicals are known to induce femaleness and maleness as desired. The spraying of ethrel (2-choloro-ethyl-phosphonic acid) 200-300 ppm at two and four true leaf stage and another at flowering is useful for inducing the pistilate flower successively in first few nodes on the female in bottle gourd, pumpkin and squash for F1 seed production. The row of male parent is grown side by the side of female and natural cross pollination is allowed. In the absence of insect, hand pollination is possible when two sexes are separate. Four to five fruit set at initial nodes are sufficient for hybrid seed. The complete suppression of male flowers in squash can be achieved by applying ethrel at higher concentration (400-500 ppm) twice.

The other chemicals like GA3, (10-25 ppm) in cucumber, MH-(100 ppm), ethephon (600 ppm) in squash induces female flowers.

Lecture 23

SEED CERTIFICATION

It is a legally sanctioned system for quality control and seed multiplication and production. It involves field inspection, pre and post control tests and seed quality tests.

Purpose of seed certification

To maintain and make available to the farmers, through certification, high quality seeds and propagating materials of notified kind and varieties. The seeds are so grown as to ensure genetic identity and genetic purity.

Eligibility for certification of crop varieties

Seeds of only those varieties which are notified under section 5 of the Seeds Act, 1966 shall be eligible for Certification.

Breeder seed is exempted from Certification. Foundation and Certified class seeds come under Certification.

Breeder seed is produced by the plant breeder which is inspected by a monitoring team consisting of the breeder, representative of seed certification agency (DDA), representative of NSC (Deputy Manager) & nominee of crop co-ordinator (s – 11). The crops shall be inspected at appropriate stage.

Phases of seed certification or Seed certification procedures

1. Receipt & Scrutiny of application
2. Verification of seed source
3. Field inspection
4. Post harvest supervision of seed crops
5. Seed sampling & testing
6. Labelling, tagging, sealing and grant of certificate.

1. Receipt & scrutiny of application

a. Application for registration

Any person, who wants to produce certified seed shall register his name with the concerned Assistant Director (AD) of seed certification by remitting Rs. 25/- per crop, per season. There are 3 seasons under certification viz., kharif (June-Sep), Rabi (Oct. – Jan.) & Summer (Feb-May).

The applicant shall submit two copies of the application to the ADSC 10 days before the commencement of the season or at least at the time of registration of sowing report.

On receipt of the application, the ADSC will verify the time limit, variety eligibility & its source, the class mentioned, remittance of fee etc.

The application, if accepted will be given an application no (e.g. Paddy / k / 01- 05-06, where Paddy refers the crop to be registered, K-the season, 01-the application no & 05-06 -the

financial year). The original application is retained and the duplicate is returned to the applicant.

b. Sowing report: (Application for the registration of seed farm)

The seed producer who wants to produce certified seeds shall apply to the ADS.C, in the prescribed sowing report form in quadriplicate with prescribed certification fees along with other documents such as tags to establish the seed source.

Class of seed	Source of seed
1. Foundation class	Breeder seed
2. Certified class	Foundation seed
3. F. Class stage II	Foundation class stage – I
4. C. Class stage II	Certified class stage - I

Separate sowing reports are required for different crop varieties, different classes, different stages and if the seed farm fields are separated by more than 50 metres.

Separate sowing reports are also required if sowing or planting dates differ by more than 7 days and if the seed farm area exceeds 25 acres.

The sowing report shall reach the concerned ADAS.C within 35 days from the date of sowing or 15 days before flowering whichever is earlier. In the case of transplanted crops, the sowing report shall be sent 15 days before flowering.

The producer shall clearly indicate on the reverse of sowing report, the exact location of the seed farm in a rough sketch with direction, distances marked form a permanent mark like mile stone, building, bridge, road, name of the farm if any, crops grown on all four sides of the seed farm etc, to facilitate easy identification of the seed farm by the seed certification officer.

The AD S.C, on receipt of the sowing report, scrutinizes & register the seed farm by giving a S.C number for each sowing report. Then he will send one copy of the sowing report to the S.C officer, one to the D.D.S.C & the third to the producer after retaining the fourth copy.

2. Verification of seed source

During his first inspection of seed farm the S.C officer, will verify whether the seed used to raise the seed crop is from an approved source.

3. Field Inspection

Objective

The objective in conducting field inspection is to verify the factors which can cause irreversible damage to the genetic purity or seed health.

Inspection Authority

The seed certification officer authorized by the registering authority shall attend to field inspections.

Crop stages for inspection

The number of field inspections and the stages of crop growth at which the field inspections should be conducted vary from crop to crop. It depends upon duration, and nature of pollination of the seed crop.

If the crop is grown for hybrid seed production, the no. of field inspections during the flowering stage should be more than in the case of self-pollinated / cross/ often cross pollinated varieties.

In hybrid seed production and variety seed production of cross pollinated crops, the inspection during flowering should be made without any prior notice of the seed grower to judge the quality of operation undertaken by him to maintain the genetic purity of the crop. But in the case of self-pollinated crops the seed grower may be informed about the date of inspection.

In the former case if prior notice is given to the seed grower, it may not be possible to detect the damage by the contaminants, whereas in the latter case prior notice will lead to improvement of the quality of the seed production work and thus the quality of seed.

The key points to be observed at each stage of inspection are

Stage of crop	Key points to be observed at Inspection
I.Pre-flowering stage (Vegetative stage)	Verification of seed source
	Confirmation of acreage given in the report
	Land requirement to keep check on genetic as well as physical contamination and spread of disease inoculums.
	Planting ratio
	Border rows
	Isolation distance
	Guide the grower in identification of Off-types, pollen shedder, diseased plants, shedding tassels etc.
II. Flowering Stages: **(May be II & III inspections, When 5% of plants begin to flower)**	Confirm the observation of plants inspection were correct.
	Confirm whether grower had continued thorough roguing, after the previous inspection.
	Verify the removal & occurrence of Off-types, pollen shedders, shedding tassels, objectionable weed plants & diseased plants.
III. Inspection during post flowering and pre-harvest stage	Confirm the correctness of observations, made in earlier inspections
	Guide the grower on roguing, based on pods, earhead, seed & chaff characters such as colour, shape & size
	Explain to the grower when & how to harvest the crop &

	process
IV. Inspection during harvest **(This is the last inspection conducted on a seed crop)**	Verify that male parent rows have been harvested separately.
	Ensure complete removal of off-types, other crops, weeds & diseased plants etc.
	Seal properly by the certification agency of the threshed produce after initial leaning & drying.
	Instruct the seed growers for safe storage & transportation.

MINIMUM NUMBER OF FIELD INSPECTIONS REQUIRED
FOR DIFFERENT CROPS FOR CERTIFICATION

Crop	**Minimum no. of inspection**	**Stages of crop**
Paddy & Wheat	2	Flowering to harvest
Sorghum Hybrid	4	Ist before flowering, II nd & IIIrd during flowering, IVth prior to harvest.
Varieties	3	Ist before flowering, II nd during flowering and IIIrd prior to harvest
Maize Inbred lines, Single crosses, Other hybrids	4	Ist before flowering Rest during flowering
Varieties	2	I st before flowering IInd during flowering
Bajra Hybrids	4	Ist before flowering II nd & IIIrd during flowering, IVth prior to or during harvest
Varieties	3	Ist before flowering IInd during 50% flowering IIIrd prior to harvest
Green gram,Black gram, Red gram Cowpea	2	Ist before flowering II nd at flowering & fruiting stage
Ground nut	2	Flowering to harvest
Sesame (Gingelly)	3	Ist before flowering II nd during flowering IIIrd from fruit maturity to harvest

Sunflower	2	Flowering to harvest
Rape & mustard	3	Ist before flowering II nd from flowering to fruiting IIIrd from fruit maturity to harvest
Soyabean	2	Flowering to harvest
Castor	2	Flowering to harvest
Cotton (Varieties) (Hybrids)	2 4	Flowering to harvest Ist before flowering II nd & IIIrd during flowering IVth during harvest
Brinjal, Tomato **Chilli, Bhendi**	3	Ist before flowering IInd from lowering to fruiting IIIrd during maturity
Carrot	3	Ist early (20-30 days after sowing), IInd when lifted & re-planted, IIIrd during flowering.
Cabbage	3	Ist before marketable stage IInd when the heads have formed IIIrd during flowering
Cauliflower	4	Ist before marketable stage IInd during curd formation IIIrd when most plants have formed curds IV th during flowering
Onion **(seed to seed)**	3	Ist during early vegetative stage IInd during bulb formation IIIrd during flowering

Field Counts

The purpose of field inspection is to find out field standards of various factors in the seed farm. It is impossible to examine all the plants in the seed farm. Hence, to assess the field standards of various factors random counting is followed.

The number of counts taken and the method employed in taking counts vary from crop to crop. It is necessary to take a minimum of 5 counts upto 5 acres & an additional count for every 5 acres or part thereof as given below:

Area of the field (in acres)	No. of counts to be taken
Upto 5	5
6-10	6
11-15	7
16-20	8
21-25	9

Double Count

In any inspection, if the first set of counts shows that the seed crop does not confirm to the prescribed standard for any factor, a second set of counts should be taken for that factor. However, when the first set of counts shows a factor more than twice the maximum permitted, it is not necessary to take a second count.

On completion of double count, assess the average for the two counts. It should not exceed the minimum permissible limit.

NO. OF PLANTS FOR A COUNT

S.no.	Crop	No. of plants / heads per count	Remarks
1.	Soyabean, Jute, Lucerne, Mesta, Berseem	1000 plants	Closely planted crops
2.	Beans, Cluster beans, Cowpea, Peas, Green gram, Blackgram, Mustard,Niger, Sesame, Bengal gram, Safflower	500 plants	Medium spaced crops
3.	Bhendi, Brinjal, Chilli, Castor, Cole crops, Cotton, Cucurbits, Maize, Potato, Groundnut, Redgram, Tomato & Sunflower	100 plants	Wide spaced crops
4.	Bajra, Barley, Oats, Paddy, Wheat, Ragi, Sorghum	1000 heads	Tillering crops

Points to be observed before counting

1. All plants falling in each count must be examined for each factor
2. In hybrid seed field, the prescribed number of the field counts should be taken in each parent separately.

Sources of contamination or factors to be observed

The contaminants are

1. Physical contaminants
2. Genetical contaminants.

    1. Physical contaminants are inseparable other crop plants, objectionable weed plants and diseased plants.
    2. Genetical contaminants consist of off-types, pollen shedders and shedding tassels.

a. Off Type

Plant that differs in morphological characters from the rest of the population of a crop variety. Off-type may belong to same spp. or different spp. of a given variety. Plants of a different variety are also included under off-types.

Volunteer plants & mutants are also off-types.

b. Volunteer Plant

Volunteer plants are the plants of the same kind growing naturally from seed that remains in the fields from a previous crop.

c. Pollen Shedders

In hybrid seed production involving male sterility, the plants of 'B' line present in 'A' line are called Pollen shedders.

Sometimes 'A' line tends to exhibit symptoms of fertile anthers in the ear heads of either on the main tiller or side tiller and these are called Partials. These partials are also counted as pollen shedders.

d. Shedding Tassels:These are plants which shed or shedding pollen in female parent rows. When 5 cm or more of the entire spike shed pollen they are also counted as Shedding tassels.

e. Inseparable Crop Plants

These are plants of different crops which have seeds similar to seed crop.

Crop	Inseparable crop plants
Wheat	Barley, oats, gram, & Triticale
Barley	Oats, gram, wheat & Triticale
Oats	Barley, gram, wheat & Triticale
Triticale	Wheat, barley, oats, gram & Rye

f. Objectionable Weed Plants

these are weeds

1. Whose seeds are difficult to be separated once mixed
2. Which are poisonous
3. Which have smothering effect on the main crop
4. Which are difficult to eradicate once established.
5. Difficult to separate the seeds. These seeds cause mechanical admixtures

S.No	Crop	Common name of the weed	Botanical name
1.	Paddy	Wild rice	*Oryza sativa var fatua*
2.	Wheat	Wild morning glory	*Convolvulus arvensis*
3.	Sunflower	Wild sunflower	*Helianthus spp*
4.	Bhendi	Wild okra	*Abelmoschus spp*
5.	Rape, mustard	Mexican prickly poppy	*Argemone mexicana*
6.	Lucerne	Dodder	*Cuscuta spp*

g. Designated Diseases

The diseases which may reduce the yield and quality of seeds are termed as Designated diseases.

S.No	Crop	Name of the Disease	Casual organism
1.	Wheat	Loose smut	Ustilago tritici
2.	Sorghum	Grain smut Head smut	*Sphacelotheca sorghii*
3.	Pearl millet	Ergot Grain smut Downy mildew	*Claviceps microcephala* *Tolyposporium pencillariae* *Sclerospora graminicola*
4.	Cowpea	Anthracnose	*Colletotrichum lindemuthianum*
5.	Green gram	Halo blight	*Pseudomonas phasiolicola*
6.	Gingelly	Leafspot	*Cercospora sesami*
7.	Sunflower	Downy mildew	*Plasmopara halstedii*
8.	Brinjal	Phomopsis blight	*Phomopsis vexans*
9.	Chilli	Leaf blight Anthracnose	*Alternaria solani* *Colletotrichum capsici*
10.	Tomato	Early blight Leaf spot Tobacco mosaic virus	*Alternaria solani* *Stemphylium solani* *(TMV)*

Land Requirement

The field offered for certified seed production should not been grown in the previous season with the same crop. If it was grown, the variety should be the same. In that case, the field should be irrigated at least 3 weeks before sowing and ploughed just prior to sowing, in order to destroy germinating seeds.

Isolation

Separation of seed fields from fields of other varieties of the same crop, same variety fields not conforming to varietal purity requirements, and other related species fields and fields affected by diseases to prevent genetic & disease contamination.

The minimum distance to be maintained between the seed crop and the contaminant is called Isolation distance.

Crop	F.S (m)	C.S (m)
Self pollinated crops **Cereals and Millets**		
Paddy	3	3
Wheat	3	3
Pulses		
Green gram	10	5
Black gram	10	5
Soya bean	3	3
Bengal gram	10	5
Cowpea	10	5
Lab lab	10	5
Oil Seeds		
Groundnut	3	3
Vegetables		
Tomato	50	25
Cluster beans	10	5
French beans	10	5
Peas	10	5
lettuce	50	25
Potato	5	5
Often Cross Pollinated crops Millet		
Sorghum Variety	200	100
Sorghum hybrid	300	200

Pulses		
Red gram	200	100
Oil Seeds		
Sesame	100	50
Cotton (variety)	50	30
Vegetables		
Brinjal	200	100
Chillies	400	200
Bhendi	400	200
Cross Pollinated Crops **Millets**		
Maize (varieties)	400	200
Inbred line	400	-
Single cross hybrid	400	-
Double cross hybrid	-	200
Bajra variety	400	200
Bajra hybrid	1000	200
Sun hemp	200	1000
Castor	300	150
Sunflower variety	400	200
Sunflower hybrid	600	400
Cabbage	1600	1000
Beetroot	1600	1000
Radish	1600	1000
Cauliflower	1000	500
Onion	1000	800
Carrot	400	200
Amaranthus	1000	500
Gourds		

Inspection Report

The seed certification officer after taking field counts and comparing them with the minimum field standards, the observations made on the seed farm field should be reported in the prescribed proforma to

1. Deputy Director of S.C
2. To the Seed producer
3. AD, S.C
4. Retained with him.

Assessment of seed crop yield

It is necessary to avoid malpractices at the final stage during harvest operation. The seed certification officer is expected to fix the approximate seed yield.

L.F.R REPORT (Liable For Rejection Report)

If the seed crop fails to meet with any one factor as per the standards, L.F.R report is prepared & the signature of the producer is obtained & sent to D.DSC within 24 hrs.

RE-Inspection

For the factors which can be removed without hampering the seed quality, the producer can apply for re-inspection to the concerned D.D,S.C within 7 days from the date of F.I rejection order. For re-inspection half of the inspection charge is collected.

4. Post Harvest Supervision Of Seed Crop

The post harvest inspection of a seed crop covers the operations carried out at the threshing floor, transport of the raw seed produce to the processing plant, pre-celeaning, drying, cleaning, grading, seed treatment, bagging & post processing storage of the seed lot.

Pre-requisites for processing

1. Processing report should accompany the seed lot
2. ODV test for paddy should be done at the time of sealing & issue of processing report or before processing. If the result exceeds 1% the produce may be rejected.
3. It should correlate with the estimated yield.
4. Seed should be processed only in approved processing unit.
5. Field run seed should be brought to the processing unit within 3 moths from the date of final inspection. Processing & sampling should be done within 2 months in oil seed crops & 4 months for other crops from the date of receipt in the processing unit. In cotton, the kapas from the passed lot should be moved to the ginning factory within 5 days from the date of issue of processing report. The ginning should be done within 3 months from the date of final harvest inspection report. Ginned seeds should be moved to seed processing unit within 5 days of ginning. Inspection and sampling should be done within 3 months after ginning.

Intake of Raw Produce & Lot Identification

The seed certification officer in-charge of the seed processing plant may, after verification of the above stated documents and total amount of seed accept the produce for processing. After verification he should issue a receipt to the seed grower. Each seed lot has to be allocated a separate lot number for identification.

Processing of seed lot

1. It is done to remove chaff, stones, stem pieces, leaf parts, soil particles etc from the raw seed lot.
2. Grading to bring out uniformity in the seed lot.
3. Seed treatment to protect it from storage pests & diseases.

Processing Inspection

1. The processing should be done in the presence of concerned seed certification officer.
2. The recommended sieve size should be used for grading.
3. While processing of paddy, the work of perfect processing has to be evaluated then & there.This is done by conducting a **float test**. Take 400 seeds from the processed seed & put into a tumbler of water. Count the floating paddy seeds. Maximum float admissible is 5%. If the float seeds exceed the limit, adjust the air flow or feeding to perfect the processing.
4. In maize, before shelling, the cobs should be examined for off-type and off -coloured kernels. Individual cobs should be examined with reference to its Varietal characters. The cobs of off-types and off-coloured kernels should be rejected.
5. Seed Sorting in Cotton.

The ginned seeds will be evaluated for its quality. A maximum of 3% for the following factors can be taken into account.

- Immature seeds
- Ill-filled seeds
- Broken seeds
- Stained seeds &
- Over fuzzy seeds.

Groundnut Pod Verification

- In groundnut 4% of ill-filled pods can be allowed.
- After processing, the seeds may be treated, packed, weighed & sealed before the SCO.

- The unit of packing may be equal to the seed rate of 1/2 or one acre or ha

5. Seed Sampling & Testing

During packaging S.C officer will draw samples according to ISTA Procedure & send the sample to ADSC concerned within a day of sampling. The ADSC will inturn send the sample to the STL within 3 days of receipt of the sample for testing seed standards viz. physical purity, germination, moisture content & seed health as prescribed. The STO will communicate the result to the ADSC concerned within 20 days.

On receipt of the analytical report, the ADSC will communicate the result to the producer & SCO.

6. Labelling, tagging, sealing and grant of certificate

After receiving the seed analytical report, the SCO will get the tag from the ADSC & affixes labels (producer's label) and tags **(Blue for C.S & White for F.S)** to the containers & sealed to prevent tampering and grant certificate fixing **a validity period for 9 months.**

Tagging should be done within 60 days of testing.

Resampling & Reprocessing

When a seed lot does not meet the prescribed seed standards in initial test, on request of the producer SCO may take resample.

If the difference in germination analysed & required is within 10, then straight away re-sampling can be done. If it is > 10, reprocessing & resampling may be done.

The producer should request the SCO concerned in writing within 10 days from the receipt of the result. No charge is collected for resampling.

When a seed lot, fails even after free sampling, reprocessing can be taken upon with special permission from D.S.C. For such reprocessing a fee of Rs. 20/- Q and lab charges of Rs. 10/- Q is collected.

Lecture 24
SEEDS ACT AND RULES

Introduction

The seed is an important agricultural input and it plays vital role in increasing production and productivity. There is a need to safeguard the farmers with the supply of genetically pure and quality seeds. Any new variety produced by the Scientist has to be multiplied many times to meet the needs of the farmers. In order to ensure the availability of quality seeds, Government of India have enacted Seeds act, 1966 and Seed rules, 1968. The seed (Control) order, 1983 was promulgated under essential commodities act, 1955 in order to ensure the production, marketing and equal distribution of the seeds.

Seeds Act, 1966

The object of Seed Act is to regulate the quality of certain notified kind / varieties of seeds for sale and for matters connected therewith. The seed act passed by the Indian Parliament in 1966 was designed to create a 'Climate' in which the seeds man could operate effectively and to make good quality seed available to cultivators. Seeds rule under the act were notified in September 1968 and the act was implemented entirely in October, 1969. This act extent to the whole of India and it has 25 sections.

Seed legislation could broadly be divided into two groups

1. Sanctioning legislation

Sanctioning legislation authorizes formation of Advisory bodies, Seed Certification Agencies, Seed Testing laboratories, Foundation and Certified Seed Programmes, Recognition of Seed certification Agencies of Foreign countries Appellate authorities etc.

2. Regulatory legislation

Regulatory Legislation controls the quality of seeds sold in the market including suitable agencies for regulating the seed quality. On quality control basis, the Seeds Act could conveniently be divided into the following:

I. Minimum limit and labeling of the notified kind / varieties of seed

a. Power to notify the kind / variety
b. Labeling provisions
c. Seed testing
d. Seed analyst
e. Seed inspectors
f. Penalty
g. General provisions

II. Seed Certification

III. Restriction of Import and Export of Seeds

I. Minimum limits and labeling

Quality control as envisaged in the Act is to be achieved through pre and post marketing control, voluntary certification and compulsory labeling of the seeds of notified kind / varieties.

(a) Power to notify the kind / varieties

New varieties evolved by the State Agricultural Universities and ICAR institutes are notified and released /notified respectively under section 5 of the seeds act in consultation with the central seed committee and its sub committees constitute under section 3 and 3(5) of the Seeds Act. As on date more than 2500 varieties and 130 varieties were notified and denotified under this section. List of varieties notified and denotified from 1969 to 2005 are compiled and made available in the form of a book called catalogue of varieties notified and denotified under section 5 of the Seeds Act. Functions of the Central Seed Committee and its sub-committee are defined in Clauses 3 and 4 of part II of seed rule.

(b) Labeling provision

Minimum limits for germination, physical purity and genetic purity of varieties / hybrids for crops have been prescribed and notified for labeling seeds of notified kind / varieties under section 6(a) of the Seeds Act. Size of the label, colour of the label and content of the label were also notified under sub clause (b) of Section 6 of Seeds Act. Colour of the label is opel green and size of the label is 10 cm x 15 cm or proportionate thereof. Responsibility for making labeling content of mark or label, manner of marking, false / misleading statement on label etc., are defined under clause 7,8,9,10,11 and 12 of part V of seeds rule.

Section 7 of the act regulates the sale of notified kind or varieties. Accordingly no person shall keep for sale, offer to sell, barter or otherwise supply any seed of any notified kind or variety, after the dates recorded on the container mark or label as the date unto which the seed may expected to retain the germination not less than prescribed under clause (a) of section 6 of the Act.

(c) Seed Testing

There is a provision to set up a central seed laboratory and state seed laboratory to discharge functions under section 4(1) and 4(2) of the Seed Act, In the year 1968 there were 23 state seed testing laboratories in the country. At present there are 86 Seed testing laboratories functioning in the country. During 1995-96 these laboratories tested about 5 lakh samples. Seed testing laboratories have been assigned certain important functions under part III (5) of Seed Rule.

(d) Seed Analysts

State Government could appoint the Seed Analysts through notification in the Official Gazette under Section 12 of the Seed Act defining his area and his jurisdiction. Seed Analyst should posses certain minimum qualification as prescribed under clause 20 part IX of Seed Rule.

(e)Seed Inspectors

Classes of seed

The State Government, under section 13 of the Act may appoint such a person as it thinks fit, having prescribed qualification (Clause 22 part IX of Seed Rule) through notification, as a Seed

Inspector and define the areas within which he shall exercise jurisdiction for enforcing the seed law. He will be treated as a public servant within a meaning of section 21 of the I.P.C. (45 of 1860). He has power to examine records, register document of the seed dealer. He will also exercise such other powers as may be necessary for carrying out the purposes of this Act or rule made there under. Duties of Seed inspectors are defined in clause 23 of part IX of Seed rule. He can issue, stop sale order in case the seed in question contravenes the provision of relevant Act and rules for which he can use form No.III. When he seizes any record, register documents or any other material , he should inform a magistrate and take his order for which he can use form No.IV.

(f)Penalty

If any person, contravenes any provision of the Act or Rule, or prevents a seed inspector from taking sample under this Act or prevents a Seed Inspector from exercising any other power conferred on him could be punished under section 19 of the act with a fine of five hundred rupees for the first offence. In the event of such person having been previously convicted of an offence under this section with imprisonment for a term, may extend to six months or with fine, which may extent to one thousand rupees or with both.

II. Seed certification

The object of the Seed Certification is to maintain and make available to the public through certification high quality propagating material of notified kind / varieties so grown and distributed as to ensure genetic identity and genetic purity. The certified standards in force are Indian Minimum seed certification standards and seed certification procedures form together for the seed certification regulations. Seeds of only those varieties which are notified under section under Section 5 of the seeds act shall be eligible for certification.

- Breeder seed
- Foundation seed
- Certified Seed

Breeder seed

- Breeder seed is a seed directly controlled by the breeder.
- Breeder seed should be genetically so pure as to guarantee that in the subsequent generation.
- Breeder seed could not come under the perview of seed certification as it is not meant for public sale.
- Breeder seed should be packed and supplied with breeder's golden yellow stag as per the guideline given in Indian Minimum Seed Certification standards. It is also the fact that no standard for breeder seed have been prescribed.

Foundation seed

- Foundation class of seed and certified class of seed are to be certified by the Certification Agencies as per the Indian Minimum Seed Certification Standards.
- Section 8 of the Seeds Act provide state government or the Central Government consultation with State Government may be notification in official gazette, established certification agencies for the state to carry out the functions entrusted to certification agency by or under this Act (Part IV, clause 6, part VI clause 14 of Seeds Rule).

Certified seed

- Seed act section 9 provides any person desires of producing certified seed shall register his name with concerned seed certification agency duly remitting the prescribed fee in form No.1 for grant of certificate. Certificate could be granted in form No.11 after meeting the requirement of certification agency prescribed under Part VII clause 15,16 and 17 of Seed rule.
- It should have the minimum genetical purity of 99%
- Certified seed may be the progeny of certified seed , provided this reproduction does not exceed two generations beyond foundation seed and provided that if certification agency determines the genetic and physical purity, if not be significantly altered
- In case of highly self pollinated crops certification of one further generation may be permitted
- Certified seed produced from certified seed ,shall be eligible for further seed increase under certification, except in case of highly self pollinated crops, where certification of one further generation may be permitted
- Certification tags issued once for certified seed not eligible for further seed increase under certification
- For paddy and wheat, certified seed produced from certified seed is eligible for certification by NSC up to two generations from foundation seed

Seed (Control) Order, 1983

III. Restriction of Export and Import of Seeds
There is a provision to restrict export and import of seeds of notified kinds or varieties.
The **section 17** defines as under "No person shall for the purpose of sowing or planting by any person (including himself) export or import or cause to be exported or imported any seed of any notified kind or variety unless.

- It conforms to the minimum limits of germination and purity specified for that seed under clause (a) of Section 6 and

- Its container bears in the prescribed manner the mark or label with the correct particular thereof specified for that seed under clause (b) of section 6.

Background of the case

The Ministry of civil supplies through an order dated 24.4.1983 had declared the seed for sowing or planting materials of food crops, fruits, vegetables, cattle fodder and jute to be essential commodities in exercise of power conferred by Section 2(a) (viii) of Essential Commodities Act, 1955. It was followed by the issue of Seed (control) order dated 30th December, 1983 by the Ministry of Agriculture, Dept. of Agriculture and Co-operation in exercise of powers contained in section 3 of Essential Commodities Act, which deals with Central Governments power to control, and regulate production, supply and distribution of essential commodities.

The Seed (control) order, 1983 had been notified as per Gazette notification, G.S.R 832(E) dated 30. 12.1983. The notification under reference holds good and remains operative. Joint Secretary (Seeds), Government of India, Ministry of Agriculture, Department of Agriculture and Cooperation has been appointed as Seed Controller for implementation of seed (control) order.

Gist of the Seed (Control) order, 1983

Issue of License to dealers

All persons carrying on the business of selling, exporting and importing seeds will be required to carry on the business in accordance with terms and conditions of license granted to him for which dealer has to make an application in duplicate in Form 'A' together with a fee of Rs.50/- for license to licensing authority unless the State Government by notification exempts such class of dealers in such areas and subject to such conditions as may be specified in the notification.

Based on such enquiry as it thinks fit for licensing authority may grant in form 'B' or refuse in provisions of the Order. The refusal to grant license shall be accompanied by clear recording of reasons for such refusal.

Renewal of License

A holder of license shall be eligible for renewal upon and applicable being made in the prescribed form 'C' (in duplicate) together with a fee of rupees twenty before the expiry of license or at the most within a month of date of expiry of license for which additional fee of Rs.25/- is required to be paid.

Appointing of Licensing authority

The state government may appoint such number of persons as it thinks necessary to be inspector and define the area of such Inspector's jurisdiction through notification in the official gazette.

Time limit for analysis of samples by Seed testing lab

Time limit for analysis of samples by seed testing lab and suspension / cancellation of license may be done by Licensing authority after giving an opportunity of being heard to the holder of license, suspend or cancel the license on grounds of mis-representation of a material in

particular or contravention in provision of the order.

Suspension / Cancellation of license

The Licensing authority may after giving an opportunity of being held to the holder of license, suspend or cancel the license on grounds of mis-representation of material in particular or contravention in provision of the Order.

Appeal

The state government may specify authority for hearing the appeals against suspension / cancellation under this order and the decision of such authority shall be final. Any person aggrieved by an order of refusal to grant or amend or renew the license for sale, export / import of seed may within 60 days from the date of Order appeal to the designated authority in the manner prescribed in the Order.

Miscellaneous

The licensing authority may on receipt of request in writing together with Rs.10/- can amend the license of such dealer. Every seed dealer are expected to maintain such books, accounts and records to this business in order and submit monthly return of his business for the preceding months in Form 'D' to the licensing authority by 5th day of every month

The Seeds Act, 1966

(Act No.54 of 1966) [29th December, 1966]

An Act to provide for regulating the quality of certain seeds for sale, and for matters connected therewith.

It is enacted by Parliament in the Seventeenth Year of the Republic of India as follows:

Short Title, Extent and Commencement

1. (1)This Act may be called the Seeds Act, 1966.

(2)It extends to the whole of India.

(3) It shall come into force on such date as the Central Government may, by notification in the Official Gazette, appoint, and different dates may be appointed for different provisions of this Act, and for different States or for different areas thereof.

Definitions

2. In this Act, unless the context otherwise requires,

1. "Agriculture" includes horticulture;
2. "Central Seed Laboratory" means the Central Seed Laboratory established or declared as such under sub-section (1) of section 4;
3. "Certification agency" means the certification agency established under Section 8 or recognised under Section 18;
4. "Committee" means the Central Seed Committee constituted under sub-section (1) of Section 3;
5. "Container" means a box, bottle, casket, tin, barrel, case, receptacle, sack, bag, wrapper or other thing in which any article or thing is placed or packed;
6. "Export" means taking out of India to a place outside India;

7. "Import" means bringing into India from a place outside India;
8. "Kind" means one or more related species or sub-species of crop plants each individually or collectively known by one common name such as cabbage, maize, paddy and wheat;
9. "notified kind or variety" , in relation to any seed, means any kind or variety thereof notified under Section 5;
10. "Prescribed" means prescribed by rules made under this act;
11. "seed" means any of the following classes of seeds used for sowing or planting-

- seeds of food crops including edible oil seeds and seeds of fruits and vegetables;
- cotton seeds;
- seeds of cattle fodder;

and includes seedlings, and tubers, bulbs, rhizomes, roots, cuttings, all types of grafts and other vegetatively propagated material, of food crops or cattle fodder;

12. "Seed Analyst" means a Seed Analyst appointed under section 12;
13. "Seed Inspector" means a Seed Inspector appointed under section 13;
14. "State Government", in relation to a Union territory, means the administrator thereof;
15. "State Seed Laboratory", in relation to any State, means the State Seed Laboratory established or declared as such under sub-section (2) of section 4 for that State; and
16. "Variety" means a sub-division of a kind identifiable by growth, yield, plant, fruit, seed, or other characteristic.

Central Seed Committee

3. (1) The Central Government shall, as soon as may be after the commencement of this Act, constitute a Committee called the Central Seed Committee to advise the Central Government and the State Governments on matters arising out of the administration of this Act and to carry out the other functions assigned to it by or under this Act.

2. The Committee shall consist of the following members, namely:-

- a Chairman to be nominated by the Central Government;
- eight persons to be nominated by the Central Government to represent such interests that Government thinks fit, of whom not less than two persons shall be representatives of growers of seed;
- One person to be nominated by the Government of each of the States.

(3) The members of the Committee shall, unless their seats become vacant earlier by resignation, death or otherwise, be entitled to hold office for two years and shall be eligible for renomination.
(4) The Committee may, subject to the previous approval of the Central Government, make bye-laws fixing the quorum and regulating its own procedure and the conduct of all business to be transacted by it.
(5) The Committee may appoint one or more sub-committees, consisting wholly of members of the Committee or wholly of other persons or partly of members of the Committee and partly of other persons, as it thinks fit, for the purpose of discharging such of its functions as may be delegated to such sub-committee or sub-committees by the Committee.
(6) The functions of the Committee or any sub-committee thereof may be exercised notwithstanding any vacancy therein.
(7) The Central Government shall appoint a person to be the secretary of the Committee and shall provide the Committee with such clerical and other staff as the Central Government considers necessary.

Central Seed Certification Board

"8A. ,(1) The Central Government shall, by notification in the Official Gazette, establish a Central Seed Certification Board (hereinafter referred to as the Board) to advise the Central
Government and the State Governments on all matters relating to certification and to co-ordinate
the functioning of the agencies established under section 8.

(2) The Board shall consist of the folJowing members, namely:-

(i) a Chairman, to be nominated by the Central Government;

lii) four members, to be nominated by the Central Government from out of the persons employed by th~ State Governments as 'Directors 'of Agriculture;

(iii) three members, to be nominated by the Central Government from out of the persons employed by the Agricultural Universities as Directors of Research;

(iv) thirteen persons, to be nominated by the Central Government to represent such interests as that Government thinks fit, of whom not less than four persons shall be representatives of seed producers or tradesmen.

(3) A member of the Board shall, unless his s~at becomes vacant earlier by resignation or otherwise - be entitled to hold officefor two years from the date of his nomination:

Provided that a person nominated under clause *(if)* or clause *(iii)* of sub-section (2) shall hold office only for so long as he holds the appointment by virtue of which his nomination was made.

Central Seed Laboratory and State Seed Laboratory

4. (1) The Central Government may, by notification in the Official Gazette, establish a Central Seed Laboratory or declare any seed laboratory as the Central Seed Laboratory to carry out the functions entrusted to the Central Seed Laboratory by or under this Act.

(2) The State Government may, by notification in the Official Gazette, establish one or more State Seed Laboratories or declare any seed laboratory as a State Seed Laboratory where analysis of seeds of any notified kind or variety shall be carried out by Seed Analysts under this Act in the prescribed manner.

Power to notify kinds or varieties of seeds

5. If the Central Government, after consultation with the Committee, is of opinion that it is necessary or expedient to regulate the quality of seed of any kind or variety to be sold for purposes of agriculture, it may, by notification in the Official Gazette, declare such kind or variety to be a notified kind or variety for the purposes of this Act and different kinds or varieties may be notified for different States or for different areas thereof.

Power to specify minimum limits of germination and purity, etc.

6. The Central Government may, after consultation with the Committee and by notification in the Official Gazette, specify-

a. the minimum limits of germination and purity with respect to any seed of any notified kind or variety;
b. the mark or label to indicate that such seed conforms to the minimum limits of germination and purity specified under clause (a) and the particulars which such mark or label may contain.

Regulation of sale of seeds of notified kinds or varieties

7. No person shall, himself or by any other person on his behalf, carry on the business of selling, keeping for sale, offering to sell, bartering or otherwise supplying any seed of any notified kind or variety, unless-

a. such seed is identifiable as to its kind or variety;
b. such seed conforms to the minimum limits of germination and purity specified under clause (a) of section 6;

c. the container of such seed bears in the prescribed manner, the mark or label containing the correct particulars thereof, specified under clause (b) of section 6; and
d. he complies with such other requirements as may be prescribed.

Certification agency

8. The State Government or the Central Government in consultation with the State Government may, by notification in the Official Gazette, establish a certification agency for the State to carry out the functions entrusted to the certification agency by or under this Act.

Grant of certificate by certification agency

9. (1) Any person selling, keeping for sale, offering to sell, bartering or otherwise supplying any seed of any notified kind or variety may, if he desires to have such seed certified by the certification agency, apply to the certification agency for the grant of a certificate for the purpose.

(2) Every application under sub-section (1) shall be made in such form, shall contain such particulars and shall be accompanied by such fees as may be prescribed.

(3) On receipt of any such application for the grant of a certificate, the certification agency may, after such enquiry as it thinks fit and after satisfying itself that the seed to which the application relates conforms to the minimum limits of germination and purity specified for that seed under clause (a) of section 6, grant a certificate in such form and on such conditions as may be prescribed.

Revocation of certificate

10. If the certification agency is satisfied, either on a reference made to it in this behalf or otherwise, that-

a. the certificate granted by it under section 9 has been obtained by misrepresentation as to an essential fact; or
b. the holder of the certificate has, without reasonable cause, failed to comply with the conditions subject to which the certificate has been granted or has contravened any of the provisions of this Act or the rules made thereunder;

then, without prejudice to any other penalty to which the holder of the certificate may be liable under this Act, the certification agency may, after giving the holder of the certificate an opportunity of showing cause, revoke the certificate.

Appeal

11. (1) Any person aggrieved by a decision of a certification agency under section 9 or section 10, may, within thirty days from the date on which the decision is communicated to him and on payment of such fees as may be prescribed, prefer an appeal to such authority as may be specified by the State Government in this behalf:

Provided that the appellate authority may entertain an appeal after the expiry of the said period of thirty days if it is satisfied that the appellate was prevented by sufficient cause from filing the appeal in time.

(2) On receipt of an appeal under sub-section (1), the appellate authority shall, after giving the appellant an opportunity of being heard, dispose of the appeal as expeditiously as possible.

(3) Every order of the appellate authority under this section shall be final.

Seed Analysts

12. The State Government may, by notification in the Official Gazette, appoint such persons as it thinks fit, having the prescribed qualifications, to be Seed Analysts and define the areas within which they shall exercise jurisdiction.

Seed Inspectors

13. (1) The State Government may, by notification in the Official Gazette, appoint such persons as it thinks fit, having the prescribed qualifications, to be Seed Inspectors and define the areas within which they shall exercise jurisdiction.

(2) Every Seed Inspector shall be deemed to be a public servant within the meaning of section 21 of the Indian Penal Code (45 of 1860) and shall be officially subordinate to such authority as the State Government may specify in this behalf.

Powers of Seed Inspector

14. (1) The Seed Inspector may-

2. take samples of any seed of any notified kind or variety from-
    3. any person selling such seed; or
    4. any person who is in the course of conveying, delivering or preparing to deliver such seed to a purchaser or a consignee; or
    5. a purchaser or a consignee after delivery of such seed to him;
    6. send such sample for analysis to the Seed Analyst for the area within which such sample has been taken;
    7. enter and search at all reasonable times, with such assistance, if any, as he considers necessary, any place in which he has reason to believe that an offence under this Act has been or is being committed and order in writing the person in possession of any seed in respect of which the offence has been or is being committed, not to dispose of any stock of such seed for a specific period not exceeding thirty days or, unless the alleged offence is such that the defect may be removed by the possessor of the seed, seize the stock of such seed;
    8. examine any record, register, document or any other material object found in any place mentioned in clause (c) and seize the same if he has reason to believe that it may furnish evidence of the commission of an offence punishable under this Act; and

9. exercise such other powers as may be necessary for carrying out the purposes of this Act or any rule made thereunder.

(2) Where any sample of any seed of any notified kind or variety is taken under clause (a) of sub-section (1), its cost, calculated at the rate at which such seed is usually sold to the public, shall be paid on demand to the person from whom it is taken.
(3) The power conferred by this section includes power to break-open any container in which any seed of any notified kind or variety may be contained or to break-open the door of any premises where any such seed may be kept for sale:
Provided that the power to break-open the door shall be exercised only after the owner or any other person in occupation of the premises, if he is present therein, refuses to open the door on being called upon to do so.
(4) Where the Seed Inspector takes any action under clause (a) of sub-section (1), he shall, as far as possible, call not less than two persons to be present at the time when such action is taken and take their signatures on a memorandum to be prepared in the prescribed form and manner.
(5) The provisions of the Code of Criminal Procedure, 1898 (5 of 1898), shall, so far as may be, apply to any search or seizure under this section as they apply to any search or seizure made under the authority of a warrant issued under section 98 of the said Code.

Procedure to be followed by Seed Inspectors

15. (1) Whenever a Seed Inspector intends to take sample of any seed of any notified kind or variety for analysis, he shall-

10. give notice in writing, then and there, of such intention to the person from whom he intends to take sample;
11. except in special cases provided by rules made under this Act, take three representative samples in the prescribed manner and mark and seal or fasten up each sample in such manner as its nature permits.

(2) When samples of any seed of any notified kind or variety are taken under sub-section (1), the Seed Inspector shall-

12. deliver one sample to the person from whom it has been taken;
13. send in the prescribed manner another sample for analysis to the Seed Analyst for the area within which such sample has been taken; and
14. retain the remaining sample in the prescribed manner for production in case any legal proceedings are taken or for analysis by the Central Seed Laboratory under sub-section (2) of section 16, as the case may be.

(3) If the person from whom the samples have been taken refuses to accept one of the samples, the Seed Inspector shall send intimation to the Seed Analyst of such refusal and thereupon the Seed Analyst receiving the sample for analysis shall divide it into two parts and shall seal or fasten up one of those parts and shall cause it, either upon receipt of the sample or when he delivers his report, to be delivered to the Seed Inspector who shall retain it for production in case legal proceedings are taken.

(4) Where a Seed Inspector takes any action under clause (c) of sub-section (1) of section 14:

15. he shall use all despatch in ascertaining whether or not the seed contravenes any of the provisions of section 7 and if it is ascertained that the seed does not so contravene, forthwith revoke the order passed under the said clause or, as the case may be, take such action as may be necessary for the return of the stock of the seed seized;

16. if he seizes the stock of the seed, he shall, as soon as may be, inform a magistrate and take his orders as to the custody thereof;

17. without prejudice to the institution of any prosecution, if the alleged offence is such that the defect may be removed by the possessor of the seed, he shall, on being satisfied that the defect has been so removed, forthwith revoke the order passed under the said clause.

(5) Where as Seed Inspector seizes any record, register, document or any other material object under clause (d) of sub-section (1) of section 14, he shall, as soon as may be, inform a magistrate and take his orders as to the custody thereof.

Report of Seed Analyst

16.(1) The Seed Analyst shall, as soon as may be after the receipt of the sample under sub-section (2) of section 15, analyse the sample at the State Seed Laboratory and deliver, in such form as may be prescribed, one copy of the report of the result of the analysis to the Seed Inspector and another copy thereof to the person from whom the sample has been taken.

(2) After the institution of a prosecution under this Act, the accused vendor or the complainant may, on payment of the prescribed fee, make an application to the court for sending any of the samples mentioned in clause (a) or clause (c) of sub-section (2) of section 15 to the Central Seed Laboratory for its report and on receipt of the application, the court shall first ascertain that the mark and the seal or fastening as provided in clause (b) of sub-section (1) of section 15 are intact and may then despatch the sample under its own seal to the Central Seed Laboratory which shall thereupon send its report to the court in the prescribed form within one month from the date of receipt of the sample, specifying the result of the analysis.

(3) The report sent by the Central Seed Laboratory under sub-section (2) shall supersede the report given by the Seed Analyst under sub-section (1).

(4) Where the report sent by the Central Seed Laboratory under sub-section (2) is produced in any proceedings under Section 19, it shall not be necessary in such proceedings to produce any sample or part thereof taken for analysis.

Restriction on export and import of seeds of notified kinds or varieties

17. No person shall, for the purpose of sowing or planting by any person (including himself), export or import or cause to be exported or imported any seed of any notified kind or variety, unless-

a. it conforms to the minimum limits of germination and purity specified for that seed under clause (a) of section 6; and
b. its container bears, in the prescribed manner, the mark or label with the correct particulars thereof specified for that seed under clause (b) of section 6.

Recognition of seed certification agencies of foreign countries

18. The Central Govt. may, on the recommendation of the Committee and by notification in the Official Gazette, recognise any seed certification agency established in any foreign country, for the purposes of this Act.

Penalty

3. If any person-
   4. contravenes any provision of this Act or any rule made thereunder; or
   5. prevents a Seed Inspector from taking sample under this Act;**or**
   6. prevents a Seed Inspector from exercising any other power conferred on him by or under this Act;

he shall, on conviction, be punishable-

7. for the first offence with fine which may extend to five hundred rupees, and
   8. in the event of such person having been previously convicted of an offence under this section, with imprisonment for a term which may extend to six months, or with fine which may extend to one thousand rupees, or with both.

Forfeiture of property

9. When any person has been convicted under this Act for the contravention of any of the provisions of this Act or the rules made thereunder, the seed in respect of which the contravention has been committed may be forfeited to the Government.

Offences by companies

21. (1) Where an offence under this Act has been committed by a company, every

person who at the time the offence was committed was in charge of, and was responsible to the company for the conduct of the business of the company, as well as the company, shall be deemed to be guilty of the offence and shall be liable to be proceeded against and punished accordingly:

Provided that nothing contained in this sub-section shall render any such person liable to any punishment under this Act if he proves that the offence was committed without his knowledge and that he exercised all due diligence to prevent the commission of such offence.

(2) Notwithstanding anything contained in sub-section (1), where an offence under this Act has been committed by a company and it is proved that the offence has been committed with the consent or connivance of, or is attributable to any neglect on the part of, any director, manager, secretary or other officer of the company, such director, manager, secretary or other officer shall also be deemed to be guilty of that offence and shall be liable to be proceeded against and punished accordingly.

Explanation. – For the purpose of this section,-

10. "company" means any body corporate and includes a firm or other association of individuals; and

11. "director", in relation to a firm, means a partner in the firm.

Protection of action taken in good faith

22. No suit, prosecution or other legal proceeding shall lie against the Government or any officer of the Government for anything which is in good faith done or intended to be done under this Act.

Power to give directions

23. The Central Government may give such directions to any State Government as may appear to the Central Government to be necessary for carrying into execution in the State any of the provisions of this Act or of any rule made there under.

Exemption

24. Nothing in this Act shall apply to any seed of any notified kind or variety grown by a person and sold or delivered by him on his own premises direct to another person for being used by that person for the purpose of sowing or planting.

Power to make rules

25. (1) The Central Government may, by notification in the Official Gazette, make rules to carry out the purpose of this Act.

(2) In particular and without prejudice to the generality of the fore-going power, such rules may provide, for-

12. the functions of the Committee and the travelling and daily allowances payable to members of the Committee and members of any sub-committee appointed under sub-section (5) of section 3;

13. the functions of the Central Seed Laboratory;
14. the functions of a certification agency;
15. the manner of marking or labeling the container of seed of any notified kind or variety under clause (c) of Section 7 and under clause (b) of section 17;
16. the requirements which may be complied with by a person carrying on the business referred to in section 7;
17. the form of application for the grant of a certificate under section 9, the particulars it may contain, the fees which should accompany it, the form of the certificate and the conditions subject to which the certificate may be granted;
18. the form and manner in which and the fee on payment of which an appeal may be preferred under section 11 and the procedure to be followed by the appellate authority in disposing of the appeal;
19. the qualifications and duties of Seed Analysts and Seed Inspectors;
20. the manner in which samples may be taken by the Seed Inspector, the procedure for sending such samples to the Seed Analyst or the Central Seed Laboratory and the manner of analyzing such samples;
21. the form of report of the result of the analysis under sub-section (1) or sub-section (2) of section 16 and the fees payable in respect of such report under the said sub-section (2);
22. the records to be maintained by a person carrying on the business referred to in section 7 and the particulars which such records shall contain; and
23. any other matter which is to be or may be prescribed.

(3) Every rule made under this Act shall be laid as soon as may be after it is made, before each House of Parliament while it is in session for a total period of thirty days which may be comprised in one session or in two successive sessions, and if, before the expiry of the session in which it is so laid or the session immediately following, both Houses agree in making any modification in the rule or both Houses agree that the rule should not be made, that rule shall, thereafter have effect only in such modified form or be of no effect, as the case may be; so however, that any such modification or annulment shall be without prejudice to the validity of anything previously done under that rule.

New seed policy {1988}

The Government of India evolved a New seed policy implemented **from October 1, 1988.**

The policy laid special emphasis on

- Import of high quality of seeds
- A time bound programme to modernize plant quarantine facilities
- Effective implementation of procedures for quarantine /post entry quarantine and
- Incentives to encourage the domestic industry
- Import of quality seeds.

a. Bulk import of seeds of coarse cereals, pulses and oil seeds may replace (or) displace the local productions.
b. Transfer of technology may not be actual one, because due to bulk import of seeds or import of technology, instead we can import the germplasm of superior variety if any and could be developed locally to meet the demand (i.e.,) incorporate the advantages of exotic variety to the local types(or) even direct multiplication's after adaptive trials.
c. As we have superior varieties of international standard (e.g.) Maize, Sorghum, Bajra, or even in oil seeds like groundnut etc., the bulk import is not necessiated. Instead we need varieties suitable to agroclimatic zones besides higher yields.
d. Import of flower seeds could be encouraged in order to earn foreign exchange through export of flowers and it can be imported under (OGL) open general license. But there is a fear of introduction of new pest and diseases as they are coming without post entry quarantine checkup.

Strengthening of quarantine

Since, 1st October 1988 only bulk import of seeds was under taken without any progress either in the strengthening of quarantine facilities.

Threat of pest and disease

Introduction of new pest and disease would pose a new problem due to bulk import due to lack of post entry quarantine. To avoid this threat, the imported seeds should be subjected to testing and it should be done by one person from ICAR. Entry of exotic variety without proper field testing may change the disease pattern if that particular strain is becoming susceptible to existing pathogens.

(e.g.) Kernal burnt - which was not noticed in the previous years is now a major disease on wheat after the introduction of Kalyansona.

Genetic erosion

It is another danger, due to introduction of similar strains there is a danger of genetic

uniformity and eliminates local diversified strains which leads to problem of non-availability of improved strains if there is any outbreak of disease.

Incentives to domestic seed industry

Indigenous seed production / seed industry will be affected because of the entry of multi nation diseases. Since the policy is allowing indiscriminate bulk imports through private sectors at the same time the import duty on seeds has been reduced to 15 per cent. Import duty on advanced machines and equipment used in seed production or processing has also been reduced and interest on post shipment credit has also been slashed down to help importers. Income tax rebate and deduction are available to the taxpaying units on the revenue expenditure or in house research and development. Incentives are also being provided to seeds located in backward areas and growth centers.

Application of biotechnology in agriculture

The multination would prevent the III world countries in enjoying the full benefit of biotechnology. The bulk import of seed indicates accepting the monopoly rights and the limitation of potential bio-technology in agriculture.

Advantages of biotechnology in agriculture

Certain plants fertilize themselves through nitrogen fixation, which is one of the most promising areas of genetic engineering. Bacterium on the roots of plants like groundnut, and soyabean take nitrogen from the air and transform it into nitrates. Scientists are studying the possibility of transforming the genes responsible for nitrogen fixation in wheat, rice, and maize (in which nitrogen fixation doses not occur). They feel new strains can be grown without expensive chemical fertilizers.

Plant variety protection (PVP) and the Indian agriculture (Protection of Plant Variety & farmers right Bill,2001)

The Intellectual Property Rights (IPRs) are generally being applicable to industrial property only. The patent laws of India did not provide for IPRs on living organisms including plant varieties. The question of plant variety protection has been brought in to sharp focus by Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS) which is a part of Agreement establishing World Trade Organization (WTO). India is a signatory to TRIPS agreement, which casts an obligation on member countries to provide for a system of plant variety protection either through patents or through a *sui generis* legislation framework or a combination thereof. Under these agreements, a legislative framework for plant variety protection has to be provided by member countries within a specified time period. While this has lent some urgency to the question of plant variety protection, the question of plant variety rights, even independent of the obligations posed by TRIP's agreement, has been under active consideration in view of our strong agricultural research system. The plant breeding programmes have become more sophisticated and high input based. The extent of

investment by the State on public research, in evolving varieties of commercial significance, is coming down with responsibility of evolving new varieties of crops of commercial significance being left to the private sector commercial organisations. There is also a move on the part of the international research institutions, who at one time played a pioneering role in plant breeding and genetic work, to focus on pure or strategic research. In the wake of the global economic liberalization, it is only expected that agriculture is accorded the status of an industry and given all incentives and impetus, normally required for a fast developing, competitive business. To meet our food demands, as well as to exploit our export potential in agricultural commodities, development and use of new plant varieties having specific agronomic nutritive or market preference characteristics are essential. New varieties may be bred for higher yields, greater resistance to biotic and abiotic stresses, longer shelf life, better consumer preference, higher industrial value, low input requirements and so on. To meet these demands the variety improvement activities based on conventional as well as biotechnological methods requires heavy investments both in scientific, man power and economic terms. It is therefore, understandable that the fruits of such intensive efforts will have to be protected from misuse, and also ensuring an appropriate incentive (reward) to the breeder.

The following are the plant variety protection steps:

1. Historical developments of plant variety protection

For over 60 years, different forms of protection of new plant varieties through the system of Plant Breeders' Right (PBR's) have been in existence in industralised countries which essentially means that the holder of the PBR can prevent others from producing propagating material of the protected variety and / or marketing the same. In order to coordinate inter country implementation of PBR a " Union Internationale Pour La Protection Des Obtention Vegetables" (UPOV) was established by International Convention for Protection of New Varieties of plants (the UPOV convention), which was signed in Paris in 1961. The convention entered into force in 1968. It was revised in 1972, 1978 and 1991. The 1978 Act entered into force in 1981. The 1991 act has not yet entered into force.

The purpose of UPOV convention is to ensure that the member States of the Union acknowledge the achievements of breeder of new plant varieties by making available to them exclusive property rights, on the basis of a set of uniform and clearly defined principles. To be eligible for protection, varieties have to be (I) distinct from existing known varieties (ii) sufficiently homogenous (uniform) (iii) stable and (iv) new in the sense that they must not have commercialised prior to certain dates established by reference to the date of the application for protection.

2. Scope of protection of plant varieties under UPOV convention

Both the 1978 and 1991 conventions set out a minimum scope of protection offer to member states for the possibility of taking national circumstances into account in their

legislation. Under 1978 Act, the minimum scope of the Plant Breeders' right requires that the holders' authorization for the production for purposes of commercial marketing, the offering for sale and marketing of propagating material of protected variety.

The 1991 Act contains more detailed provision defining the acts concerning propagating material in relation to which holders' authorization is required. Exceptionally, but only where the holder has no reasonable opportunity to exercise his right in relation to the propagating material, his authorization may be required in relation to any specified acts done with harvested material of the variety.

3. Duration of plant breeder's rights

Like all intellectual property rights, plant breeder's rights are granted for a limited period of time (15-20 years) at the end of which varieties protected by them pass into public domain. The rights are also subject to controls, in the public interest, against any possible abuse.

4. Exemptions

It is also important to note that authorization of the holder of plant breeders' rights is not required for the use of his variety for research purpose, including its use in the breeding of further new varieties.

From the inception of UPOV in 1961, farmers have been allowed to use their own harvested material of protected varieties for the next production cycle on their own farms. On farm saving is still a practice in UPOV countries. The 1991 UPOV convention contains an "Optional exception" which provides that it is unto the national government to decide whether to permit farmers to use the seed of a PBR protected variety for propagation purposes on their own holdings or not.

5. Sovereign rights on biological resources

Another major development, which has taken place along with India signing the World Trade Agreement, is global Biodiversity Convention. India is a signatory to this convention, which became operational on December 29, 1993. Among other things it reaffirms that "the states have sovereign rights over their own biological resources" and that states are responsible for conserving their biological diversity and for using their biological resources in a sustainable manner".

6. Suggestions for a SUI system of plant variety protection

The proposal of 1991 UPOV convention which extents plant breeders rights to the harvested material, is not appropriate for our country. The frame work for plant variety protection has to be evolved in a manner that prevents situations where repeated imports of improved varieties are not required so as to avoid dependence on foreign sources of supply.

While, finalizing legislation on PVP, the government needs to strike a balance between its commitment under WTO, growth of the seed sector and their interests of the farmers, which through a difficult task, is not impossible to achieve.

7. Seed Industry Development in Post PVP period

In the post PVP period, we anticipate fairly high investment in seed research from private sector and healthy competition with public sector in crop breeding and seed production and distribution. However, public sector institutions will continue to play major role in developing varieties of wheat rice, chick pea, pigeon pea, mungbeans, urdbeans, groundnut, sugarcane, jute, potato and millets. The continued improvement of these crops is most vital for our food security system. The public sector will have to continue to develop varieties for rainfed, salt affected, hilly and low lying flood prone regions. In export potential of food grains and other agricultural commodities, breeding for quality of produce will have to be given priority. We may also tailor varieties suited to the needs of the importing countries. Since there is growing concern about the use of chemical pesticides in crop production, the present research programme of breeding for resistance against the pests and diseases will have to be strengthened further. **Strategic research on breeding for research against pests and diseases will be priority areas of research of a public institution**. We anticipate that the material generated from these research programmes will be made available to the private sector.

Seed industry both in public and private sector is likely to develop at a fast rate after the legislation on plant variety protection is enacted. The recent experience shows that contribution of both public and private sector in Seed industry development is complimentary. While private sector seed companies are concentrating on hybrids of millets, oil seeds, cotton and vegetables, the public sector seed corporations are engaged in seed production and distribution of self-pollinated crops. It has also been observed that due to competition among the seed companies, the farmers have been benefited not only in respect of stability in prices of hybrid seeds but also better quality of seeds. It is expected that with programmatic policy planning, faster growth of both public and private sector in seed research and development will be ensured so that they can play important role in improving the incomes and standards of living of our farmers.

Lecture 25

INTELLECTUAL PROPERTY RIGHTS (IPRs)

Intellectual property rights (IPRs) can be broadly defined as legal rights established over creative or inventive ideas. Such legal rights generally allow right holders to exclude the unauthorized commercial use of their creations/inventions by third persons. The rationale for the establishment of a legal framework on IPRs is that it is a signal to society that creative and inventive ideas will be rewarded. There are two broad categories of IPRs: one, industrial property2 covering IPRs such as patents, trademarks, geographical indications and industrial designs; two, copyright and related rights covering artistic and literary works, performances, broadcasts and the like. IPRs that do not fit into this classical division are termed *sui generis*, meaning one-of-its-kind. Such *sui generis* rights include those covering lay-out designs of semi conductor chips and plant breeders' rights.

IPRS Relevant to Agriculture

Several of the IPRs mentioned above are relevant to the agricultural sector in that they can be used to protect goods or services produced in the agricultural sector. These are mainly patents, plant breeders' rights, trademarks, geographical indications and trade secrets. Patents are probably the most important IPR today for agricultural goods and services as they provide, wherever these are available, the strongest protection for patentable plants and animals and biotechnological processes for their production. Patents universally give the patentee the right to prevent third parties from making, using or selling the patented product or process. Patents, however, have to be disclosed to the public through the patent documents. This enables researchers to develop further useful products or services. Patentable products have to meet the criteria of patentability, viz., novelty, i.e. that which is not known in the prior art, non-obviousness i.e. that which involves an inventive step and usefulness i.e. that which is industrially applicable. With some differences the patent laws of all countries follow these criteria. However, not all countries allow the patenting of plants and animals or even microorganisms or biotechnological processes.

Biotechnology is the sector that holds the most potential for advances in agriculture to improve productivity. Biotechnology R&D is mostly concentrated in the hands of large multinational enterprises in the US, Europe and Japan. This gave rise to the patenting of micro-organisms found in nature, if it involved a new, inventive and useful technical intervention by man. Thus, research on the cloning of animals, which is advancing rapidly, would be eligible for patents in at least some developed countries.

Many countries have developed plant breeders' rights to reward conventional plant breeding efforts. Such *sui generis* protection is weaker than patent protection in that the right holders can only prevent third parties from commercially exploiting the protected material. The criteria used to grant such protection is also lower than that used to determine patentability as these are distinctness, i.e. distinguishable from earlier known varieties, uniformity i.e.display of the same essential characteristics in every plant and stability i.e. the retention of the essential characteristics on reproduction. Such protection encourages breeding efforts in the private sector. Historically, in developing countries, such efforts have emanated from the public sector or from international research institutions. It is only in recent years that developing countries have begun to institute such protection.

The Protection of Plant Variety and Farmers Rights Act 2001

India's plant variety protection and Farmers' Rights Act, 2001 The General Agreement on Trade and Tariffs (GATT), the predecessor to the World Trade Organization (WTO), was established to restore world trade after the end of the Second World War in 1945. Several GATT rounds starting from 1948, dealt with the quotas and duties of tradable commodities between nations. The 1986 GATT Round, popularly known as the Uruguay Round, brought in new elements into the trade discussion, especially relating to agriculture. One of the most controversial agreements of the Uruguay Round is that relating to the granting of Intellectual Property Rights on biological materials embodied in the Trade Related Intellectual.

TRIPS specifically require member nations to grant patents on microorganisms, non/biological and microbiological processes as well as effective IPR protection for plant varieties.
TRIPS provide a choice for protecting plant varieties. Members may choose from patents, a sui generis system or a combination of the two. Most developing countries including India have decided not to have patents for plant varieties and have chosen the sui generis option instead. The sui generis system (translating roughly into selfgenerating) means any system a country decides on, provided it grants effective Plant Breeders' Rights. TRIPS does not specify what kind of breeders' rights is meant and it does not say what else a member state can include in its law, apart from breeders' rights. In short, TRIPS is a flexible system, which leaves a lot to the discretion of members. As a response to the TRIPS agreement, India has started enacting a series of domestic laws to implement the commitments it has made. The Plant Variety Protection and Farmers Rights Act, 2001, is the Indian sui generis legislation. The Indian law, which has been hailed as a progressive, pro-developing country legislation, has some notable features. Apart from a well-defined breeders' right, it has strong and proactive farmers' rights. In fact the Indian legislation succeeds in balancing the rights of Breeders and Farmers and exploits the flexibility granted in TRIPS, in an intelligent manner. There are clauses to protect the rights of researchers and provisions to protect the public interest.

The Indian legislation is the first in the world to grant formal rights to farmers in a way that their self-reliance is not jeopardized. What is significant and positive about this legislation is that it charts its own course, deviating from the norms set by the Union for the Protection of New Plant Varieties (UPOV). UPOV is at present the only platform for regulating plant breeders' rights. It is a platform for developed countries which is modulated to protect the interests of agriculture in industrial countries. It does not even have the notion of farmers rights. The innovative Indian legislation has opened up interesting possibilities for developing a developing country platform for regulating breeders' and farmers' rights so that both, not just one, are acknowledged and protected. The salient features of the new law are described in this article.

Breeders Rights

On registration of a particular variety, the plant breeder has rights of commercialization for the registered variety either in his/her own person or through a designated person. These rights include the right to produce, sell, market, distribute, import or export a variety, in short, full control over formal marketing. Violation of the breeder's right can be construed at several levels. It applies to the variety itself as also to its packaging. Infringement will be established if the packaging is the same or even similar, such that the package could appear to be that of the Breeder. Legally, a similar looking package will be considered "Passing Off" and so actionable. Any one other than the breeder can not use the registered name or denomination. The use of the same or similar name in any way, by action or even suggestion, will constitute a violation and will be punishable. Penalties are prescribed for applying false denomination and for selling varieties to which false denomination is applied.

Farmers Rights

The Act recognizes the farmer not just as a cultivator but also as a conserver of the agricultural gene pool and a breeder who has bred several successful varieties. There are provisions for such farmers' varieties to be registered with the help of NGOs so that they are protected against being scavenged by formal sector breeders. The law allows the farmer to sell seed in the way he has always done, with the restriction that this seed can not be branded with the Breeder's registered name. In this way, both farmers and breeders rights are protected. The breeder is rewarded for his innovation by having control of the commercial market place but without being able to threaten the farmers' ability to independently engage in his livelihood, and supporting the livelihood of other farmers.

Apart from the right to sell non-branded seed of protected varieties, the rights of farmers and local communities are protected in other ways too. There are provisions for acknowledging the role of rural communities as contributors of landraces and farmer varieties in the breeding of new plant varieties . Breeders wanting to use farmers varieties for creating Essentially Derived Varieties (EDVs) can not do so without the express permission of the farmers involved in the conservation of such varieties. Any one is entitled to register a community's claim and have it duly recorded at a notified center. This intervention enables the registration of farmer varieties

even if the farmers themselves cannot do this due to illiteracy or lack of awareness. If the claim on behalf of the community is found to be genuine, a procedure is initiated for benefit sharing so that a share of profits made from the use of a farmer variety in a new variety goes into a National Gene Fund.

Protection against Bad Seed

In providing a liability clause in the section on Farmers Rights, the farmer in principle is protected against the supply of spurious and/ or poor quality seed leading to crop failures. But at present there is too much left to the discretion of the Plant Variety Authority which will fix the compensation. This could lead to arbitrary decisions and should be amended. (Sahai, 2001 a,b)

Rights of Researchers

All IPR systems must strike a balance between the monopoly granted to the IPR holder, in this case the plant breeder, and the benefits to society, in this case the farmers and consumers. Since nobody concerned with public interest would want plant breeding to shift into just a few hands, it is important to maintain competition and vitality in the plant breeding sector. That is why freedom and rights for other researchers to use all genetic material, including IPR protected material, is important. The Bill has provisions for researcher's rights which allows scientists and breeders to have free access to registered varieties for research. The registered variety can also be used for the purpose of creating other, new varieties. The breeder cannot stop other breeders from using his/her variety to breed new crop varieties except when the registered variety needs to be used repeatedly as a parental line. In that case authorization is required.

There is however some difference of opinion. Some view that the Indian law actually grants very restricted rights to researchers because of the acknowledgment of Essentially Derived Varieties, EDV. It is felt that all kinds of research will become subject to the breeders authorization if a protected variety is used for research. In the Indian Act, the Breeders authorization is needed for making EDVs.

Protection of Public Interest

The PPV legislation includes public interest clauses, like exclusion of certain varieties from protection and the grant of Compulsory Licensing. To secure public interest, certain varieties may not be registered if it is felt that prevention of commercial exploitation of such variety is necessary to "protect order or public morality or human, animal and plant life and health or to avoid serious prejudice to the environment".

The Act also provides for the granting of compulsory license to a party other than the holder of the Breeders certificate if it is shown that the reasonable requirements for seeds have not been satisfied or that the seed of the variety is not available to the public at a reasonable price. The breeder is entitled to file an opposition but should the charge be valid, the breeder may be ordered by the Authority to grant a compulsory license under certain terms and conditions

including the payment of a reasonable license fee. Compulsory License however will not be awarded if the Breeder can demonstrate reasonable grounds for his inability to produce the seed.

Lecture 26
VARIETAL IDENTIFICATION

1. Grow - Out Test

Objective

To determine the genetic purity status of a given seed lot of the notified cultivar / hybrid and the extent to which the sample in question conforms to the prescribed standards.

Field of applicability

Grow-out Test is the official measure for controlling the genetic purity of the seed lot. It serves as a pre-control as well as a 'post-control' test for avoiding genetic contaminations. According to the official regulations in India, it is pre-requisite for seed certification of hybrids of certain species such as **cotton, castor, musk melon and brinjal**.

The test is required to be conducted for checking the sellers label with respect to genetic purity status of the seed lot **under the provisions of the seeds Act 1966**. In addition grow-out test can also be used as a measure to judge the efficacy of the certification agency or the inspector.

Sampling

The samples for 'Grow-out test shall be drawn simultaneously with the samples for other seed quality tests in accordance with the prescribed sampling procedures.

Size of submitted sample

The size of submitted samples shall vary according to the species as exemplified in this Table.

Recommended size of submitted sample for Grow-out Test

1,000 g	- for maize, cotton, groundnut, soyabean and species of other genera with seeds of similar size;
500 g	- For sorghum, wheat, paddy and species of other genera with seeds of similar size;
250 g	-Beta and species of other genera with seeds of similar size;
100 g	-For bajra, jute and species of all other genera;
250 tubers / planting stakes / roots/ corms	- Seed potato, sweet potato and other vegetatively propagating crops.

Size of working sample

The working sample for grow out test shall be obtained through subsequent mixing and dividing of the submitted sample in accordance with the prescribed procedure for seed sampling.
The minimum population required for taking the observations shall be 400 plants; however, it will also depend on the maximum permissible off-type plants prescribed for the species under consideration in the Indian Minimum seed Certification standards
The number of seeds required for raising the crop to obtain the required number of plants shall depend on the germination percentage of the seed sample and hence seed rate should be adjusted accordingly.

Number of plants required per sample for grow out test

Maximum permissible off types (%)	Minimum genetic Purity (%)	Number of plants required per sample
0.10	99.9	4,000
0.20	99.8	2,000
0.30	99.7	1,350
0.50	99.5	800
1.00 and above	99.0 and below	400

Procedures

To achieve the accuracy and reproducibility of the grow out test results, the procedures provided hereunder must be followed:

Location of the grow out test

The grow out test shall be conducted in specified areas recommended for the cultivar / hybrid or in off-season nurseries.

Standard sample

The standard sample of a cultivar (control) is the official standard against which all other samples of the seed of the cultivar will be judged.
The standard sample must not differ significantly in any character and be obtained from the originating plant breeder / breeding institute and be stored under controlled temperature and humidity conditions so as to use it each year to sow control plots for cultivars under test.

Further quantities of sample must be obtained from the originating plant breeder as and when required. A comparison must be made between the two lots of the standard sample before changing from one standard sample to other.

Method of raising the crop

Standard and recommended agronomic / cultural practices such as field preparation, size of the plot, row length, distance between the rows, distance between the plants, irrigation and fertilization, etc., in respect of the specific crop shall be followed both for the sample in question and its control (standard sample).

The germination percentage of the sample (s) in question and the standard sample must be determined to adjust the seed rate. The sowing should be done by dibbling or small plot drill. Seed drill must be carefully checked to ensure its cleanliness. Subsequent thinnings is not recommended. The samples of the same cultivars must be sown in succession and the standard samples are sown at suitable intervals. (one standard sample for every ten sample to be tested).

The size of the plot, row length and spacing shall differ according to the crop. Recommended specification for the above variables are provided in Table mentioned below which can suitably be modified if considered essential.

Recommended row length, distances, spacing for some important crops

S. No.	Crop	Row length (m)	Plant to plant distance (cm)	Space between rows (cm)	Space between plots (cm)
1.	Wheat, barley oats	6	2	25	50
2.	Pea, Cowpea	6	10	45	90
3.	Chickpea, green gram black gram	6	10	30	60
4.	Maize	10	25	60	90
5.	Hybrid cotton	5	10	45	45
6.	Paddy: • Very early to medium • Late and very late	 6 6	 15 25	 20 30	 45 60
7.	Pearl millet	6	10	60	90
8.	Sorghum	6	10	45	60

The field plots should be grown in two replicates to guard against failure in one part of the field and to reduce environmental and soil fertility variations.

Methods for taking observations

Grow-out test plots must be examined throughout the growing season with emphasis on the period from the flowering to ripening. All plants must be examined keeping in view the distinguishing characters described for the cultivars both in the test crop as well as the control. While taking the observation, the plants showing deviations in characters against the control should be tagged and examined carefully at a later stage to confirm whether they are off-types or not. The number of the total plants and the off-type plants found should be recorded.

Calculation and interpretation of the results

Percentage of other cultivars, species or aberrants found must be calculated upto first decimal place. While interpreting the results, tolerances should be applied by using the reject number for prescribed standards with reference to sample size as provided in Table.

Reject number for prescribed standards and sample size

	Reject numbers for sample size of	
	800	400
99.5 (1 in 200)	8	*
99.0 (1 in 100)	16	8
95.0 (5 in 100)	48	24
90.0 (10 in 100)	88	44
85.0 (15 in 100)	128	64

** indicates that the sample size is too small for a valid test.*

Reporting of results

- The results of the grow-out test shall be reported as percentage of other species, cultivars or off-type plants.
- If the sample is found to be a cultivar other than stated by the sender, the results shall be reported as such.
- If plants of other cultivars are more than 15 per cent, the report shall state that the sample consists of mixture of different cultivars.

- If nothing worthy of special comments is found, the report shall state that the results of the grow-out test of the sample in question revealed nothing to indicate that the name of the cultivar or species stated by the sender is incorrect.

2. Electrophoresis

It is the latest method of cultivar identification based on protein banding and isoenzyme activity. Here single seeds are defatted and extracted for protein and esterases. The extracted proteins or esterases are separated by polyacrylamide gel electrophoresis. Based on the banding pattern of protein and esterase's the varieties can be differentiated and identified.
Electrophoresis for proteins and enzymes: Seeds, seedlings or mature leaves etc. of a crop plant have a specific mix of proteins which are not only crop specific but also variety specific (genotype specific). The electrophoresis in a suitable medium separates the mixture of proteins extracted from seeds, seedlings or mature leaves into distinct bands. Each variety (or genotype) thus has a specific "banding pattern" on the basis of which admixtures of other varieties, differing in "banding pattern" could be detected. This is done by comparing the banding pattern of analysed sample with the standard banding pattern of that variety. The electrophoresis is now being increasingly used for determining the genetic purity of seed samples.
Principle: The term 'electrophoresis' refers to the migration of a charged particle under the influence of an electric field. The movement of ions takes place in a suitable medium, such as, polyacrylamide gel, which acts as a molecular sieve and cut down convection currents and diffusion, so that the separated components remain as sharp zones with maximum resolution. The separation into distinct bands is due to,
1. differences in the size of molecules (molecular weight) of various proteins. Particles with smaller molecular weights migrate faster than those with higher weights, and
2. differences in charge. The molecules with the higher charge migrate faster than those with a lower charge.
Since proteins carry a net charge at any pH other than their isoelectric point, they migrate in an electric field, the rate of which depends on the charge density (that is, the rate of charge to mass of the molecule). Proteins with higher charge density will migrate faster, thus resulting in differential rates of movement of proteins when a mixture of different proteins is subjected to an electric field. By altering the gel pore size (using polymers at different concentrations) and the charge on the protein molecule (by changing the pH of the system) a high degree of resolution can be achieved for separation of protein molecules in a mixture.

Lecture 27
SEED DRYING

The process of elimination of moisture from the seed is called drying. Seed drying should reduce the seed moisture content to safe moisture limits to maintain its viability and vigour during storage, which may otherwise deteriorate quickly owing to mold growth, heating and enhanced microbial activity. Seed drying also permits early harvesting, long term storage of seeds, more efficient use of land and manpower, the use of plant stalks as green fodder and production of high quality seed.

Depending upon the climate and method of harvesting adopted the threshed seed may or may not be dry enough for safe storage. Under less favorable conditions, threshed seed needs further drying.

Stage of moisture elimination

The moisture from the seed is eliminated in 2 stages

- Surface moisture of the seed that initially removed by the drying air.
- The removal of the moisture in the surface cause an imbalance in the moisture potential in the surface of the seed and the inner portion of the seed which leads to the migration of moisture from the inner organ to the surface.

The migration of moisture to the surface is slower than the evaporation and a moisture gradient is developed in the kernal.

Elimination of moisture from the seed depends upon the relative humidity and temperature of the environment surrounding the seed. When RH of the atmosphere is less than the seed, moisture is eliminated from the seed. While drying, care should be taken to minimize /prevent oxidation and decomposition and volatilization. In this process there will be loss of dry weight of seed which is widened when the processes take place at high temperature. Hence, high moisture seeds should be dried at low temperature.

Equilibrium moisture content

A seed is in equilibrium with the environment when the rate of moisture loss from the seed to the surrounding atmosphere is equal to the rate of moisture gained by the seed from the atmosphere.

Drying temperature

Greater the seed moisture content lesser should be the drying temperature and vice versa.

10%	MC and below	110 o F (43.3o C)
10-18 %	MC	100 o F (42.2 o C)
18-30 %	MC	90 o F (32.2 o F)

The rate of drying depends on

- Initial seed moisture content
- Size of the bin and capacity
- Depth of spread of seed
- The rate of air blow
- Atmosphere air temperature and relative humidity
- Static pressure
- Drying temperature

Methods of drying

I. Physical drying (or) natural drying (or) traditional sun drying
II. Mechanical (or) artificial drying

- Drying with forced natural air
- Drying with forced artificially heated air
- Drying with desiccants
- Drying with infrared rays

I. Physical drying / Natural drying / Traditional Sun drying

This is the common conventional method in which drying of the harvested crop is carried out in the field or threshing floor by the radiant energy of the sun. This does not involve any expenditure. To achieve uniform drying, the seed should be spread in thin layer. High moisture content seed with a moisture content of more than 17% should be dried first under shade / light to reduce the moisture content less than 17% and then dried under heavy sun i.e. noon drying. Sun dried seeds should not be allowed to remain open in the floor during night, since seed will absorb moisture from air. 2-4 days are needed to reduce the moisture content to 10-12%. Direct sunlight also can adversely affect seed germinability owing to high temperature and ultraviolet radiation, especially if the moisture content of the seed is high.

Advantages

1. Easy and cheap
2. Does not require any expenditure or fuel.

Disadvantages

1. The rate of drying is slow
2. Loss due to attack by insects, birds and animals
3. Large floor area is required
4. Involves extra labour for collecting and exposing during the day
5. Sun drying cause sun checks or hot spots due to variation in temperature from time to time. This checks or spots induce high amount of breakage while processing
6. mechanical admixtures are possible
7. Dust, dirt and other foreign materials get admixed
8. High weather risks and damage by heavy wind and rains

II. Mechanical drying or artificial drying

Forced air drying

In forced air drying, natural air or air supplemented with heat is blown through a layer of seed until drying is completed.

Generally ordinary seed godowns are provided with two types of ventilators for free movement of air circulation. In modern godowns, provisions are to be made for forcible circulation of air with the help of an electronic blower. The outside air which is comparatively dry is circulated in the godown and thereby the seed get dried up in this process. This is possible only in dry months.

Two types of driers are used: batch and continuous flow driers.

- **Batch dryers**

In batch drier, relatively dry air is blown through a layer of seed until the seed is dried completely, after which it is removed and replaced by another batch of seed. The method is simple and well suited to small quantities of seed, allows easy cleaning and is recommended for farm drying.

In horizontal drier, the seed is contained in a box or chamber with a perforated floor through which the air is blown. Air ducts can be installed in a barn floor and the seed to be dried piled over them.

In a modified sack drier, seed contained in a woven sack is placed on a grid through which air is blown. A cylindrical storage bin with raised perforated floor arranged to blow air underneath the floor can also be used.

A vertical batch drier consists of two concentric perforated cylinders. The space between the two cylinders is filled with seed and air is blown into the inner cylinder from where it passes outward the seed. The size of the batch determines the drying rate.

In horizontal batch drier, the seed at the bottom dries first, with the dry zone extending gradually upward. The drying of the uppermost seed may be delayed unduly if the seed layer is too thick or the airflow is inadequate. The seed layer should not exceed a depth of 3m and for high moisture forage seed, it should be reduced to 1m or less. If the seed is dried in a storage bin, a layer of undried seed can be added on top of the dried batch and drying continued, but only if the seed is already fairly dry and air is not too hot. Seed loss also can be avoided by drying in two stages. After the first batch has partially dried, the emerging air is passed through a second batch held in another chamber, repeating the process with second batch and so on.

The air blown through a batch must not be too hot, because the seed at the bottom may be overheated by direct exposure to the entering hot air. It is often not necessary to heat the air at all, and heating to less than 10o C above the ambient temperature can be very effective, but on a hot humid day in the tropics even a few degrees above ambient temperature can harm the seeds. Dehumidifiers may need to be used under these circumstances.

An appropriate drying rate is very important. Too rapid drying may harm the seed because of the high drying temperature or a quick loss of water from the seed. Slow drying may mean maintaining a high moisture seed at a higher temperature for a prolonged time, resulting in deterioration of seed.

2) Continuous flow dryers

In this type of drier, the seed moves horizontally or vertically through a stream of hot air and then into a cooling chamber. These driers are however difficult to clean when there is a change of cultivar. These driers can use air temperature higher than those of batch dries, because the seed is heated for a much shorter time.

i) L.S.U. dryers (Louisiana State University dryers)

This is a continuous column heated air drier largely used for paddy. The paddy seeds are fed from the top with the help of gravity force in zig zag manner and heated air is blown from the bottom usually at right angles to the direction of seed motion. The falling seeds get dried up by the heated air and this process is repeated till to get a reduction of moisture content to the expected level.

ii) Non mixing column dryer

These dryers consist of a tall vertical column through which paddy flows by gravity. No provision is made for agitating the paddy as it flows and hence there is no attempt to drive the paddy from a straight path. Paddy descends gradually between two parallel screens and heated air is forced through the screens.

Advantages over bin dryers

1. Short drying period
2. Less damages or spoilage during wet weather
3. Drying is more uniform.

Advantages of mechanical drying

- Quick method, timely and uniform drying is possible
- Makes early harvest possible
- It reduces the chances of losses due to over ripening and shattering of seed
- Losses due to rodents and birds are prevented.
- Less damage during processing operation.
- Permits long time storage by preventing sun checks and other damages.

Disadvantages

- Initial cost of drying the equipment is high
- Fuel is expensive
- It produces possible fire hazards
- Considerable supervision is necessary.

Storage structures for Seed drying

Building requirements for a seed drying system depend upon the size of operation, the number of different seeds to be dried, the level of mechanization desired and future expansion. Different types and forms of storage structures can be built for handling seeds to be dried with forced air. These may be made of steel, wood, plywood or concrete and they may be cylindrical or rectangular in shape.

Regardless of the type of structure, all storage bins used for forced air drying in storage of seeds must have the following features.

- Small grain seeds in bulk exert large pressures against the sidewalls. The side pressures are converted to a vertical load on the foundation, which should be strong enough to hold the seed lots.
- The roof and walls of bins must be airtight for drying to proceed satisfactorily.
- The openings for filling and removal of seed should be large and convenient to use. A full size entrance door is desirable.
- A hand space about 1 m should be provided for easy inspection of seed. Cleaning and spraying operations should be convenient. For fumigation, the structures should be airtight, with a provision for temporary sealing of all openings.
- The structure should be able to dry and store more than one kind of seed.
- The dryingair should be uniformly distributed through all portions of the seed lot for efficient drying.
- Theflow of air leaving the seed should proceed rapidly so that back pressures do not hinder the flow of drying into the seed.

Air-Distribution Systems

Agrawal described three types of air-distribution systems used for seed drying.

- The main and lateral duct system b) a single central perforated duct and c) the perforated false floor system.

Multiple bin storage structures for drying can be built so that they are arranged to enable the drying of several seed lots simultaneously using the same drying fans. Alternatively, different seed lots can be dried successively with sliding air gates controlling the flow of air to the respective bins. A multiple bin arrangement is particularly useful to dry more than one kind of seed simultaneously.

Heated air drying system

Heated air driers consist of (a) a heater unit where fuel is burned and (b) a fan to force the heated air through a canvas connecting duct into the air distribution system of the drying bin. Safety features such as automatic thermostatic high limit temperature control, which cuts off the burner flame if the air temperature exceeds a certain safe maximum and

flame failure control, which automatically cuts off fuel flow to the burner if the flame goes out are provided. A thermostat can also automatically maintain the air temperature at a desired setting. In many driers, such thermostats are provided as a standard feature.

Two main types of driers are available, which differ in the manner heat is supplied to the air. Direct fired and indirect fired. In a direct fired drier, the fuel is burned and the hot combustion gases are thrown directly into the air distribution system. Although the heat is used very efficiently, there is possibility of blowing soot, unburned fuel and objectionable fumes into the seed. The burner, therefore, needs to be adjusted properly to burn the fuel completely. With certain fuels, there is also a danger of blowing small sparks into the seed.

In indirect fired driers, the hot combustion gases pass into a chamber. The drying air circulates around this chamber and picks up heat as in a hot air furnace. The drying air thus does not include combustion gases, sparks, soot or fumes. These driers are less efficient in the use of heat, but are safer than direct fired types.

The driers are designed to burn various types of fuels (eg. liquid propane or butane, natural gas, fuel oil and coal. Both liquid propane and natural gas burn readily with minimum soot and are the best fuels for direct driers and kerosene oil is better for indirect fired driers.

Two important aspects that must be considered while calculating the requirements of a suitable to crop drier are the required air flow volume and the heat capacity (BTU/hr) for drying seeds at the specified desired rate. The fan requirements can be computed by knowing the total air flow at the static pressure of the seed at a given drying depth and heater requirement are estimated by calculating the amount of water to be removed from the seed per hour. Based on these calculations, a suitable crop drier can be selected to provide a minimum required airflow volume(bin capacity x air flow rate) and heat capacity in BTU/hr. Agrawal categorized types of heated driers as layer-in -bin, batch-in-bin, batch and continuous driers and described their functions.

Stirring devices keep the seed in a loose fill condition, allowing easy airflow through the bottom layers. Such mechanisms alleviate the problems of uneven drying (or over drying) by breaking up pockets of fires and trash and blending the seed by constant mixing.

Large differences in the degree of drying between the top and bottom layers of seed have been noticed during drying by heated air. It is therefore, advisable to dry seed at shallow depths to minimize these differences and avoid overheating of the bottom layer. Agrawal recommended maximum seed depths and temperatures for batch drying of seeds of different crop species in bins.

Crop seed	Maximum depth (cm)	Recommended maximum temperature (0C)
Shelled corn	50.8 (20 in)	43.3 (110 o F)
Wheat	50.8 (20 in)	43.3 (110 o F)
Barely	50.8 (20 in)	40.4 (105 o F)
Oats	91.4 (36 in)	43.3 (110 o F)
Rice	45.7 (18 in)	43.3 (110 o F)
Soyabean	50.8 (20 in)	43.3 (110 o F)
Peanuts	152.4 (60 in)	32.2 (90 o F)
Grain Sorghum	50.8 (20 in)	43.3 (110 o F)

Heated air drying requires higher rates of airflow, because water is evaporated faster and more air is needed to carry it away. The higher air flow rate also ensures more uniform drying of the top and bottom layers of the seed, completing the drying much faster at the recommended temperatures.

The general procedure for bin drying of seeds with heated air consists of charging seed into the bin to the recommended depth. The drier is operated at the recommended temperature of the seed using either manual or thermostatic controls to set the desired temperature. After drying is completed, blowing of the air through the seed is continued for sometime without heat to bring the seed to an ambient temperature.

Some variations of batch drying with heated air include wagon drying, bag drying and box drying. In wagon drying, the seed is loaded directly onto a wagon especially constructed for drying. The wagon is then drawn to the drier unit and connected with a canvas distribution duct. Forcing the air up through the perforations in the wagon floor dries the seed. After drying, the wagon is disconnected from the canvas duct and the seed is cooled with a fan towed to the storage bins. Wagon drying provides continuous drying, vwrsatality, easy cleaning and low initial cost.

Bag drying is another suitable variation to handle several varieties of smaller quantities of seed simultaneously. Seed received in jute bags is exposed to airflow with minimum static pressure, because the drying bed is only one sack deep. Typical design criteria provide 25 - 40m3 of air/min/m3 seed at a static pressure of 3cm less. The construction is simple and inexpensive.

A box drier is modified bag drier well adopted to dry smaller quantities of basic or foundation seed. With box driers, it is possible to maintain the identity of small seed lots despite handling. The boxes can be constructed of locally available materials, which are fitted with perforated metal or woven wire bottoms.

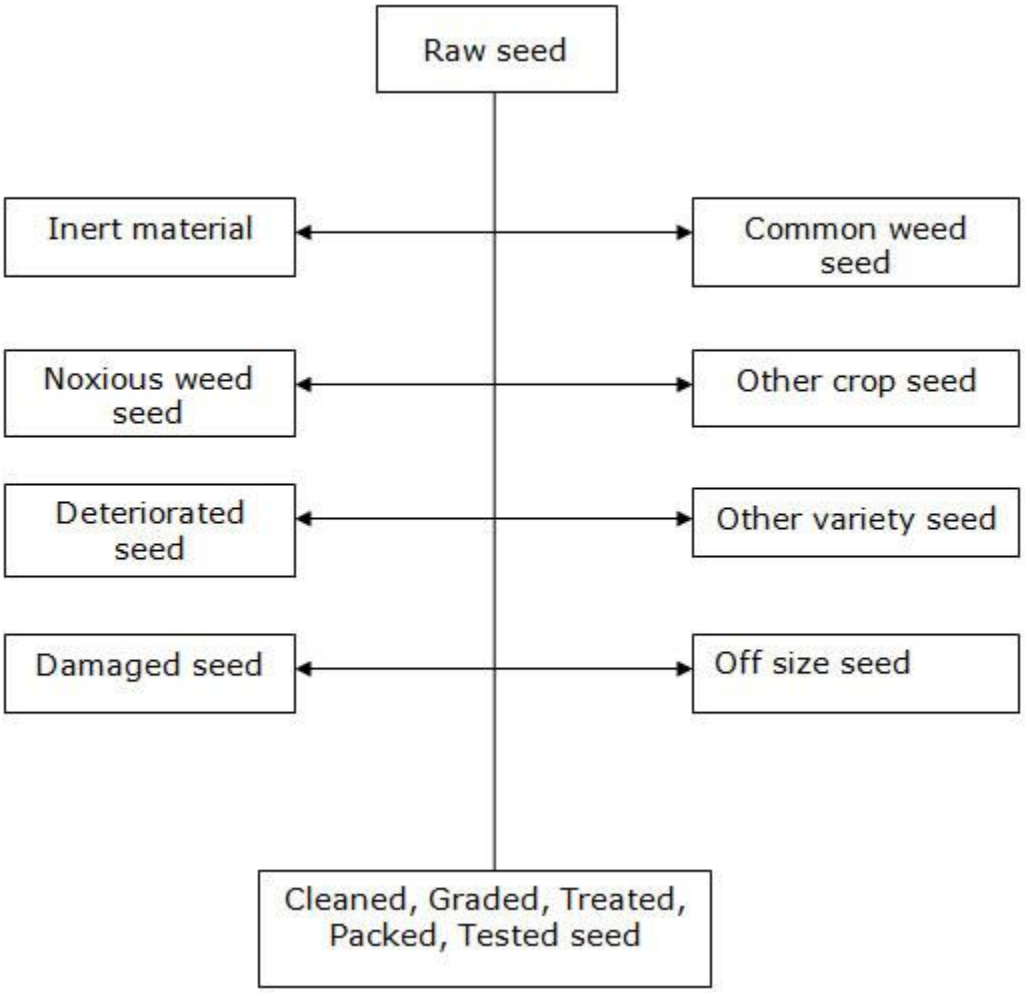
Tempering

Seed is usually dried in stages with heated air each stage consisting of a pass through the drier. Between passes the seed is stored in bins for an equilibrium period known as tempering period. This period of tempering shortens the total drying time. During drying, surface moisture is removed and internal moisture moves towards the surface are slower than

evaporation, and a moisture gradient develops in the kernel. The outside becomes drier than the inside and evaporation rate decreased. During tempering moisture concentration equalizes in the kernel and then evaporation of surface moisture is nearly as rapid as at the start of drying.

Lecture 28
SEED PROCESSING

Seed lots received from the field are often at high moisture content and contain trash and other inert material, weed seeds, deteriorated and damaged seeds, off-size seeds, etc. Seed processing is necessary in order to dry the seeds to safe moisture level; remove or reduce to the extent possible the various undesirable material, weed seeds, other crop seeds, deteriorated or damaged seeds.



Other than this the seed lot heterogeneity in its physical characters like size, colour, shape etc. The seed lot is heterogeneous due to the following reasons

1. The soil is heterogeneous and there is a lot of variability in the fertility status of the soil due to the availability of nutrients, physical, chemical and biological properties.
2. Variability is introduced due to the position of seed set on the plant/fruit , time of pollination and fertilization over a period of time
3. Variability is created by biotic factors like pest and variability infestation.
4. Variability is also due to the management practices like water, land preparation, leveling, staggered sowing, and uneven distribution of fertilizer and irrigation water, uneven plant protection sprays and uneven maturity at harvest.

The inherent qualities such as germinability and vigour are exemplified by certain physical characteristics of the seed i.e., large size, a denser seed, optimum length etc., So, if grading is done to obtain a particular range of size, shape, length and density of the seeds, the quality of the lot is upgraded.

In its common usage in India, seed processing refers to all the steps necessary for preparation of harvested seed for marketing, namely, handling, drying, shelling, preconditioning cleaning, size grading, treating and packaging, etc.

Seed Processing Plant Layout Planning

Layout plan for construction of a seed processing plant should be carefully planned to ensure that the thorough seed cleaning, upgrading, seed treatment and other seed processing operations are carried out efficiently, without mixing and damaging seed lots, with a minimum of equipment, personnel, time and at minimum cost. The following factors should be considered in planning and designing a seed processing plant:

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

The key to efficient plant layout is a thorough knowledge of what needs to be done, and sound planning. First, the general sequence of processes involved between the time seeds enter the processing plant and the time they are cleaned, packaged and ready for shipment, must be charted. The sequence of operations depends upon the kind of crop and the initial quality of seed lot, type of contaminants, moisture content of the seed lot, etc. The layout planner must have an intimate knowledge of the seed to be processed, its physical characteristics, the contaminants in it, and also of the selection of machines used to bring the

seed to acceptable marketing standards.

Seed Processing Plant Building Layout

Seed processing plant building will comprise of following components:

1. Receiving-cum-drying platform
2. Processing area
3. Auxiliary building

Receiving-cum-drying platform

This area will be utilized to receive the raw seed and to sun dry small lots of crop seeds. This area can also be utilized for storage of seeds on wooden palettes. The platform will be connected to processing shed through a rolling shutter.

Processing area

The processing area should be situated between the shed and ventilated storage building. The hall should be connected to ventilated flat stores through a covered gallery for easy movement of processed and packaged seed to seed stores. The hall should have a big rolling shutter in the processing plant to permit entry of seed processing equipment into the hall for installation. Height will be kept to facilitate installation of the seed processing equipment and machinery. A sequence of processing machines to be installed is shown in Fig. 1. Floor of the processing hall should be above the ground level.

The shed should have sufficient provision for natural as well as forced ventilation in order to maintain congenial atmosphere inside the shed. The shed should accommodate seed scalping, seed processing and packaging equipment and will have sufficient space for weighing and packaging.

Auxiliary building

In addition to building discussed above, a provision should be made for generator room. Sufficient length of road should be provided to connect various functional buildings with each other and main highway. Boundary wall should be provided all around the complex for security reasons. Entire complex should have a good drainage system.

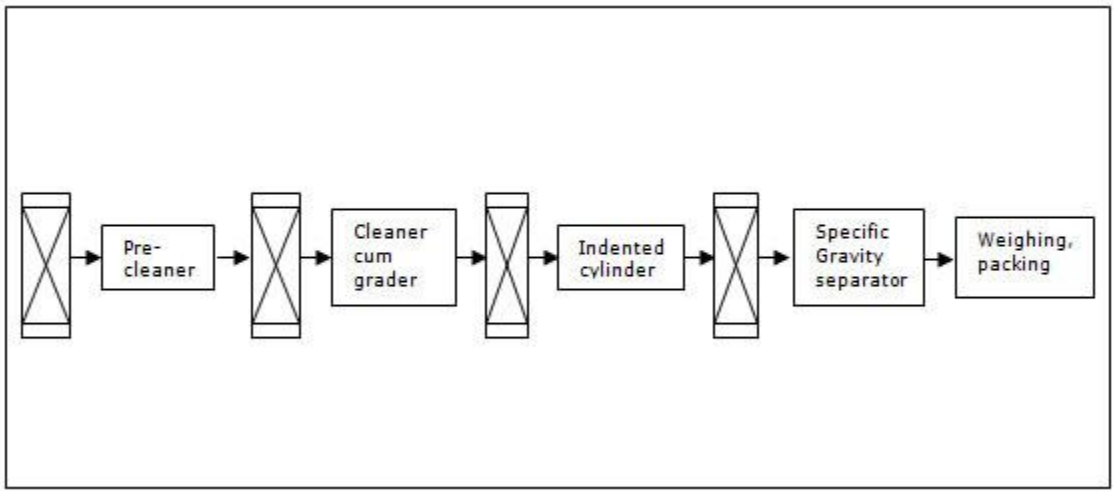
Provision for firefighting equipment such as extinguishers, water buckets, sand buckets etc. should be made to fight minor fire hazards.

The processing plant building should be constructed as per CPWD/PWD norms. It should have tubular trusses, AC sheets pitched hole roof, cement concrete flooring finished with water-proofing cement paint, aerated, ventilated, rat proof and bird protection. Sealed doors should be provided in these buildings. Buildings will be suitably planned to have interconnection for movement of seeds and materials.

Analysis of Operation

a) Processing sequence: After the machines needed have been identified, the next step is to determine the proper processing sequence. The seed separators, elevators, conveyors and

storage bins should be so arranged that seeds flow continuously from beginning to end, and yet be flexible enough to bypass a machine or return to a part for re-cleaning.



b) Matching capacity: Equipment size of capacity must be carefully planned to prevent bottlenecks. When the overall operating capacity needs have been determined, all machines must be able to handle that capacity with some reserve capacity for problem lots. Surge bins can handle variations in individual machine capacities. But when differences are great, either larger models, or more than one machine installed in parallel flow, must be used to maintain uninterrupted flow.

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

Type of Layouts

There are three main types of processing plant layouts: multistorey, single level and combination.

Multistorey: In this system, seed is carried by elevators to the top floor and emptied into large bins. Cleaning machines are then arranged in a vertical series on the lower floors. Seed flows from one machine down into the next by gravity.

Single level: In the single storey plant, seed is moved from one machine to the next by elevators placed between the machines. A great advantage of the single level system is that one man can supervise the processing line without running up and downstairs. He can thus maintain closer supervision of all operations.

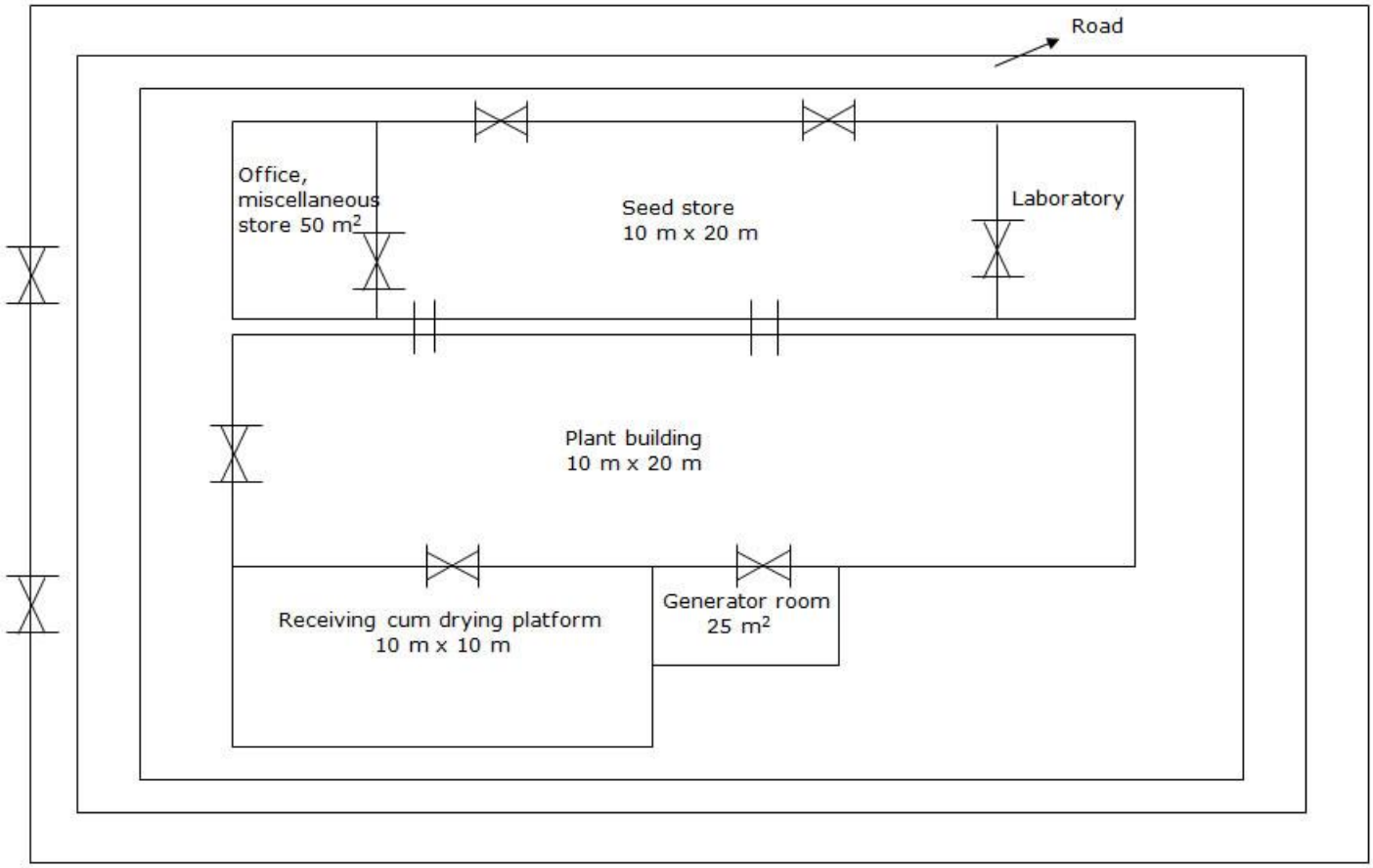
Combined designs: A compromise between the single and multistorey system could also be adapted.

Planning

After the proper machines, elevator capacities, cleaning sequences, and lay out design have been selected, detailed layout planning can begin. Careful layout planning can identify

and remedy bottlenecks and trouble spots before the plant is built, and thus prevent trouble later.

As the lay out or design develops, it should be drawn on paper. A good method is to draw lines of flow first and then convert these flow lines into machine lines. After appropriate revisions, detailed drawings can be made to show exact locations of equipment and distances. Scale drawings are the most widely used method of layout planning. Scale models and scale templates are also very effective, but are more expensive.



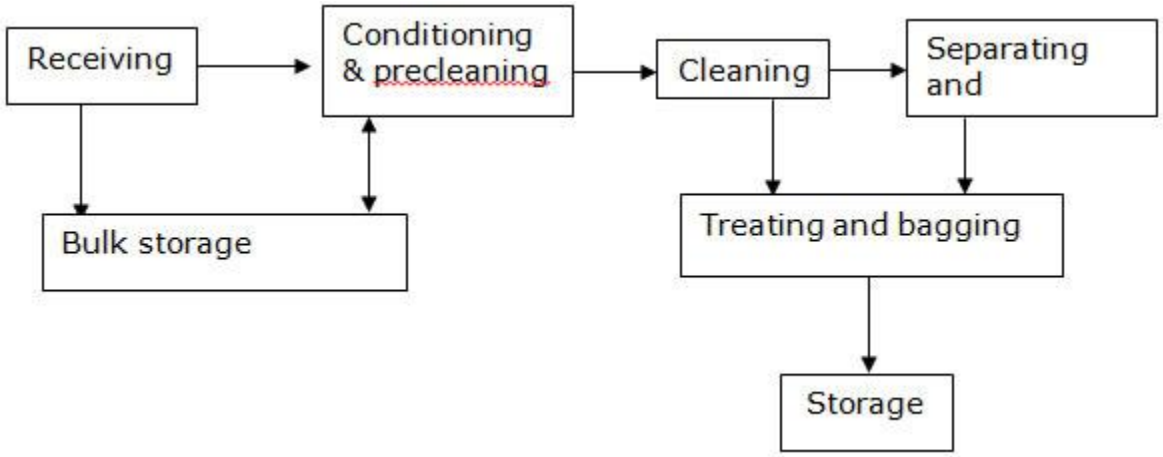
Building layout plan

Requirements in seed processing

1. There should be complete separation
2. Minimum seed loss
3. Upgrading should be possible for any particular quality
4. Efficiency
5. It should have only minimum requirement

Movement of seed in a processing plant

Handling of seed at the processing plant adheres to a definite path irrespective of crop for easy management of seed which is sensitive at each and every step of handling and ready to lose or gain its quality all through the steps.



Physical characteristics used to separate seeds are

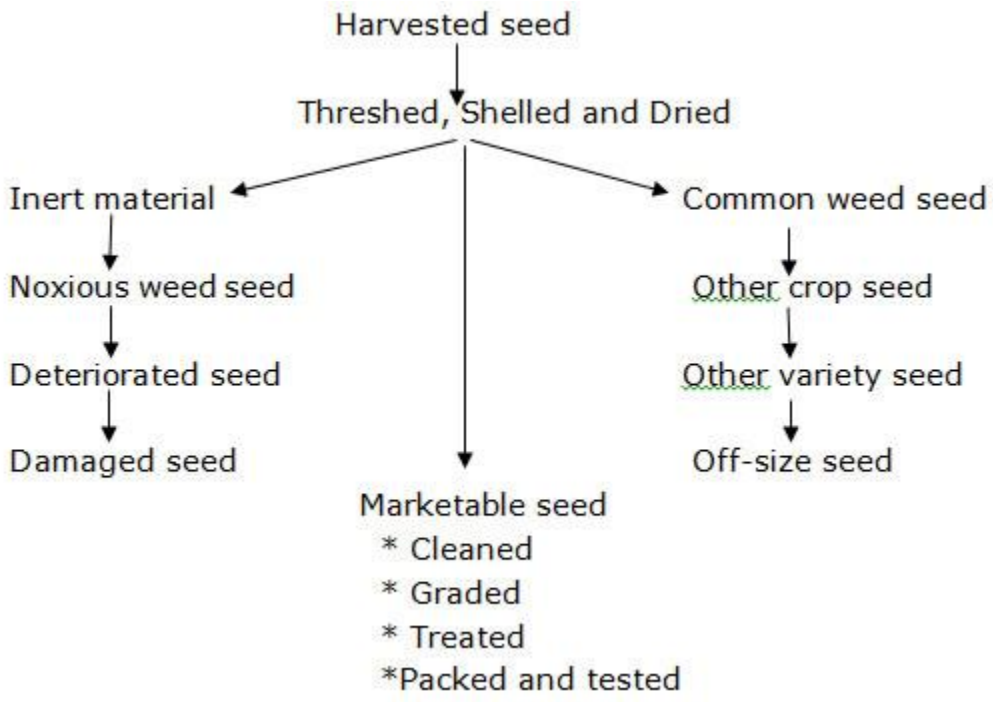
1. Size grader : Based on size it can be separated with air screen cleaner cum
2. Length : Disc or indented cylinder separator
3. Weight : Specific gravity separator
4. Shape : Spiral separator or draper separator for round and flat seeds
5. Surface texture : Rough from smooth surface seed- dodder mill
6. Colour : Electronic colour separator
7. Electrical conductivity

Seed differing in their ability to conduct electrical charge can be separated with electronic separator.

8. Affinity to liquid

The seed coat of seed will absorb water, oils etc., which provides a means of separating seed on the magnetic separator.

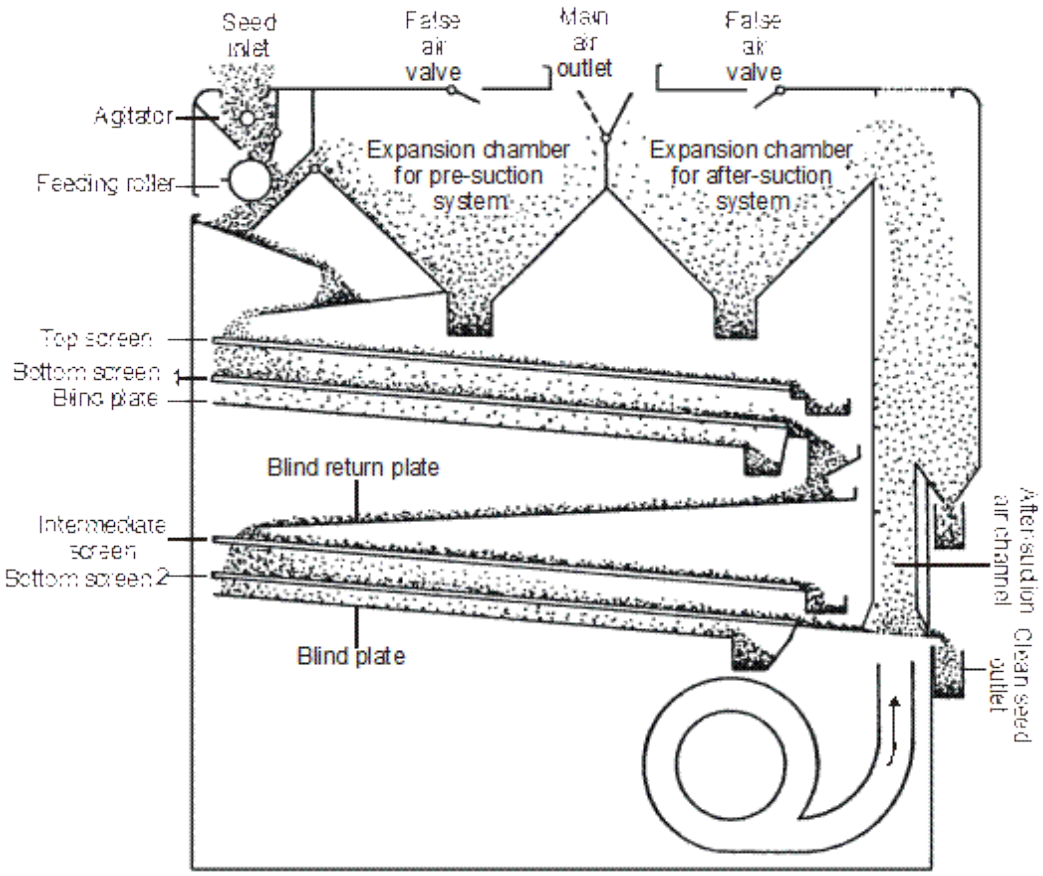
The flow charts illustrating the types of materials removed from harvested produce during processing.



Seed processing equipments

I. Air screen cleaner

This is the most important machine of every cleaning plant. It uses screens and aspiration (air blow) for two separations (Fig.6). A coarse upper screen removes larger material, a lower fine screen stops the seeds and lets through fine matter and then the seed fraction passes through a transverse or nearly vertical air stream which can separate light impurities such as empty or partly filled seeds, husks and glumes from the seed. In most cases a number of sieves with different sized perforations are used and the cleaning is a process of gradually shifting out smaller particles. Factors which determine the quality and quantity of seed cleaned include (i) size of the perforations, (ii) the precision of the perforation, (iii) the angle at which the sieves operate, (iv) the amplitude and speed of movement of the sieves and (v) correct cleaning and maintenance of the equipment.



II. Cleaner cum grader

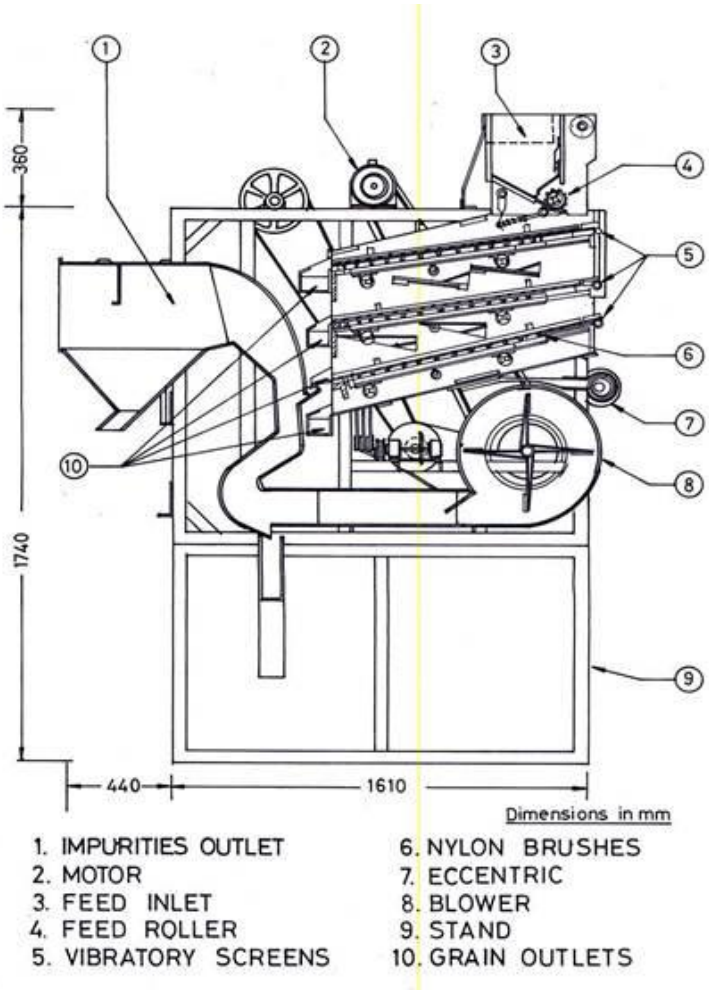
The dried seeds should be cleaned and graded with help of a cleaner cum grader. For large scale cleaning and grading the commonly available machine is the "Crippen Model Seed Cleaner cum Grader".

It consists of the following parts

- A hopper in the top for seed filling
- A flutted roller below the hopper to regulate the seed flow to the screen.
- Screen (or) sieves: Perforated metal sheet with specific size of perforation in which there are two types.
- Rectangular perforations for paddy and
- Round perforations for seed other than paddy
- Screen shaking unit : for oscillating the sieves to move the seeds on the screens
- Screen brushes to remove the blocked seeds
- Air blower with adjustments for air outlet
- Collecting outlet
- Air duct for directing the blown up light particles to outside
- Collecting bins.

Working principle

The seeds are fed into the hopper and they are guided to fall on the first sieve. The first sieve is a scalping screen which scalps all the foreign materials larger and heavier than seed and the entire quantity of seed passes through the first sieve. The second sieve is a cleaning sieve which removes all the unwanted particles larger in size than the seed. The third sieve is actually the grading sieve which size grade the seed lot and bring into a uniform size and which also screen the undersized, shriveled and immature seed, dust and dirt. The seeds are then rolled and passed through air column, where they are relived of the light chaffy and other materials by the blowing air.



while and takes the charge either to pass or to roll.

Types of seed cleaner cum grader

I) Crippen model cleaner cum grader

ii) Clipper model cleaner cum grader

iii) Petkas cleaner cum grader

III. Disc separator

Adjustments

Flutted roller

The speed of this roller can be adjusted so as to increase (or) decrease the flow of seeds to the hopper of the sieves.

Slope (or) inclination of the screen

The angle of inclination of the screens can be adjusted according to the nature of seeds.

Rate of vibration of sieve

This can be adjusted either to increase or to decrease the speed of the rolling seeds on the screen.

Volume of air flow: By increasing (or) decreasing the air inlet.

Choice of screens: According to variety we have to change the screen

Screen dams

Small check dams, which can be provided here and there on the screens so that the seeds can be stopped a

It consists of a series of discs, which revolve together on a horizontal shaft inside the cylindrical body. Each disc contains many under cut pockets. The seed enter the intake end of the separator and move through the open centers of the discs towards the discharge end of machine. As the discs revolve through the seed mass the pockets lift out short seed but rejects longer seed. Longer seeds are conveyed by flights on the disc spokes towards the discharge end of the machine where they go out through the tailings gate. The rate of seed travel through the open disc centers is controlled by conveyor or blades attached to the spokes of the discs. The disc separator makes a very precise separation. No factor other than seed length and shape affects its separation. Flexibility is obtained by varying size of the pockets.

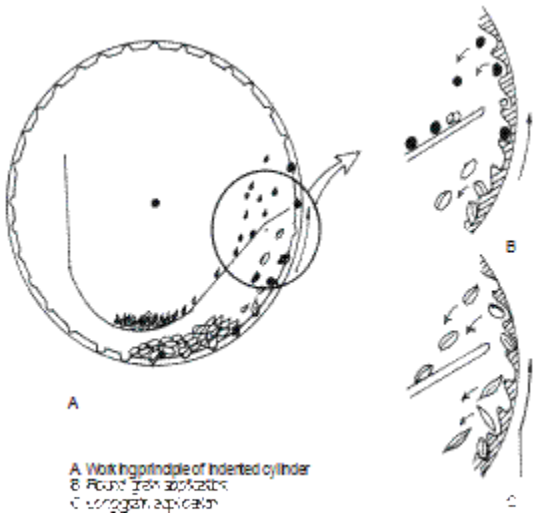
IV. Indented cylinder separator

The indented cylinder separator is a rotating, almost horizontal cylinder with movable, horizontal separating adjustments which are mounted inside it. Indent lines are there inside the surface of the cylinder. The indented cylinder revolves, turning the seed mass to give each seed a chance to fit into indent. Short seeds are lifted out of the seed mass and are dropped into the lifting and long seeds remain in the cylinder and are discharged out via., a separate spout at the end of the cylinder.

Lab Model

As the cylinder revolves, it creates centrifugal force which helps to hold the seed in the indent. Short seeds are held in the indent until the cylinder turns to the point where the indent is inverted enough for gravity to cause the seed to fall out of the indent. The length, surface texture and size of seeds determine how they fit into the indent, so that it can be lifted out of the seed mass. The speed of the cylinder creates centrifugal force which holds the seeds in the indent as it are lifted upward. Thus the shape and size of the seed to cause some seeds to fall

out after being lifted only a short distance, while other seeds are lifted closer to the top of the cylinder before they fall out.



Working principle of the indented cylinder separator

As the seeds enter the cylinder, the small, short, easy to separate seeds are quickly removed. The center cylinder section removes the intermediate sizes of seeds still in the cylinder. All indents in a cylinder are the same size, only the progressively declining amount of material to be lifted causes this difference in separating action.

Adjustments

1. Cylinder speed 2) Size of the indent 3) Trough setting 4) Tilt of the cylinder 5) Adjustable retarder.

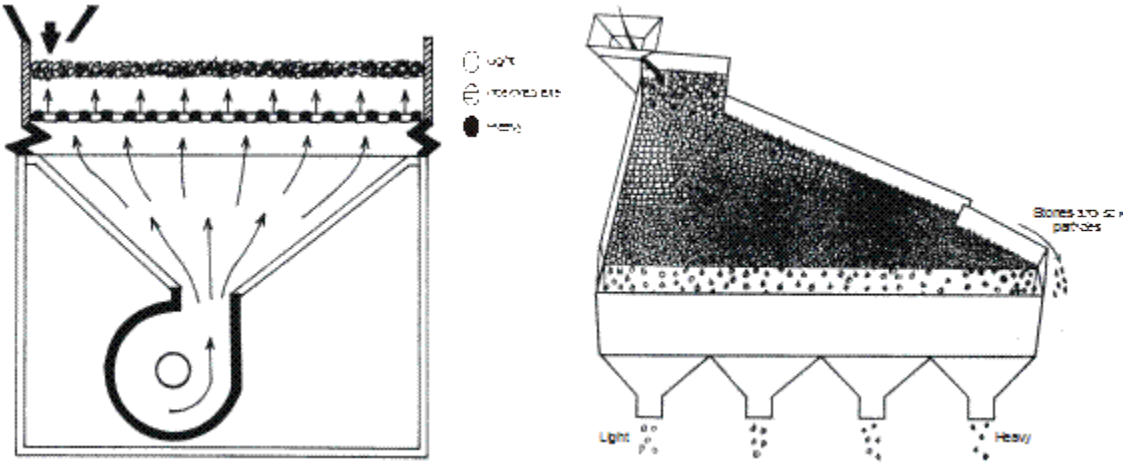
V. Specific gravity separator

Seeds of the same size and general shape can often be separated because they differ in specific gravity or relative weight. This difference is very useful in removing light, immature seeds or heavy sand and rocks to improve the purity and germination of crop seeds.

Lab Model

If seeds which differ in specific gravity (relative weight / unit of volume) are placed on

substrate of intermediate density, seeds of higher specific gravity will fall down through the substrata, while seeds of lower specific gravity will be buoyed up the substrata. Here air is used as separation substrata.



Working principle of the specific gravity separator

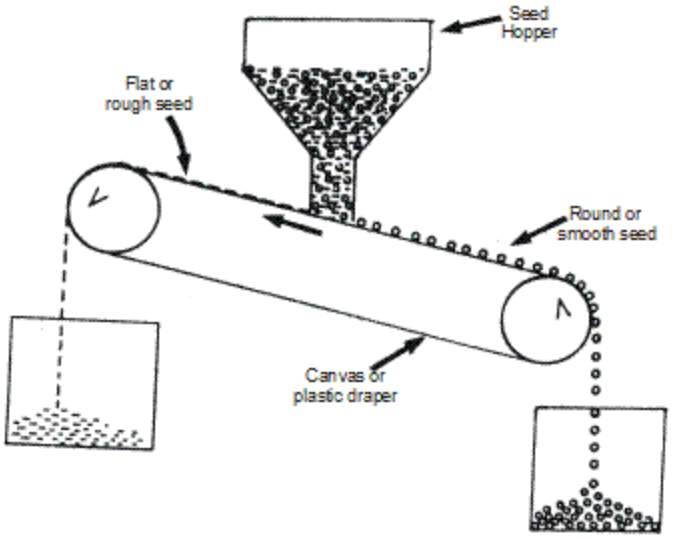
As seeds flow on the deck of the gravity separator, they enter a column of air coming up through the porous surface of the deck. The pressure of terminal velocity of the air rising through the deck can be controlled very closely to separate two kinds of seeds differing in specific gravity, the air is adjusted so that only the lighter seeds are lifted up off the deck surface. These lighter seeds are held up by air pressure and tend to float on the deck surface. The heavier seed possess a velocity greater than that of the air columns so they are not lifted and so will lie on the deck surface. The air column thus stratifies the seed mixture into vertical zones of relative weight with the heavier seed lying on the deck and the lighter seeds lifted up to the top of the seed mass.

Adjustments

1. Feed rate 2) Air flow 3) End slope 4) Side slope 5) Deck oscillation speed 6) Deck speed.

VI. Roll mill or dodder mill or velvet roll mill

It is used to separate the seeds based on surface texture and shape. This separator should be used only after the seed has been carefully cleaned and separated from the chaff. These are effective in separating seeds with a rough seed coat or shape angles from smooth seeds.



Working principle of the roll mill

The roll mill consists basically of two roller, covered with flannel or velvet, placed side by side, so that they touch each other down their entire length. The rollers are mounted on an incline and they turn in opposite directions. A curved adjustable shield is mounted above the rollers.

Separating action

The mixture of smooth and rough seeds is fed into the place, where the rollers touch each other, at the high end of the machine. As the rollers turn up and out, seeds that are rough or have sharp or broken edges are caught by the nap of the fabric covering the rollers. These seeds are thrown up against the curved shield. They strike the shield at an angle, bounce back down to the roller and are again thrown up against the shield. Smooth seeds bounce down the inclined position forward between the rollers, and discharge at the lower end of the machine. They are not affected by the fabric roller covering, and are not pitches over the side of the rollers.

Adjustments

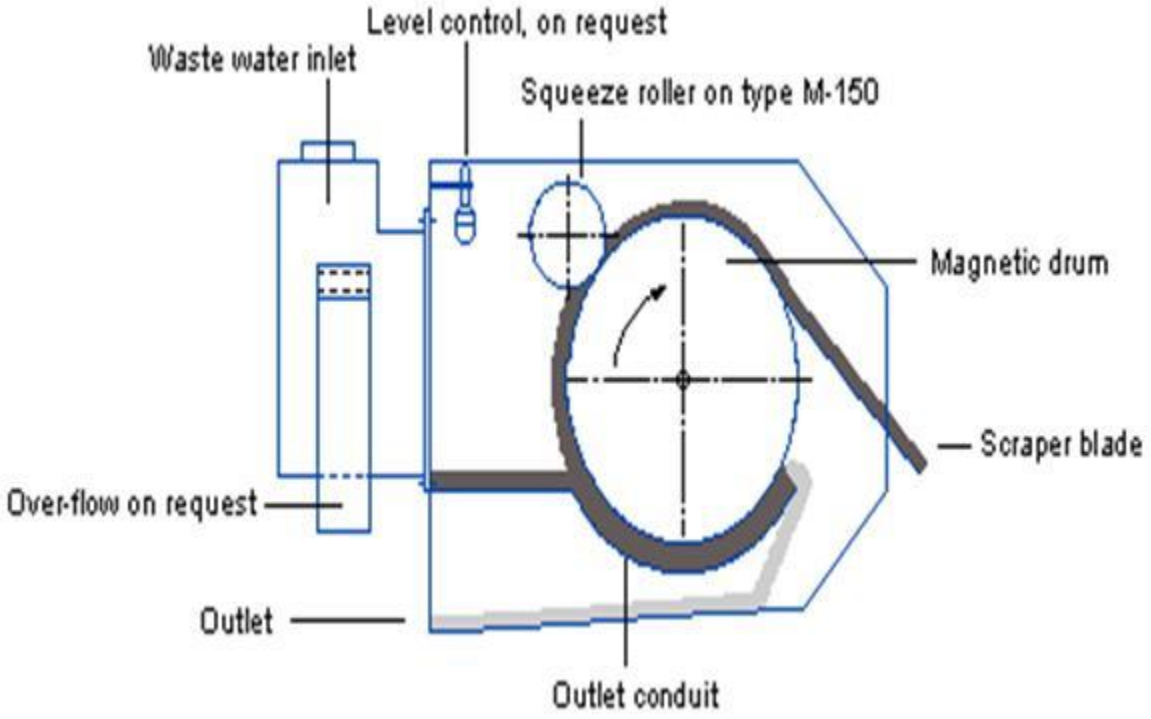
1) Rate of feed 2) Speed 3) Clearance between shield and rolls 4) The angle of inclination of rolls.

VII. Magnetic separator

The separation is mainly based on the affinity for liquids which is used for separation. Since seeds contains no free iron and are not attracted by a magnet they must be selectively pretreated with a magnetic material such as finely ground iron powder. Rough seed coats, cracked or broken seed coats, dirt lumps, chaff or seed with a sticky residue on the surface will hold the liquid and become sticky, so that iron powder will adhere to them. Smooth coated seeds will not absorb liquid. So no iron powder will adhere to them.

The seed are then discharged from mixing chamber and brought into contact with a powerful magnet, which removes the iron coated seeds. Most magnetic cleavers pass the seeds over a

revolving drum which has a high intensity magnetic field. Seeds with an affinity for liquids which are now coated with iron powder are attracted by the magnet and adhere to the drum until they are removed by a brush or scraper. Seeds which are relatively free of iron powder are not attracted by the magnet and will fall into a separate discharge spout.



The first requisite of magnetic seed separation is that the seed to be separated must possess different seed coat characters. Crop seeds should have a smooth surface, while the seeds to be removed should have a rough surface which will retain liquid and can accept the iron powder. Success in separating the components depends upon the magnitude of seed coat differences and thoroughness with which the moistened seeds and the iron powder are blended.

VIII. Colour separator

Many large crop seeds such as peas and beans differ in colour between varieties. Colour variation may also occur due to immaturity or disease. Electronic colour sorting machines can separate such seeds by difference in colour and also remove mud balls and discoloured seeds in the same operation.

The electronic colour sorter views each seed individually with photo electric cells. The seed is compared with a selected back ground or colour range and is discharged from the machine according to its colour. If it is the great desired colour, the seed is discharged through the good seed spout. If its colour or shade falls within the reject range, a blast of compressed air deflects the seed and sends it in to the reject discharge spout. These are highly sensitive. Since the machine views each seed individually, capacity is low, but the initial cost is high and operating cost is less. The usefulness of machine is greater with large seeded crops.

IX. Spiral separator

The separator, which classifies seed according to its shape and rolling ability, consists of sheet metal strips fitted around a central axis in the form of a spiral. The unit resembles an open screw conveyor standing in a vertical position. The seed is introduced at the top of the inner spiral. Round seeds roll faster down the incline than flat or irregularly shaped seeds, which tend to slide or tumble.

The orbit of round seed increases with speed on its flight around the axis, until it rolls over the edge of the inner flight into the outer flight where it is collected separately. The slower moving seed does not build up enough speed to escape from the inner flight. Most spirals have multiple inner flights arranged one above the other to increase the capacity.

Processing equipments used for improving the quality of the seed

From harvest upto final stage of seed storage, the seeds are to pass through various seed proessing equipments depending upon the speciality and specificity. But some equipment like driers and seed cleaner cum graders are common for all types of seed. The processing machineries and equipments used in the seed handling are as hereunder.

S.No.	Processing equipments	Usage with reference to specific seed management
A.	Threshing with extraction equipments	
1.	Thresher	To remove the seeds from the inflorescence especially in cereals
2.	Ginning machine	To separate the lint and seed from kapas in cotton
3.	Maize sheller	To shell the seed from the cobs
4.	Pulse thresher	To remove seed from the pods
5.	Tomato seed extractor	To extract tomato seed from fruit without wasting the pulp
6.	Chilli seed extractor	For easy removal of seed from chilli fruits
7.	Groundnut decorticator	To shell the kernel (seed from the pods
8.	Sunflower thresher	For removal of seeds from the head
9.	Debearder	To remove the awns form (Barley) the seed
10.	Mechanical scarifier	To scarify the hard seed mechanically to improve the germination of seeds
11.	Pebble mill	To remove webby hairs from grasses
12.	Timothy bumper mill	To remove weed seed from timothy seed
13.	Hammer mill	To remove the hook or appendages from the seeds (i.e. Stylosanthus)
B.	Driers	To reduce the moisture content to lower or needed level for safe handling both for processing and for storage at the final stage
C.	Grading equipments	
14.	Cleaner cum grader	This homogenize the precleaned seed based on size and is known as basic grading in seeds. The sieve sizes requirement vary with crop
15.	Precleaner and aspirator	This remove the inert material and dust particles from seed and improve the grading efficiency
D.	Upgrading machines	
16.	Specific gravity separator	Improve the quality of graded seed further using its weight or specific gravity. Heavier seeds are good storers and expresses maximum field establishment
17.	Indent cylinder	In lengthier seeds it maintains the size of seed (breadth and length). The broken / damaged are removed and good seeds are selected
18.	Disc separator	It is for removal of weed seeds and to improve the general appearance of seed

19.	Roll mill	To separate smooth seed from rough seed based on the surface texture especially the weed seed
20.	Magnetic separator	Removal of weed seed from clovers, alfalfa, trefoils and vetch
21.	Inclined draper	Separation of smooth or round seeds from rough, flat or elongated seeds
22.	Electronic colour sorter	Separation of off-coloured seed
23.	Electrostatic separator	Based on electrical properties removes Johnson grass from sesamum seeds (Specific utility)
24.	Spiral separator	Separation of seeds based on shape (eg.) separation of rape, vetch and soybean seed form wheat, oat or rye grass
25.	Polishers	To improve the luster of seed
26.	Picker belts	To remove undesirable ears / pods from shelled seeds (eg.) Groundnut, Corn
27.	Vibratory separator	Removal of weed seed
28.	Seed treater	To treat the seed with fungicide and pesticide
29.	Seed packing machine	To easier the work and to avoid human error of mixing
30.	Conveyors / Elevators (Belt , Bucket)	Easier the transfer of seed from machine to machine and avoids the contamination of seed at various level.

Though all the machines are highly useful in improving the seed quality, specific machines are utilized for specific crop. The sequential usage of machineries varies with crop seeds (Gregg, 1967).

Precautions in handling processing equipment

All machine adjustments like the speed, oscillation and duration should be perfect. Otherwise, it will result in mechanical damage of seed which reduces the quality of seed in terms of vigour, viability, storability and field stand. Drying of seed should be designed properly as the moisture content needed for threshing; grading, treating and bagging vary with operations. Dosage, exposure period and choice of chemical are important in mechanical seed treatment.

Lecture 29
SEED TREATMENT

Maintaining the quality of seed is dependent on many environmental factors, some of which are moisture, temperature, humirlity, and storage conditions. Even though these factors are properly accounted for, seed quality may still be reduced by certain seedborne diseases or destroyed by insects and other pests. Research has shown that treating seed with one or more pesticides is the most economical and efficient way to protect seed from these pests and improve seed quality. Since pesticides are poisonous, extra care and safety precautions must be taken when applying them and in handling seed after it has been treated.

Definition of treated seed

The term "treated" means "to give an application of a pesticide or subject seed to a process designed to reduce, control or repel disease organisms, insects, or other pests which attack the seed or seedlings."

Types of Seed Treatment

A. Pre sowing seed treatments

It is the treatments given to the seeds before sowing to improve the germination and vigour potential and as well as to maintain the health of the seed.

Pre sowing seed treatments includes the following

I. Chemical treatments to improve germination and vigour potential.

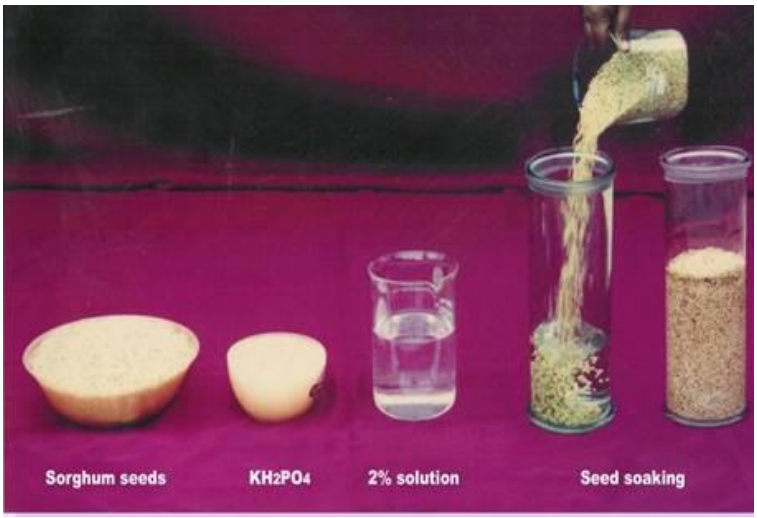
II. Insecticidal and fungicidal treatment.

III. Special treatments

I. Chemical treatments to improve germination and vigour potential

Soaking / treating the seeds with nutrients vitamins and micronutrients etc.

Paddy: Seeds can be soaked in 1 % KCl solution for 12 hours to improve the germination and vigour potential.



Sorghum: Seeds could be soaked in NaCl2 (1 %) or KH2PO4 (1%) for 12 hours for improving the germination and vigour potential.

Pulses : Seeds can be soaked in $ZnSO_4$, $MgSO_4$ and $MnSO_4$ 100 ppm solution for 4 hours to improve the germination and vigour potential.

II. Insecticidal and Fungicidal treatments

Seed health: It is an important attribute of quality seed. Though a seed lot that meets high standards of germination, vigour and purity if it is contaminated with seed borne pathogens and insect pests, may be useless to farmers because it may result in severe yield loss or even crop loss in an entire area.

Benefits of the insecticidal and fungicidal treatments:

1. Prevents the spread of plant diseases
2. It protects the seed from seed rot and seedling blights.
3. It improves the seed germination
4. It provides protection from storage insects.
5. It controls the soil insects.

Seed may be affected by viruses, bacteria, fungi, nematodes and insects. Seed pests and diseases of which the seed is a victim (e.g., grain weevils, Tricoderma spp., and storage pathogens such as Aspergillus flavus) should be distinguished from seed-borne diseases of which the seed is the vehicle of pest and pathogen dissemination (e.g., bunt of cereals, Tilletia spp.)

Seed Treatment Fungicides

Fungicides are applied to seed prior to planting to provide effective protection against many seed and soil-borne plant pathogens. Chemical (fungicide) treatment guards against the various seed rots and seedling blights that occur during storage or after planting. It is not usually a "cure-all" and will not provide disease protection throughout the growing season after the plants become self-sufficient. (An exception to this would be the control of loose smut by seed disinfection).

Fungicidal seed treatment may be divided into three categories, depending on the nature and purpose of the treatment. These categories are: (1) seed disinfection, (2) seed disinfestation, and (3) seed protection. A given fungicide may serve in one or more of these categories.

Seed disinfection - Disinfection is the elimination of a pathogen which has penetrated into living cells of the seed, infected it and become established-for example, loose smut of barley and wheat.

Seed disinfestations - Disinfestation is the control of spores and other forms of pathogenic organisms found on the surface of the seed.

Seed protection - Seed protection is chemical treatment to protect the seed and young seedling from pathogenic organisms in the soil.

Seed treatment materials are usually applied to seed in one of four forms: dust; slurry (a mixture of wettable powder in water); liquids; and planter-box formulations.

Based on composition, seed treatment fungicides may be organic or inorganic, metallic or non-

metallic, and, until recently, mercurial or non-mercurial. Before the cancellation of the 'volatile mercurials, fungicides for treating seed were generally classified as volatile and non-volatile. Vlith the elimination of the volatile mercurials, most fungicides now approved for use on seed are classified as non-volatile. When using this type material, complete coverage of the seed is necessary to obtain effective control.

Some of the systemics, a fairly new class of pesticides, may now be used as seed treatment materials. The desirability of having materials that would move inside the seed or plant and control the pest has long been recognized. Such materials are called "systemic." When used according to the manufacturer's recommendation (see label), a systemic moves through the host plant and controls or retards the growth of certain fungi and insects without affecting the host's metabolic system.

Seed Treatment Insecticides

Insecticides are often applied to seed to control or reduce insect damage to seed during storage and, to a lesser degree, to prevent damage from such insects as wireworms and seed corn maggots in the soil.

Combinations

Since some pesticides are selective in their control of pests, many times two or more compounds are combined in the treater tank, or an extra tank may be used, to give the spectrum of control needed.

The manufacturers of pesticides are now making combinations available to seed processors, but should a processor blend two or more pesticides, the compatibility of the materials must be determined, since some combinations of materials may seriously reduce seed germination. Also, when applying two or more pesticides, even at different times, the sequence of application may be very important. Whether a single pesticide or a combination is to be applied to the seed, read the label and follow the manufacturer's directions carefully.

Formulation of fungicides /insecticides

Fungicides / insecticides are available in the form of dusts, wettable powders and liquids.

1. Dusts : It is usually applied @ 200-250 gms / quintal of seed. Main dis-advantage is dusty condition will prevail during the seed treatment and after handling.
2. Slurry : This type of fungicide is applied to the seed along with soap like water suspension which can be mixed with seed by using special slurry treater.
3. Liquids : The use of liquid solution is known as the "quick wet ' method. Here a volatile fungicide is applied to the seed and it throughly mixed with them.

e.g. Chemicals like panogen, mercuran, etc. can be applied by this method.

Safety

There is a general tendency to use chemicals that are safe for user and environment. Very toxic substances, such a organic mercurials (Ceresan and others) and very persistant fungicides, such as Hexachlorobenzene ((HCB), are being replaced by new chemicals, In the past, these chemicals have caused severe cases of poisoning, some resulting in death. Most if not all occurred because treated seed was used for human consumption or livestock feeding instead of for planting. Even with the new, less toxic chemicals, the following safety precautions must be taken.

1. Treated seed must be clearly labelled and under no circumstances be used for feed or food.
2. Seed treatment should be carried out in a well-aerated area. Contact with chemicals through breathing of dusts and skin contact must be avoided. Protective clothing should be worn.
3. As with all pesticides, empty containers should be properly disposed of and never reused in a household or on the farm.

III. Special treatments

i) Seed hardening treatment

Seeds can be hardened for 2 purposes I) Drought tolerance ii) Cold tolerance
The treatments are imposed to the seeds mainly to tolerate initial drought and cold. Cold tolerance treatment is given to germinated seeds, such treatments are given only to temperate crop and tree seeds.
The most important factors to be considered while seed hardening are

1. Seed : solution ratio (1:1)
2. The duration of soaking
3. Method of drying.

The effectiveness of the treatment depends upon the conduct of seed hardening process. The solution amount never be higher than the amount of the seeds. All solution added should be imbibed by the seeds. There should not be any leftover solution as it causes leaching effect. Once the seeds imbibe water, the germination process takes place. At the end of soaking period the seeds should be dried back to its original moisture content. These seeds when sown the germination will be completed earlier whereas in non hardened seeds the process germination takes a longer period.
Chemicals used : $CaCl_2$, KCl, KH_2PO_4,

ii) Seed fortification

Main aim is to supply nutrients to seeds. The main objective is to achieve the high vigour

to overcome unfavourable soil reactions. eg.) seed fortification with MnSO4 @ 0.5 to 1 %. will improve oxidation - reduction potential of seeds, which ultimately leads to higher germination.

iii) Moist sand conditioning

It is a need based treatment the concentration can be increased upto 2-4 %. Amount of solution should be 1:1 ratio or slightly excess amount of water can be used. Protinaceous seeds should not be soaked in water (e.g) soybean, etc. for these seeds, mix the seeds with moist sand @ 5 to 10% MC. It should be kept for specified period of time. The method is known as moist sand hydration.

iv) Seed pelleting

Here the nutrients are coated on the seeds. This technique is very much adopted in forest tree seeds.

Importance

1. Normally in small seeds this technique is adopted .
2. By pelleting we can increase the size of sees and we can make it free flowing one.
3. Through this we can able to reduce the seed rate.
4. It is also important for aerial sowing (gum arabica) in tree seeds.

Materials used : Nutrients , adhesive, filler material.
Inert materials: Lime, CaCO3, Chalk powder.
Plant products : Neem, Notchi, Arappu, Arappu (Albizia amara) is found good contains a susbstance saponin (growth promoter) which is similar to GA in action.

v) Seed infusion

Infusion of nutrients and growth promoting substances with organic solvents like acetone and dichlormethane. The organic solvents, slowly increase the chemicals in to the seed. In this method there is no need for drying the seed materials to bring back the original moisture content of seed. The organic chemicals are evaporative in nature, after infusion is over, just we have to keep the seeds as such for 5 to 10 minutes in dry condition the organic solvents will evaporate during this time and we can perform sowing. Seed infusion can also be used for breaking the seed dormancy.

vi) Osmotic priming

It is a very expensive but it is a required process, particularly for large seeded legumes like peas, beans etc., They have high protein content and large embryo and are susceptible to soaking injury. High protein seeds are hygroscrpic and hydrophilic.

Osmotic priming is nothing but making the seeds to imbibe water very slowly. Osmotic

solutions used are (PEG) (poly ethylene glyster). Maintol is highly toxic. PEG is inert and will increase very slowly the water in to seeds. By preconditioning through osmotic priming, the seeds are invigourated which results in uniform, early and higher field emergence and higher seedling vigour.

vii) Fluid drilling

This is a technology evolved for mechanical sowing of seeds particularly the germinated seeds. The seeds are coated with a jelly material called guar gel. It is to have a buffer action to avoid damage of the germinated seeds during sowing.

viii) Separation of viable seeds

It is a new concept particularly for groundnut. This is a good method to get desired seed germination and plant population. Incase of groundnut the actual population requirement is 30 plants / m2. Actual seed multiplication rate in groundnut is 1:8 . There are about 30-40% of dead seeds and of such dead seeds are eliminated, and then we will be able to maintain the required plant population in the field. This is the base for evolving this technology.

This can be done in 2 ways

1. Manual separation based on radicle emergence (groundnut)
2. IDS (Incubation - Drying and Separation) method.

B. Pre storage treatments

Prestorage treatments of harvest-fresh seed are primarily aimed towards protection against deteriorate senescence during storage. Seed storage which is again threatened by insect and pathogen attack, can also be taken care of by prescribed prestorage seed treatments.

1. Halogenation
2. Antioxidant treatment
3. Seed sanitation

C. Mid storage treatments

Seeds in storage accumulate damage to cell membranes during senescence. Mid storage seed treatments are capable of reducing the age induced damages and restoring the seed vigour to a certain extent besides, the seed viability and productivity of stored seeds are also improved.

i) Hydration – Dehydration

It is the process of soaking the low and medium vigour seeds in water with or without added chemicals usually for short durations to raise the seed moisture content to 25 – 30% and drying back the seeds to safe limits for dry storage.

The hydration – dehydration treatments

1. Should be given only to stored seeds.
2. Is effective in low and medium vigour non- leguminous seeds,
3. The moisture equilibration and moist sand conditioning treatments in which moisture is

taken up by the seed in a slow and progressive manner, are recommended for relatively high-vigour seeds and seeds of pulses and leguminous vegetable crops
6. Direct soaking of leguminous seeds should be avoided.
7. Would not make a seed germinable, which has already lost viability.

Types of H-D treatments

The wet treatments include soaking-drying, dipping-drying, spraying-drying, stepwise hydration-drying, moisture equilibration-drying, moisture equilibration soaking-drying, moist and conditioning-drying, etc. The choice of the treatment depends upon the characteristics of seed and initial vigour status of the seeds.

Soaking – Drying (S-D)

Stored seed is soaked in water or solution of chemicals sufficient to cover it and kept at room temperature for 2-6 hour depending on the material with occasional stirring. The soaked seed is taken out and after surface drying in the shade for some time, dried back to the original moisture content Dilute solution of chemicals such as sodium or potassium phosphate (di and mono basic), sodium chloride,
p-hydroxy benzoic acid, p-amino benzoic acid, oxalic acid, potassium lodide, etc can also be used at 10-4 to 10-3 M concentrations. Fungicidal and insecticidal formulations can also be incorporated in the soak water.

Dipping – Drying (D-D)

Seeds are dipped in water or solutions of the aforesaid chemicals for only 2-5 minutes and the wet seed is taken out immediately and kept covered for 2 – 6 hours depending on the material, for absorption of surface water followed by drying back in S-D. This treatment is effective in most high and high-medium vigour seeds of rice, wheat, jute, summer and winter vegetables

Spraying – Drying

Seeds are spread in a thin layer and then an amount of water (approximately 1/5 to ¼ of the seed weight) is sprayed on to it in two equal installments (turning over the seed layer after the first spray) and then kept covered by a polythene sheet for 2-4 hours before drying back. This treatment is similar to D-D in its efficacy and suitability.

Moisture equilibration – drying (ME – D)

Here, the seeds are placed in thin layers on trays kept on a raised platform in a closed moisture saturated chamber lined internally with moist blotters giving nearly 100% RH at room temperature. After 24-48 hours, depending on the material and ambient temperature, the seed is dried back in the usual way. For soaking injury prone seeds this treatment, which gives a slow and progressive rise in moisture content, is very effective. ME-D, however, difficult to practice on a large scale and is not advocated for low vigour non leguminous seeds because of possible aging effect of the treatment especially when given for prolonged periods.

Moist sand conditioning – drying (MSC-D)

This treatment is similar to the moisture equilibration treatment but easier to practice. For slow

and progressive moisture uptake, the seed is thoroughly mixed with pre-moistened sand, using 3 times the amount of air dry sand than seed. Moisture content of sand is adjusted to 5-10 by adding the requisite amount of water or solution of chemicals to previously washed and dried fine grain building grade sand. The addition of water should be so adjusted as to get the required hydration effect without initiating the germination process. After mixing the dry seed with the premoistened sand, the mixture is kept at room temperature for 16 – 36 hours depending on the material and sand moisture content. The seed absorbs moisture from sand and after incubation the hydrated seed is separated from sand by sieving and dried back to the original weight.

Mode of Action The main purpose of hydration is to raise the seed moisture content to 25 – 30% (wet weight basis) before drying back to safe limits for dry storage. The hydration - dehydration treatment may improve the vigour by controlling free radical reactions and consequent peroxidative damage to lipoprotein cell membranes.

SEED TREATING EQUIPMENT

Commercial seed treaters are designed to apply accurately measured quantities of pesticides to a given weight of seed. Basically, there are three types of commercial seed treaters on the market: dust treaters, slurry treaters, and direct treaters-the Panogen and Mist-O-Matic treaters are examples of direct treaters.

1. Dust Treater *(Gustafson XL Dry Powder Seed Treater)*

Controlling the Flow of Seed:

The amount of seed which flows into the weigh pan (which is just beneath the feed hopper on top of the treater) is controlled by opening or closing the gates of the feed hopper by means of the hand wheel on the side of the hopper. The scale on the hopper shows how far the gates are open (in inches). Gates should be open to whatever number of inches it takes to keep the weigh pan filled to the required number of pounds per dump as it tilts in either direction. The number of pounds per
dump is adjusted by correctly setting the counterweight up or down on the counterweight arm.

Powder Application:

To be sure that the correct amount of powder is being applied to the seed flow, a preliminary test must be made in which a given number of pounds of seed (such as 100 lbs) is run through the feeder.

During this run, the measuring cup provided with the feeder should be used to catch the powder as it comes off the vibrator. After the given amount of seed has run through, the powder should be weighed in order to determine how much is being applied to that amount of seed. The vibrator speed can then be adjusted accordingly. Then a second or more tests should be run until proper setting of the vibrator speed is determined for correct coverage.

Approximate Setting

No. Dumps	Powder Scale Opening	Syntron Setting	Oz. Produced/100 lbs.
25	1/2	60	2
25	3/4	60	5
25	3/4	70	6
25	3/4	80	7
25	1	60	10

Number 4 on counterweight arm gives five pounds per dump.

2. Slurry Seed Treater

The slurry treatment principle involves suspension of wettable powder treatment material in water. The treatment material applied as a slurry is accurately metered through a simple mechanism composed of a slurry cup and seed dump pan. The cup introduces a given amount of slurry with each dump of seed into a mixing chamber where they are blended.

While operation of the slurry treater is relatively simple, the various operation procedures must be thoroughly understood.

1. The metering principle is the same in direct, ready-mix or fully automatic treaters-i.e., the introduction of a fixed amount of slurry to a given weight of seed.

1. To obtain a given dump weight, slurry treaters are equipped with a seed gate that controls seed flow to the dump pan. With the proper seed gate setting, a constant dump weight for a given can be obtained.

1. The amount of treatment material applied is adjusted by the slurry concentration and the size of the slurry cup or bucket. As the dump pan fills, a point is reached where it over-balances the counter weight and dumps into the mixing chamber. This brings the alternate weighing pan in position to receive the inflow of seed and activates a mechanism to add a cup of slurry to the mixing chamber. Thus, one cup of slurry is added with each dump of seed.

1. The mixing chamber is fitted with an auger type agitator that mixes and moves seed to the bagging end of the chamber. The speed of the auger is important, because at slow speeds more uniform distribution is obtained.

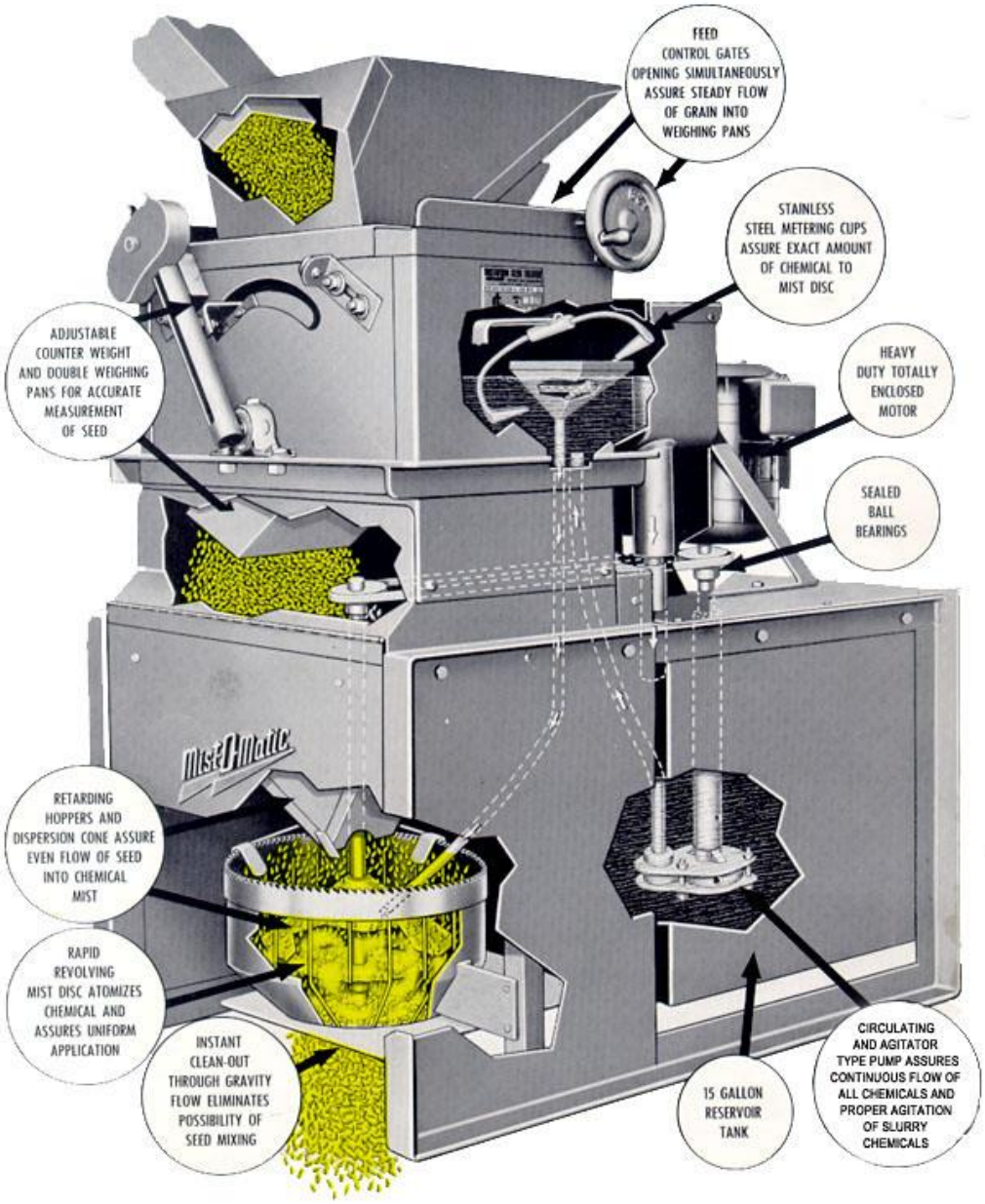
Slurry tanks have 15 to 35 gallon capacities, depending upon the size of the treater. They are equipped with agitators that mix the slurry in the tank and keep it suspended during operation. It is important that the powder be thoroughly suspended in water before treating. If the treater has been idle for any period of time, sediment in the bottom of the slurry cups must be cleaned out.

The proper size slurry cup must be used. Most machines now have cups with ports and rubber plugs for 15 cc, 23 cc, and 46 cc quantities. Some users prefer to mix the slurry in an auxiliary tank and then transfer to the slurry chamber as needed.

DIRECT TREATERS

Direct treaters are the most recent development and include the Panogen and Mist-O-Matic treaters. These two were initially designed to apply undiluted liquid treatment. Instead of applying 23 cc of material per 10 pounds of wheat, as in slurry treaters, they apply 14 to 21 cc (1/2 to 3/4 ounces) per bushel of "wheat. This small quantity of material is suitable only with liquid materials which are somewhat volatile and do not require complete, uniform coverage for effective action.

Later modifications for direct treaters include dual tanks that permit simultaneous addition of a fungicide and an insecticide, and adaptations for the application of slurries. The metering



device used in both types of direct treater is similar to that of the slurry treater, since it is attained through synchronization of a treatment cup and seed dump. Otherwise, the two direct treaters differ decidedly from the slurry treater and from each other. Both of these direct treaters have an adjustable dump pan counter weight to adjust the weight of the seed dump. This is not practical with slurry treaters.

3. Panogen Seed treater

The operation of the Panogen treater is relatively simple. A small treatment cup, operating from a rocker arm directly off the seed dump pan and out of a small reservoir, meters one cup of treatment with each dump of the seed pan. Fungicide flows through a tube to the head of the revolving drum seed mixing chamber. It flows in with seed from the dumping pan and is distributed over the seed by
the rubbing action of the seed passing through the revolving drum.
The desired treating rate is obtained by the size of the treatment cup and by adjusting the seed dump weight. Treatment cup sizes are designated by treating rate in ounces and not by actual size-e.g., the 3/4 ounce cup applies 3/4 ounce (22.5 cc) of treatment per bushel with six dumps per bushel. The actual size of this cup is approximately 3.75cc.

4. Mist-O-Matic Seed Treater:

The "mist-o-matic" treater applies treatment as a mist directly to the seed. The metering operation of the treatment cups and seed dump is similar to that of the "Panogen" treater. Cup sizes are designated by the number of cc's they actually deliver-e.g., 2 ½ , 5, 10, 20 and 40. The treater is equipped with a large treatment tank, a pump and a return that maintains the level in the small reservoir from which the treatment cups are fed.

After metering, the treatment material flows to a rapidly revolving, fluted disc mounted under a seed-spreading cone. The disc breaks droplets of the treatment solution into a fine mist and sprays it outward to coat seed falling over the cone through the treating chamber. Just below the seed dump are two adjustable retarders designed to give a continuous flow of seed over the cone between seed dumps. This is important since there is a continuous misting of material from the revolving disc. The desired treating rate is obtained through selection of treatment cup size and proper adjustment of the seed dump weight.

Lecture 30
SEED STORAGE

Maintenance of seed vigour and viability in terms of germination from harvest until planting is of the utmost importance in any seed production programme. Care should be taken at every stage of processing and distribution to maintain the viability and vigour. The harvested seeds of most of the orthodox crop seeds are usually dried and stored for atleast one season until the commencement of the next growing season, except those of the recalcitrant seeds which require high moisture content for safe storage (once dried the viability will be lost. E.g. – Jack, Citrus, Coffee, Cocoa, Polyalthea, etc.,). In such recalcitrant seeds senescence starts in the mother plant itself. The dry weather alters moisture content of the seed, thereby reducing the viability. Some seeds require an after ripening process as in Pinus and Fraxinus. In most of the Agricultural crops ageing starts at physiological maturity, which is irreversible. Hence seeds become practically worthless if they fail to give adequate plant stands in addition to healthy and vigorous plants. Good storage is therefore a basic requirement in seed production.

Purpose of seed storage

Seeds have to be stored, of course, because there is usually a period of time between harvest and planting. During this period, the seed have to be kept somewhere. While the time interval between harvest and planting is the basic reason for storing seed, there are other considerations, especially in the case of extended storage of seed.

The purpose of seed storage is to maintain the seed in good physical and physiological condition from the time they are harvested until the time they are planted. It is important to get adequate plant stands in addition to healthy and vigorous plants.

Seed suppliers are not always able to market all the seed they produce during the following planting season. In many cases, the unsold seed are "carried over" in storage for marketing during the second planting season after harvest. Problems arise in connection with carryover storage of seed because some kinds, varieties and lots of seed do not carryover very well.

Seeds are also deliberately stored for extended periods so as to eliminate the need to produce the seed every season. Foundation seed units and others have found this to be an economical, efficient procedure for seeds of varieties for which there is limited demand. Some kinds of seeds are stored for extended periods to improve the percentage and rapidity of germination by providing enough time for a "natural" release from dormancy.

Regardless of the specific reasons for storage of seed, the purpose remains the same maintenance of a satisfactory capacity for germination and emergence. The facilities and procedures used in storage, therefore, have to be directed towards the accomplishment of this purpose.

STAGES/SEGMENTS OF SEED STORAGE

In the broadest sense the storage period for seed begins with attainment of physiological maturity and ends with resumption of active growth of the embryonic axis, i.e., germination. The entire storage periods can be divided into:

1	**Post maturation/ Pre harvest segment**	Period from physiological maturity to harvest (seed in field).
2	**Bulk seed segment**	Period from harvest to packaging (bulk seed in aeration drying bins, surge bins, etc.).
3	**Packaged seed segment**	Period from packaging to distribution (seed in Packages in warehouse).
4	**Distribution /Marketing Segment**	Period during distributing and marketing (packaged seed in transit and / or retailer's storehouse).
5	**On-farm segment**	Period from purchase to planting of seed (seed in on-farm storage).

Seeds are considered to be physiologically and morphologically mature when they reach maximum dry weight. At this stage dry-down or dehydration of the seed is well underway. Dry-down continues after physiological maturity until moisture content of the seed and fruit decreases to a level which permits effective and efficient harvest and threshing. This stage can be termed as harvest maturity. There is usually an interval of time between physiological maturity and harvestable maturity, and this interval represents the first segment of the storage period. Any delay in harvesting the seed after they reach harvest maturity prolongs the first segment of the storage period – often to the detriment of seed quality.

The second segment of the storage period extends from harvest to the beginning of conditioning. Seed in the combine, grain wagon, and bulk storage or drying bins are in storage and their quality is affected by the same factors that affect the quality of seed during the packaged seed segment of the storage period. The third segment of the storage period begins with the onset of conditioning and ends with packaging. The fourth segment of the storage period is the packaged seed phase which has already been mentioned. The packaged seed segment is followed by storage during distribution and marketing, and finally by storage on the farm before and during planting.

The seed quality can be considerably be affected at any of the stages or segments mentioned above unless sound principles involved in seed storage are practiced and the seeds are properly handled.

Types of storage

The types of storage needed can be related to the time of storage expected. Broadly this can be classified into 4 types.

1. Storage of commercial truthfully labelled and certified seed.
2. Storage of carry over seeds.
3. Storage of foundation seed stocks and enforcement seed samples.
4. Storage of germplasm seeds.

1. **Storage of commercial seeds**

This storage of commercial seed requires the largest storage need from harvest until planting. The storage period ranges from 8-9 months. Seed must be dried to 14 per cent moisture content for starchy seed and 11 percent for oilseeds.

1. **Carryover seeds**

About 20-25 per cent of stored seed may have to be carried over through one season to the second planting time. The storage period may range 1-1½ year. Storage of seeds in metal bins with tight fitting lids or in a moisture proof bag will solve the problems of moisture penetration, provided the seeds are already dry enough for sealed storage.

1. **Foundation stock and enforcement seed sample**

It is desirable to store foundation and enforcement seeds for several years since genetic drift are minimized by reproducing foundation or stock seeds. Since the quantity of seeds involved is not large, the storage room is only a small part of the total storage area and in fact, is often a small room within a large warehouse. Relative humidity and temperature combination has to be provided for maintaining the viability. A combination of 25 per cent RH at 30oC temperature or less or a RH of about 45 per cent at 20oC or less will be ideal. The required RH can be achieved by making the room moisture proof and by using a dehumidifier.

1. **Germplasm seed storage**

Germplasm seeds are required to be kept for many years, perhaps very long periods. Basic requirements for such long term storage are the coldest temperature economically possible and seed moisture is in equilibrium with 20-25 per cent RH. Germplasm storage built up so far have rooms which can be maintained at 5oC to 10oC and 30 per cent RH. In addition, the stored samples are dried to perfect moisture level.

PRINCIPLES OF STORAGE

1. Seed storage conditions should be dry and cool
2. Effective storage pest control
3. Proper sanitation in seed stores
4. Before placing seeds into storage they should be dried to safe moisture limits.
5. Storing of high quality seed only i.e., well cleaned treated as well as high germination and vigour.

FACTORS AFFECTING SEED LONGEVITY IN STORAGE

1. Kind (or) variety of seed
2. Initial seed quality
3. Moisture content
4. Relative humidity and temperature during storage
5. Provenance
6. The activity of organisms associated with seeds in storage.

1. **Kind or variety of seed**

Seed storability is considerably influenced by the kind or variety of seeds. Some seeds are short lived. E.g.: Onion, Soybean and Groundnut. As a general rule starchy seeds can be stored considerably for a longer period compared to proteinaceous or oily seeds because of their hygroscopic nature.

2. **Initial seed quality**

Seed lots having plumpy, vigorous undamaged seeds store longer than that of deteriorated. Even seed lots having good germination at the beginning of storage period, may deteriorate at a faster rate depending upon the severity of weathering damage, mechanical injury or otherwise in the field. The low quality seeds should invariably be rejected. Even at best

storage conditions, the initial quality of the seed cannot be improved (except for the dormant seed) but can only be maintained.

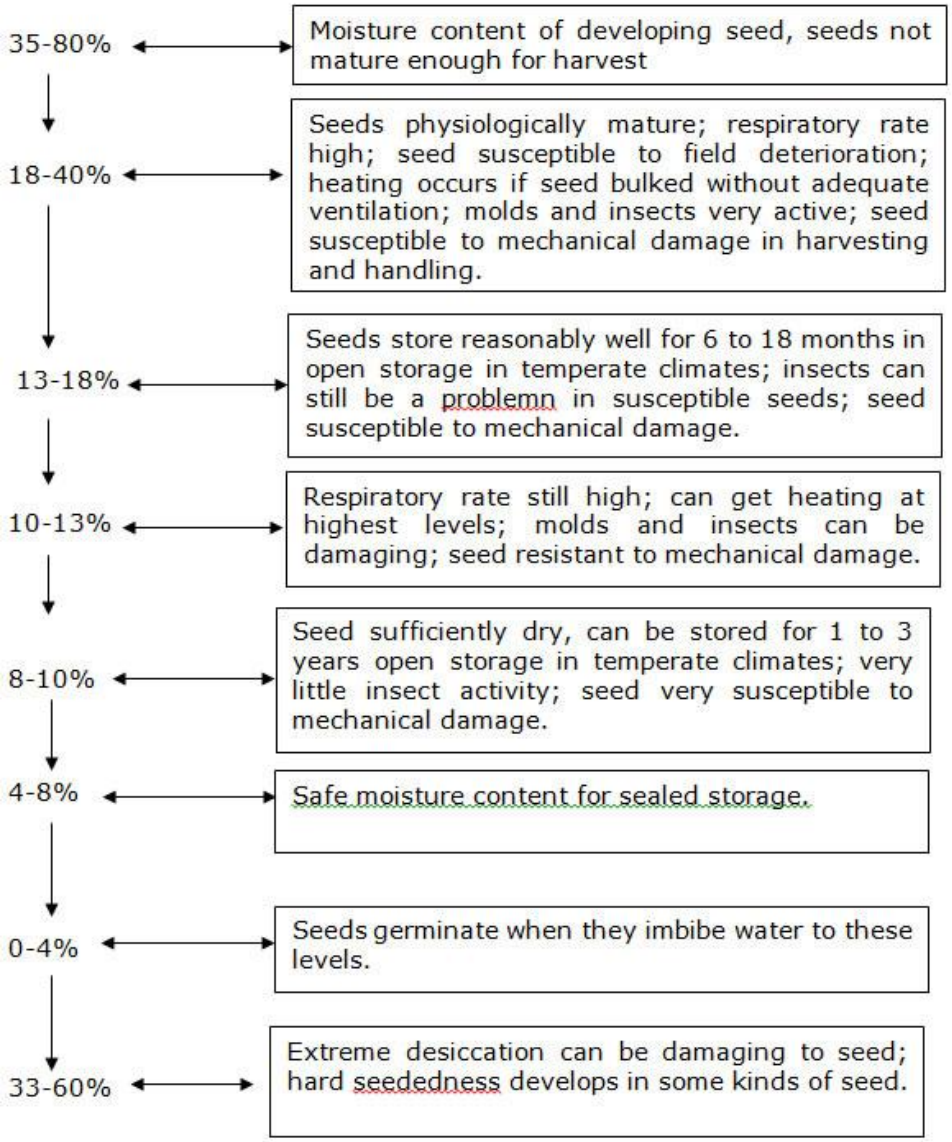
3. **Moisture content**

The most important factor influencing seed viability during storage is the moisture content and the rate of deterioration increases, as the seed moisture content increases. The drier the seed the higher will be the storage life.

Seed moisture content (%)	**Storage life**
11-13	½ year
10-12	1 year
9-11	2 years
8-10	4 years

It is well known that higher moisture content enhances the biological activity in the seeds and causes excessive heating, besides promoting mould and insect activities. The relationship of moisture content of seeds during post harvest stages furnished below would clearly indicate the role of moisture in the life of seeds in storage.

Role and importance of moisture content in the life of seeds



The importance of seed moisture content in extending the shelf life of seeds under ideal storage conditions can be well known and understood from the Harrington's thumb rule, that one per cent decrease in seed moisture content nearly doubles the storage potential of the seed. Again this rule is applicable only at a moisture range of 5-14 per cent because, moisture content below 5 per cent the physio chemical reaction may take place and at above 14 per cent fungi and insects become active. Another rule given by Harrington states that for every 5oC decrease in storage temperature, the seed life will be doubled. Again this can hold good only in the temperature range of 0-50oC. There are exceptions in this rule in a few crops like chillies, brinjal and bhendi. The safe moisture content again depends upon the period of storage, storage structures, kind and variety of seed and the packaging materials used. For

cereals under open storage, seed drying upto 10 per cent moisture content appears quite satisfactory. The storage in sealed containers during upto 4-8% moisture content depending upon the particular kind of seed may be necessary.

Use of desiccants

Desiccant like silicagel can maintain the moisture content in equilibrium with the Relative Humidity of 45%. It is kept @ 1kg/10 kg of seeds. When the silicagel turns to pink colour it should be dried at 1750 in oven and then again placed in the container.

4. Relative humidity and temperature during storage

Seeds are hygroscopic. They attain rather specific and characteristic moisture content when subjected to given level of atmospheric humidity at a particular temperature (equilibrium moisture content). The equilibrium moisture content for a particular kind of seed at a given relative humidity tends to increase as temperature decreases and the deterioration starts. Equilibrium moisture content varies among seed kinds. In general, the equilibrium moisture content of "oily" seed is lower than that of "starchy" seed at the same relative humidity and temperature. This phenomenon can be accounted for by the fact that fats and oils do not mix with water. Thus, in a seed with 50% oil content, the moisture has to be concentrated in half the seed, while in a seed containing 10% oil, the moisture is distributed throughout 90% of the seed.

Thus the maintenance of moisture content of seed during storage is a function of RH and to a lesser extent of temperature. At equilibrium moisture content there is no net gain or loss in seed moisture content when seed is placed in a new environment with RH higher or lower than that of the seed, the seed will gain or lose moisture till it reaches a new equilibrium moisture content at this particular new environment.

Dry, cool conditions during storage

The general prescription for seed storage is a dry and cool environment. At this point, the question naturally arises: How dry and how cool? It is difficult to answer this question unless three factors are known: (1) kind(s) of seed to be stored; (2) desired period of storage and (3) physiological quality of the seed.

Seed of most grain crops, e.g., corn, wheat, sorghum, barley, rye, oats, rice, will maintain germination for the 8-9 months period from harvest to planting at moisture content of 12-13% and normal warehouse temperature except possibly in Southern coastal areas. For maintenance of vigour as well as germination, moisture content should not exceed 12% (relative humidity below 60%) and temperature in the warehouse should not exceed 650 F. In the case of carry-over seed, which means a storage period of 20-21 months, the moisture content of seed of grain crops should be less than 11% and temperature should not exceed 650 F. Since the period of carry-over storage encompasses atleast one summer period, temperatures and humidity control during the period is most important.

Cotton seed stores about as well as seed of grain crops, and the conditions mentioned above are applicable.

Soybeans and peanut seed are poor storers. For one year's storage (actually 8-9 months), moisture content should be 11 to 12% and the warehouse temperature should not exceed 650F. Shelled peanuts may have to be stored in a cold room. Carry-over storage should not be attempted unless conditioned storage facilities are available: 650F and 50% relative humidity or better.

Seed of most forage grass and legume crops will store well for one year at moisture content of 10-11% at normal warehouse temperatures. When "carried-over", moisture content should be about 10% and temperature should not exceed 65%.

Vegetable seed vary considerably among kinds in their storage requirements. Generally, however, most kinds will store well for one year at a moisture content of 9-11% and a temperature that does not exceed 650F.

When a storage period longer than 19-21 months is required, conditioned storage is essential for all kinds of seed. Most kinds of seed will maintain quality for 2-3 years when stored at 600F and 50-55% relative humidity or better. For storage longer than 3 years, conditions should be 500 F and 50% relative humidity or better.

5. Provenance

The seeds harvested in different climates (or) at different times show differences in viability. Because they would have been subjected to different pre harvest conditions which will have caused different amounts of deterioration by the time, the seeds are harvested.

6. The activity of organisms associated with seeds in storage

The bacteria, fungi, mites, insects, rodents and birds may do harm to seeds in storage. The general limits of temperature and relative humidity for the multiplication of the various biological agencies infesting stored seeds are,

Organism	Temperature		Relative humidity
	Range for multiplication	Optimum range	
Insects	21-42oC	27-37oC	30-95%
Mites	8-31oC	19-31oC	60-100%
Fungi	8-80oC	20-40oC	60-100%
Microbes	8-80oC	26-28oC	91-100%

It is also interesting to note that the favourable limits of temperature and RH for germination are 16-42oC and 95-100 per cent respectively.

Sanitation in storage

There are several other recognized procedures for good seed storage that most seeds men already know. Seeds should be stored in a seed warehouse, not a fertilizer, chemicals, herbicide, or feed warehouse. Good sanitation should be a continuous practice. It will minimize storage insect infestations. If storage insects are a problem, the judicious use of insecticides and fumigants, combined with sanitation, will alleviate the problem. The best

procedure is not to place insect infested lots in storage with other lots unless all the insects have been killed by fumigation or insecticide treatment.
In warehouse with concrete floors, seed bags should be stacked on wooden pallets to keep them from contact with the floor as considerable moisture can be transmitted through concrete floors. Seed warehouses should also be adequately ventilated (unless they are conditioned) and protected against rodents.

Storage Conditions

Since seed moisture content and ambient relative humidity are in equilibrium during storage, maintenance of a "safe" moisture content requires an average level of relative humidity in the storage environment no higher than that in equilibrium with the "safe" or desired moisture content. This favorable situation can be achieved in only three ways: (1) location of the storage facility in a region where relative humidity does not rise – on the average – above the critical level; (2) maintenance of the relative humidity at the desired level by packaging seed in moisture vapor proof containers; or (3) dehumidification of the storage room atmosphere to the desired level. The desired level of relative humidity for successful storage of seed depends, of course on the kind of seed, the duration of the storage period, and the temperature.

SEED PACKAGING IN RELATION TO SEED STORAGE

In reality the seed package is a small storage container. The kind of container needed is affected by several factors including :

1. The quantity of seed desired in each package
2. The protection desired
3. The cost of the package
4. The value of the seed
5. The storage conditions into which the container is to be placed and
6. The facilities for drying the seeds

Depending upon the cost availability and the period of storage, the packaging materials are to be selected. Normally cereal seeds are being packed in cotton, jute and paper bags. Moisture vapour penetrates in these containers and they offer no protection against high relative humidity. In high humidity locations with inadequate seed storage facilities, consideration should be given to methods of packaging which can protect the seed from moisture vapour. Such moisture vapour proof containers include paper aluminium foil pouches, polyethylene bags of over 700 gauge thickness, sealed tins and gasketted rigid plastic containers. The costs of these are high, for the package of cereal seeds. Polyethylene bags have been regarded as the most attractive, because of their relatively low cost, compared to other kinds of sealed containers. Rigid plastic containers and sealed tins offer some possibility for hybrid seeds of

cotton and vegetables, if the quantity needed is not great.

Classification of packing materials or containers

1. **Moisture and vapour pervious containers**

These containers allow entry of water in the from of vapour and liquid. These are suited for short term storage. The seeds in these containers will attain seed equilibrium moisture with the surrounding atmosphere (eg) cloth bags, gunny bags, paper bags etc.

2. **Moisture impervious but vapour pervious containers**

These allow entry of water in the form of vapour and not in liquid. The seeds in the containers can't be carried over for long period in hot humid conditions (.g.) polythene bags of <300 gauge thickness and urea bags.

3. **Moisture and vapour proof containers**

These containers will not allow entry of moisture in the form of liquid or vapour. These are used for long term storage even in hot humid conditions if the seeds are sealed at optimum m.c. eg. Polythylene bags of >700 gauge thickness, aluminium foil pouches, rigid plastics etc.

Certified seeds of cereals, pulses and oil seeds are normally packed either in gunny bags or cloth bags. However, paper bag, aluminium foil pouches and polyethylene bags are used for packing flower and vegetable seeds.

Seed storage in relation to seed deterioration

The Purpose of seed storage has been previously stated, ***viz.***, to preserve or maintain the physiological quality of seed for the period desired through minimization of the rate of deterioration. Since seed storage is basically concerned with "control" of deteriorative processes, some knowledge of these processes is essential for successful seed storage operations.

Deteriorative changes in seed and their consequences

In our consideration of some of the characteristics of deterioration in seed, another might have been added that deterioration is characterized by change. Indeed, in our context, deterioration and change – detrimental change – are almost synonymous. For deterioration is identifiable only in terms of observable or measurable changes in the response reactions of the seed. Conversely, detrimental changes, e.g., loss of germination or vigour, are said to be the result of deterioration.

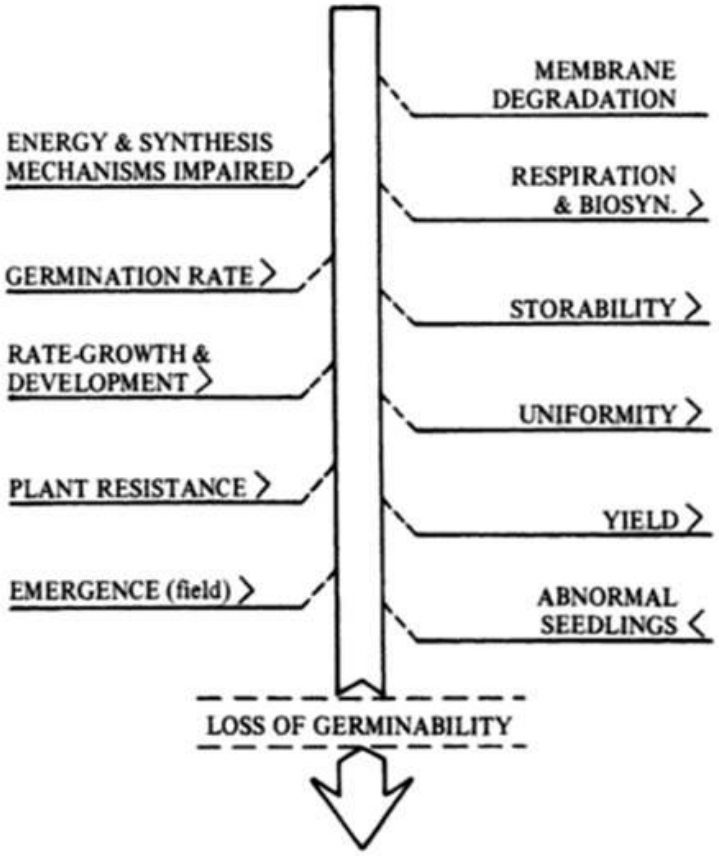
In the sequence of deteriorative changes postulated in figure 1, it can be readily seen that during deterioration, the "performance potential" of seed becomes progressively impaired (reduced) until they lose their capacity to germinate, at which time "performance potential" is zero. Since loss of the capacity to germinate is the last practically significant consequence of deterioration, the design and evaluation of storage conditions only in terms of "maintenance of germination" is not sufficient. The "lesser consequences" of deterioration must also be considered because collectively they determine the "vigour" level of the seed. And, the vigour of seed determines how well they germinate, emerge, grow, and develop in the farmer's field.

Longevity of seed is a characteristic of the species or variety

Some kinds of seed are inherently long-lived, others are short-lived, while others have an "intermediate" life span. Differences in storability extend even down to the variety level. It has been known, for example, the certain inbred lines of corn are "poor storers" and that this characteristic is inherited.

Inherent differences in seed longevity are facts, the seeds man must accept and contend with as best he can. Among the vegetables, onion seed are notoriously short-lived, radish seed are intermediate in longevity, and watermelon seed are relatively long-lived. Soybean and peanut seed do not store well as compared to seed of wheat, corn, cotton, sorghum and rice. In some cases, seed kinds which have very similar chemical and physical properties differ substantially in longevity. Tall fescue and annual ryegrass seed are similar in structure, chemical composition, and yet, ryegrass seed store better than tall fescue seed.

Possible Sequence of changes in seed during deterioration



Seed selection for extended storability

- Store well mature seeds.
- Store normal coloured seeds

- Seeds should be free from mechanical injury
- Seeds should not have met with adverse conditions during maturation
- Seeds should be dried to optimum moisture content.
- Seeds should be treated with fungicides before storage.
- Suitable packaging materials should be used for packing.

High quality seed store better than low quality seed

The storage potential of seed is greatly affected by their quality at the time they enter storage, or their pre-storage history. The pre storage history of a seed lot encompasses all the "events" in the "life" of the seeds from the time functional maturity is reached until they are placed in storage.

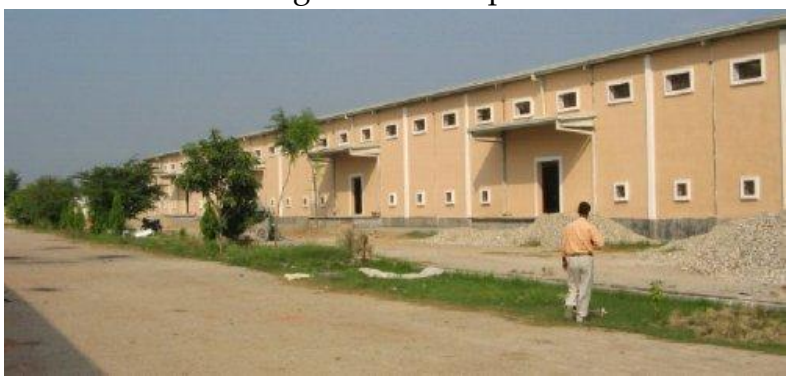
Seeds are highest in quality at the time functional maturity is attained. Since most kinds of seed reach maturity at moisture contents too high for mechanical harvest, the seeds are subjected to the field environment from maturation to harvest. The post-maturation pre-harvest period normally ranges from 1 to 4 weeks for the different kinds of seed. Adverse climatic conditions can result in rapid and severe deterioration of the seed, and so on. The degree of deterioration that occurs in seed prior to harvest determines their quality at harvest and conditions their performance in storage.

In like manner, mechanical, abuse to seed associated with harvesting, handling and processing operations, and damage caused by inadequate or improper aeration or drying can have both immediate and residual effects, i.e., performance of the seed might be affected at the time of injury or not until some later time during storage.

In characterizing seed deterioration, we pointed out that the rate of deterioration of seed in storage varies among seed lots of the same kind and among individual seeds within a lot. These variations in storability are, of course, related to the pre-storage history of seed lots. Seed lots with a "good" pre-storage history (minimal field deterioration, mechanical damage, etc.) store well, while those with a "bad" pre-storage history store poorly.

STORAGE GODOWNS AND THEIR MAINTENANCE

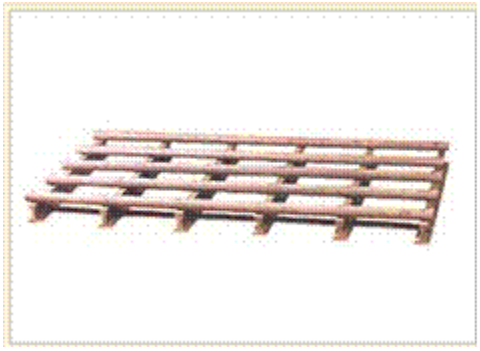
Seeds undergo deterioration due to aging in storage. This is accelerated by climatic factors and external biotic factors like insects and pathogen. In addition to seed borne pathogen and storage insects, seeds are damaged by birds and rats for their feed. Clean and hygienic godowns protect the seed from external insects and preserve the seed. Hence care should be taken in construction of godown. The points to be noted are as follows.

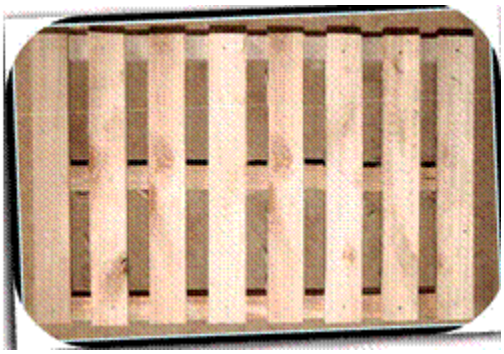


- Seed godown should be in a place where transport facilities are easily available.
- Seed godowns should not be constructed in areas near seashore. Since the high RH of atmospheric air accelerate the deterioration of seed.
- Seed godown should not be constructed in low lying water stagnating areas.
- Seed godown should be constructed in places where atmospheric RH is low, free circulation of air is possible, sunlight is adequate and elevated in nature.
- The ventilators should be at bottom for free air circulation.
- Ground moisture should not reach the floor.
- Should be rat proof with wire mesh
- Should not be near industries as smoke is injurious

In maintenance of seed in godown following points are to be considered.

1. Godown should be clean and dry
2. Seed bags should not be stacked directly on floor. Should be stacked on wooden ballets.





3. The height of the stack should not be more than 6-8 bags.
4. Different seed lot should be kept separately.
5. Godown should be sprayed periodically once in a week or fortnightly with Malathion 50 EC (1 : 300 Chemical : Water) @ 5 lit. sq. m-1 or 0.25% Nuvan @ 1 lit. 100 m3-1.
6. Altering the chemicals at weekly intervals will give better control.
7. Seed lots can be fumigated with Aluminium phophide @ 3 gm/cu.m in air tight condition for 7 days. This can be done as propylatic measure and on minimum infestation by insects.
8. Seed lots should be periodically (once in month) tested for seed quality.

9. Based on seed testing result, seeds can be dried under sun for the removal of moisture. It reduces insect and pathogen infestation.
10. New seed lots should be kept away from old seed lots to avoid secondary infestation of insects.
11. Seeds should be treated with combination of fungicide and insecticide (eg.) Thiram @ 2 g kg-1 + carbaryl @ 200 mg kg-1.
12. Frequent supervision of each and every lot is must.
13. Seed bag should be restacked once in 3 months for free aeration.
14. Instead of gunny bags low cost interwoven polythene bags should be used to prolong the life of seed.
15. Pesticides, fungicides, fertilizers, rejects should not be stored with seed.
16. Each lot should be labeled accurately and registers for stocks should be maintained.

17. Per acre or per hectare packing (small) is preferable for easy handling and effective supervision.

STORAGE INSECT MANAGEMENT
Maintenance of store house hygiene

- Cracks and crevices around corners have to be brushed to eliminate hiding pests. All debris should be removed. Provision of wire meshes to windows, ventilators, gutters, drains to prevent entry of rats, squirrels, birds, etc.
- Reduce the moisture content of seed to prevent insect build up (usually below 10%). Previously used bags, bins, etc. should be dried in the sun repeatedly.
- Elimination of conditions which favour storage pests. Uniformly graded seeds should be used, broken seeds should be removed before bagging since they favour pest build up. Stitching of all torn bags, filling bags up to the brim, no loose packing.

- Surface treatment of storehouse before storage with malathion dust 4% @ 25 g/sq m or malathion 50% EC spray @ 10 ml/lit of water and 3 lit of solution per sq. metre.
- Good dunnage by arranging wooden planks or bamboo poles or spreading thick polythene sheets on the floor. Treatment of dunnage materials with malathion as specified, arrange the bags in criscross pattern with a maximum of 15 bags and provide adequate space between the roof and the seed bags.

Prophylatic treatment of seeds

Application of malathion 4 per cent dust 25 g/sq metre or malathion 50 per cent EC 10 ml per litre of water and 3 litres of spray solution for 100 sq.m. The chemicals have to be sprayed on the walls and floors and the treatment has to be repeated based on the extent of flying and crawling insects.

Chemicals

Two chemicals are widely used : Phosphine and Methyl Bromide. Others are dichlorvos, Carbondioxide, Ethylene oxide and HCN.

Phosphine : Available in a solid form (0.6 g pellets, 3 g tablets). The active ingredient is Aluminium phosphide mixed with Ammonium carbonate and Paraffin. After exposure to the atmosphere, the pellets decompose and release the active substance, hydrogen phosphide (PH3), which has the same specific weight as air, and is thus evenly distributed in the fumigated material or chamber. Phosphine is also able to penetrate bags, carton boxes and other containers.

It must be borne in mind that fumigation particularly repeated fumigation, may seriously reduce the vigour and viability. This is particularly true for seeds with a higher moisture content of 14 per cent. Seeds with moisture content above 14 per cent should be dried, before fumigation.

Samples of seeds have to be drawn at fortnight intervals and the infestation can be classified as follows based on insects found per kg of sample.

When there is no pest	Free
Upto 2 insects	Mild
More than 2 insects	Severe

The fumigant has to be chosen and the requirement worked out on the following guidelines :

Aluminium phosphide: Three tablets of 3 g each per ton of seed for cover fumigation (only selected blocks of bags)

Twenty one tablets of 3g each for 28 cubic metres, for shed fumigation (entire godown). Period of fumigation - 5 days. The major advantages of Phostoxin are that it lacks residues and does not affect flavor or germination and is easy to handle.

Methyl bromide: Above 5.6oC, methyl bromide is in the gas phase and is available in cylinders similar to those used for cooking gas. Since, it is odorless, other gases such as chloropicrin are sometimes added to facilitate detection of leaks. Because methyl bromide is

3.5 times heavier than air, care has to be taken that it is properly distributed within the goods to be fumigated (fan can be used). The recommended dosage is 20 g/m3 for 24-48 hrs. Special safety measures are required, since methyl bromide is absorbed through the skin. It tends to accumulate in commodities which are important whenever repeated fumigation is necessary.

Equipment

Gas-proof plastic sheets with at least 50 cm overlap firmly pressed to the ground with sand, iron bars, or other weights are frequently used. Gas escape results in reduced insecticidal effect and is a hazard to users. A cement floor is necessary to prevent gas escape through soil. Care must be taken that the fumigation area is properly aerated and fans sometimes help. If a store's door and windows can be hermetically sealed, fumigation of the entire store is possible. Most stores, however, allow gas to escape through other openings. Silos are usually good fumigation facilities. When large quantities must be fumigated within a short time, a vaccum fumigation chamber is appropriate. These chambers are available in sizes between 1 and 50 m3, and sometimes as a plant of upto 6 x 50 m3, equipped with common fans, pumps and other equipment. The insecticides used are methyl bromide or ethylene oxide.

Safety

Face masks with a proper canister should be used, especially during the aeration process. When handling Phostoxin, cotton gloves should be worn. Gas concentration can be checked with a Halide gas detector for methyl bromide and with a tube detector (Draeger) for Phostoxin. A warning sign should be clearly visible to prevent people from inadvertently removing plastic sheets or entering a building under fumigation.

Rodent Management in Store Houses

Provide of wire mesh to windows, ventilators, drains and leave no gaps to doors. Use rodent baits with multi dose or anticoagulant rodenticides. The bait may be prepared as follows:

Cereal flour	450 g
Any edible oil	10 g
Powdered jaggery	15 g
Anticoagulant or rodenticide such as coumarin	25 g

Replace the consumed bait daily. If needed the single dose or acute poison bait may be prepared as follows :

Food material	97 g
Edible oil	1 g
Zinc phosphide	2 g

Before providing the poisoned zinc phosphide bait, the plain or non-poisoned bait are to be provided for two or three days to make the rats accept the bait.

Lecture 31
SEED MARKETING

A definition of seed marketing

Seed marketing should aim to satisfy the farmer's demand for reliable supply of a range of improved seed varieties of assured quality at an acceptable price.

- To the retailer in the agricultural sector, for example, it is selling seed along with other inputs to the farmer.
- To the farmer it is simply selling what he produces on his farm. However, whatever the circumstances, a well-defined sequence of events has to take place to promote the product and to put it in the right place, at the right time and at the right price for a sale to be made.
- Too many people think of marketing solely in terms of the advertising and selling of goods, whereas in reality marketing starts long before the goods exist and continues long after they are sold. Therefore, for the marketing process to be successful: the farmer consumer's needs must be satisfied; the seed company's objectives must be realized.

MARKETING STRUCTURE

Seed distribution systems

Seed distribution can be carried out by government, public sector agencies, co-operatives and the private sector or, as is often the case, by a combination of all of these. Channels for seed marketing may be described as:

Direct

The seed producing organization supplies the farmer directly. Some features of direct channel distribution are:

- the supplier has direct contact with the consumer
- a high level of service and customer support can be maintained
- direct control is maintained over the quality of the product

- the upkeep of such a system can be expensive, with high fixed costs if a

sales force is employed

- a responsive management structure and well-motivated staff are required

where there are many staff involved in a direct sales organization there can be an inbuilt inertia to change so the system may lack flexibility.

- the revenue necessary to pay for the high fixed costs will only come from

having a wide product range and achieving good market shares or selling high value products such as horticultural seeds.

Single level

The seed producing organization supplies the farmer through independent retail outlets. The main features of this system are that:

- the seed supplier relies on the retailer for contact with the consumer
- retail networks require strong service and support from the supplier
- good administrative control must be provided by the sales management
- the supplier's distribution system must be well organized and responsive
- product quality at the retail level must be monitored for deterioration and adulteration and a return system should be considered
- although the products may be well promoted, the supplier relies on the retailer to make the final sale.

Multilevel

The seed producing organization supplies a national distributor, wholesalers or regional distributors who, in turn, supply sub-distributors or the retail outlets.
This system is characterized by:

- the supplier having no direct contact with the consumer
- products being strongly promoted in order to create demand
- supplying seed to the distributors in sufficient time to achieve timely availability at the retail level
- management ensuring that there is a good system of monitoring sales and obtaining feedback from the consumer
- the distributor being interested only in the strongest selling lines.

If neither infrastructure nor the economy are well developed, national distributors may simply not be available and the seed producer will have to supply seed to regional wholesalers or distributors.

Sources of seed available to farmers

For farmers there are a number of sources available for the purchase of seed. These are:

Direct sales

The seed producer supplies the farmer directly from central seed stores and a network of his/her own supply points

Farmer producers

Farmers with seed production contracts are licensed to supply other farmers within their zone

of influence

Cooperatives

Cooperatives act as 'farmer producers' and/or as suppliers of inputs to members

Farmer dealers

Farmers act as dealers, supplying their neighbours; this can evolve into a highly developed system

Commission agents

These work directly with the producer or his/her intermediaries, passing on orders from the farmers

Grain merchants

Traders involved in the seed and grain business who are also licensed seed producers

Crop buyers

Collectors and crop or commodity traders who provide a point of contact with farmers and can be used to market seed

Retail store dealers

Town and village dealers who retail a range of agricultural inputs, with the larger operators possibly having sub-dealers

Industrial processors

Processors interested in specific crops including oilseed crushers and vegetable canners, who may have an interest in supplying seed as part of a growing contract or integrated production system

Cold store operators

Potato cold store operators trade potato seed since they deal directly with the growers and have the appropriate storage

Consumer outlets

Garages, shops and supermarkets (are best suited to display small packets of seed)

Mail order

Suitable for low volume, high value products such as vegetables and flowers.

Although government extension outlets are not strictly retail outlets, seed is sometimes supplied to the farmer through government sponsored agencies and departments which administer crop or regional development and credit programmes.

ORGANIZATIONAL CHART

- **Product management**

Concentrates on developing and implementing marketing policy for a seed product or range of products

- **Advertising, promotion and public relations**

Aims to create product awareness, influence farmers' buying decisions, (PR) and build up a positive perception of the company

- **Sales order administration and dispatch**

Involves receiving and processing orders, allocating stock and dispatching orders, and maintaining stock records

- **Stock control and quality assurance**

Involves managing the inventory for each class of seed, crop and variety, to ensure maintenance of germination and vigour

- **Distribution and transport**

Entails moving the seeds from the point of production to the point of sale

- **Sales and invoicing**

The process of making the actual sale and receiving payment for it, i.e. the end result of the marketing activity

- **Management information**

Involves collating and interpreting sales information and other information as a basis for monitoring operations and planning future activities

- **Customer care**

Involves after-sales service, dealing with complaints and maintaining customer loyalty

THE PROMOTIONAL ACTIVITIES

Resources invested in variety development and seed production will be wasted if farmers are not persuaded to use the improved varieties. All promotional activities involve sending messages to the distributors and consumers in order to inform them about a company's products and help them to make their decision to buy a particular variety or brand of seed.

- **Advertisements**

Messages sent via the media to inform and influence the farmer

- **Sales promotions**

Specific techniques designed to increase sales of particular seeds

- **Personal selling**

The importance of salesmanship

- **Publicity and public relations**

Generalized communication which is designed to promote the company's image rather than that of specific seeds

- **Extension**

Farmers in developing countries have certain characteristics:

- They have low purchasing power coupled with a low rate of return from farming.
- They are generally conservative and therefore are slow to adopt new products.
- They may not be well informed.
- They often lack mobility and the means to transport goods.

It should also be recognized that educational and literacy standards will not always be high in rural communities. The use of visual material will help to overcome some communication problems. In all forms of communication, companies should always try to make the subject of seeds interesting and relevant to the consumer.

Advertising

The published print media

This includes newspapers, periodicals, magazines, trade and professional journals. There may be both advantages and disadvantages when advertising in this manner.

Some advantages of the printed media are that:

- good coverage can be obtained and, by using the local press and specialist

papers, accurate targeting can also be achieved

- it is relatively cheap and immediate
- complex messages can be given in print; these can be read again and again
- reply and cut-out coupons with an exchange value can be used to encourage

farmers to request further information and buy the product.

Some disadvantages of the printed media are:

- the text, and therefore the message, may not be well understood due to language and literacy problems
- only limited space may be available
- printed text has limited impact and colour does not always reproduce well in newspapers
- a daily paper has a limited life and the advertisements will have to compete for attention with stories and other information.

As well as placing advertisements, press releases can be given to newspapers or features written that carry the name of the company and its products.

The broadcast media: This includes television, radio and cinema.

Television

Some advantages of television are:

- the impact will be greater as both sound, colour and movement can be used

to convey the message

  - massive coverage can be achieved and some local targeting may be possible.

Some disadvantages of television are:

- it can be very expensive and is only suitable for simple messages
- the exposure time is short and the advertisement may miss the target audience
- TV reception may be poor and if local targeting is not possible the message will not be relevant to many viewers
- there may not be any related interest programmes that will be viewed by the target audience
- in many countries farmers cannot afford television, although televisions are often available in clubs, bars and other public places.

Radio

Some advantages of radio are:

- good coverage is achieved; this is not confined to the home as people listen to the radio everywhere, including when they are working on the farm

- it is relatively cheap to broadcast on radio compared to television and advertisements are easier to prepare
- the incidence of local broadcasting, in local languages, is greater than with television
- related interest programmes and farming information spots are usually more frequent.

Some disadvantages of radio are:

- reception may be poor in certain areas
- people don't always listen closely and consequently may have poor recall of the message.

Language problems can be overcome through local broadcasting and there is always the possibility of involving local personalities to add interest and relevance to the area. Radio is useful for making announcements, such as the availability of seed in the area. Another form of broadcasting is the loudspeaker van which can be used to tour villages or towns to make similar announcements, particularly on a market day.

Cinema

In rural locations where cinema is the main entertainment a high proportion of the audience will be involved in farming so this medium could be considered for advertising. Advertising slides are not expensive to prepare and these can be shown during the show.

The outdoor media

Outdoor media include posters, signs and advertising on transport, bus shelters, walls and buildings. These forms of advertising can be used to increase the visibility of the company and its products. Outdoor advertising may have considerable and lasting impact at a low cost if it is well situated and if there is not too much competition for the available space. Exclusive arrangements can always be made for the use of space.

In addition to commercial advertising, retailers should be supplied with signs and crop boards. It is important that good sites are chosen which are highly visible and strategically placed to ensure maximum exposure.

Packaging design

Packaging is a form of advertising. Clear printing, the use of colour, brand or company logo and well reproduced photographs or images are all important components of design.

Lecture 32
PRICING POLICY

Seed pricing involves setting prices when a new product is launched or a new distribution channel is used. Also, decisions may need to be taken to change the price in response to competition and to the general market situation.
In the public sector prices are often based on an economic pricing policy. Economic pricing considers the effect of seed price on the economy, taking into account the amount officials think farmers can afford to pay and the role of the seed industry in the development of agricultural production. Ideally, however, the public sector should follow a more commercial pricing policy which accounts for all costs and allows for an element of profit.
Some objectives in government seed pricing could be:

- to induce farmers to use certified seed of improved varieties in order to increase national production
- to provide adequate incentives to seed producers to supply seed in sufficient quantity to meet demand
- to encourage the development of private distribution channels
- to implement government agro-economic policies.

Some objectives in private sector seed pricing are likely to be:

- props maximization which will be the long-term target although there may be many other shorter term considerations which will influence pricing policy, such as increasing market share and gaining acceptance of new products
- price competition, may be achieved by setting a price that gives a competitive edge in the market place but may not be lower than that of a rival because other factors, such as service, will be contributing to a company's competitive advantage
- a yield 01? investment which must be at least as good as other uses for investors' funds.

Pricing strategies
Once a company's seed pricing objectives have been established, different pricing strategies must be considered. These include:
Low price strategy
Low price strategies are used where consumers respond very positively to small downward changes in price, but a company may not always gain from setting low prices as more efficient competitors may respond with similar price cuts. If the product is not particularly price sensitive then the net effect of a price reduction can simply mean a reduction in revenue. A company may be tempted to reduce its price where similar or substitute products are also sold

or when there is an oversupply. However, seeds can become devalued by selling them cheaply especially where there are real benefits associated with the product. Imported vegetable seeds are often chosen by farmers in preference to locally produced varieties in the belief that they are better because they are more expensive. It is therefore critically important to understand the likely response of the farmer when adopting a low price strategy.

Market price strategy

Where a few large companies dominate supply, products tend to be similar (known in the seed industry as "me-too" varieties) and the role of price tends to be neutral, i.e. a market price is established.

High price strategy

This strategy can be used as a long- or short-term policy. In the case of the long-term policy the company will have identified a market segment for a high quality, value-added product such as graded and treated seed for precision drilling. A high price will reflect the exclusive image or added value of the product. A short-term, high-price policy takes advantage of a new product introduced onto the market, as may be the case with a new high-yielding variety where supply is limited.

Pricing techniques

The important influences on pricing are cost, demand, prices of the product's main competitors and short-term sales targets.

Cost-plus pricing

This method involves calculating the unit cost of a product and adding the appropriate profit margin to give a base price which might then be altered in relation to prevailing market conditions. While this seems a simple approach the fact that such pricing is production oriented and may therefore not reflect what is happening in the market place, makes it risky. A rigid application of cost-plus pricing may lead to price increases when demand is lower and reductions when demand is strong. This is the opposite of what should normally be done.

Contribution pricing

This is a form of cost-plus pricing which involves separating the different products that make up the product portfolio and allocating to them the direct costs associated with their production. The price is determined at a level which will generate revenues in excess of these costs, thereby contributing towards meeting business overheads. Individual products can be analysed in terms of their ability to cover their direct costs and contribute to overheads.

Competitive pricing

Where there is market competition, costs cannot always be the determining factor in pricing. Here the nature and extent of competition will have a major influence on the price. If a product is faced with direct competition from similar products the price will be restrained. In contrast, when a product is faced by indirect competition from products in different sectors of the market there will be more scope to vary the price. This provides the possibility of using different strategies.

Short-term pricing techniques

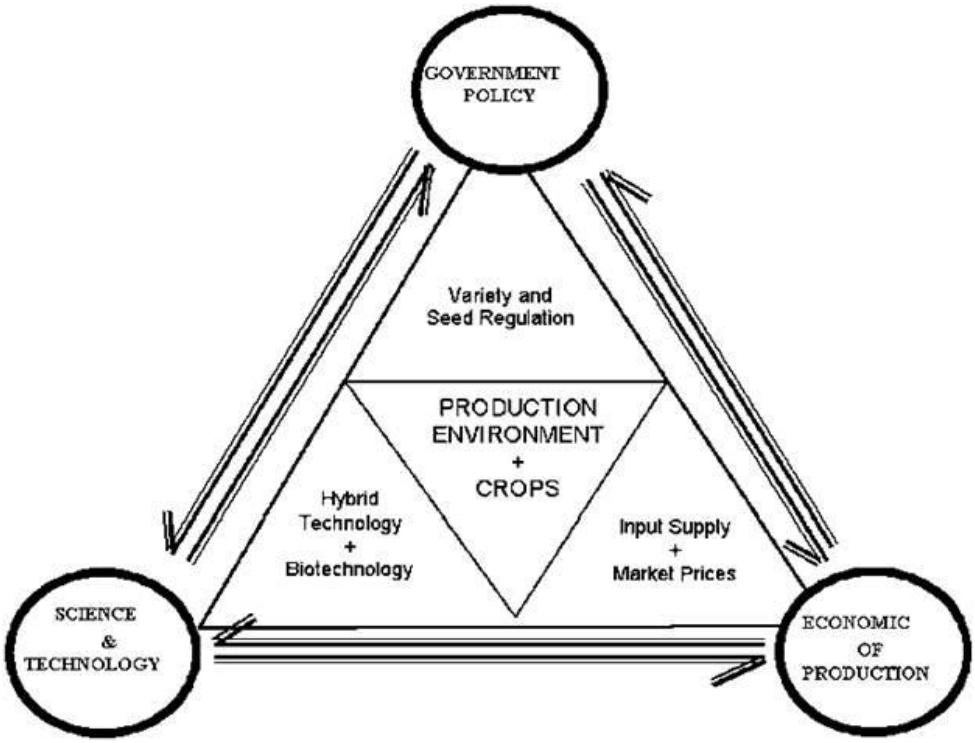
Pricing can be a useful tool for pursuing short-term marketing and sales targets. When a new variety is launched higher prices can be set, providing the opportunity of earning higher returns from those farmers willing to pay the higher prices before seed becomes more widely available. Lower prices may be linked to promotional activities such as boosting sales of established varieties, creating interest in new ones, reducing high stocks and encouraging farmers to buy early.

An overview of factors affecting the seed industry

Three broad influences determine the development and status of the seed industry, namely:

- Technology - especially the flow of new varieties from research;
- Economics - both of seed production itself and of the agricultural sector generally; and
- Policy - creates the commercial and financial environment.

All of these factors can be modified and there are many interactions between them that ultimately determine the size, viability and other characteristics of the seed industry. Figure 1 provides a diagrammatic representation of this analysis, in which various influences on the seed sector are represented within the triangle formed by these three primary elements. Policy has been placed at the top because of the major impact it can have on technology and economics. At the centre lies the production environment, which forms the basis for agriculture, and which cannot be substantially modified, except by irrigation or protected cultivation.



We should recognize seed policy as a major tool for change, but also accept that it cannot alter certain physical and environmental factors and, in a free market, it will always interact with technology and economics. In addition to the policy designed specifically for seeds, wider social and environmental policies may also have an impact on the seed sector and these may be driven by public awareness. For example, the current debate in Europe about the use of genetically-modified crops is not primarily conducted on technical issues about seeds but on wider environmental and food safety concerns. It has nonetheless had a major effect on the seed industry.

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