DEPARTMENT OF GENETICS AND PLANT BREEDING

1. Course No. : GPBR 312
2. Course Title : **Principles of Seed Technology**
3. Credit Hours : 3 (2+1)
4. General Objective : To impart knowledge to the students on the seed production and seed science and technology aspects in relation to Seed Act
5. Specific Objectives

Theory

By the end of the course, the students will be able to

i. understand the concepts of quality seed production of different field and vegetable crops
ii. study about different classes of seed and maintenance of genetic purity during seed production
iii. learn about seed certification procedure, seed drying, processing, cleaning, testing, packaging, storage, marketing etc.

Theory Lecture Outlines

1. Introduction to seed technology – definitions – concept, role and goals of seed technology – differences between scientifically produced seed and grain used as seed
2. History and development of seed industry in India – pre-Independence and post independence development – First Five Year Plan (FYP) – Grow More Food Enquiry Committee – Second FYP – Coordinated Crop Improvement Schemes and Agricultural Production Team – Third FYP – National Seeds Corporation and High Yielding Variety Programme (HYVP) – Annual Plans (1966-69) –
3. History and development of seed industry in India – Fourth FYP – Tarai Development Corporation (TDC) and Indian Society of Seed Technology (ISST) – Fifth FYP – National Commission on Agriculture (NCA) and National Seeds Programme – Sixth FYP – Seventh FVP – New Policy on seed development – Eighth FVP
4. Importance of seed production – seed policy – seed demand forecasting and planning for breeder seed, foundation seed and certified seed production
5. Testing, release and notification of varieties – Central Variety Release Committee (CVRC) and State Variety Release Committee (SVRC) – National Seeds Corporation (NSC), Andhra Pradesh State Seed Certification Agency (APSSCA) and Andhra Pradesh State Seed Development Corporation (APSSDC) and their functions
6. Deterioration of crop varieties – factors responsible for loss of genetic purity – maintenance of genetic purity during seed production – safeguards for maintenance of genetic purity
7. Seed quality – characters of good quality seed – factors affecting seed quality – classes of seed – nucleus, breeder, foundation and certified seed

8. Maintenance of nucleus and breeder seed in self and cross pollinated crops – maintenance of nucleus seed of pre-released or newly released varieties – maintenance of breeder seed of pre-released or newly released varieties – maintenance of breeder seed of established varieties – maintenance of nucleus seed of inbred lines – maintenance of breeder seed of inbred lines
9. Hybrid seed production – history – importance – development of inbred lines, single crosses, double crosses, three way crosses etc. – evaluation of single cross and double cross hybrids
10. Male sterility – inheritance, maintenance and utilization of different types (genetic, cytoplasmic and cytoplasmic genetic) of male sterility in seed production – sources of male sterility in different crops – transfer of male sterility to a new strain – procedure for converting an inbred (non-restorer) line into a restorer line
11. Foundation and certified seed production of varieties and hybrids in rice and sorghum
12. Foundation and certified seed production in of inbreds, hybrids, synthetics and composites maize and bajra
13. Foundation and certified seed production of varieties and hybrids in sunflower and castor
14. Foundation and certified seed production of varieties and hybrids in redgram
15. Foundation and certified seed production of varieties and hybrids in cotton and bhendi
16. Foundation and certified seed production of varieties and hybrids in tomato, brinjal and chillies
17. Foundation and certified seed production of varieties and hybrids in onion, bottle gourd and ridge gourd
18. Seed certification – history of seed certification – procedure for seed certification
19. Seed drying – methods of seed drying – sun drying – forced air drying – principle of forced air drying – properties of air and their effects on seed drying – moisture equilibrium between seed and air – drying zones in seed bin drying – forced air drying method
20. Seed drying – heated air drying system – building requirements – types of air distribution system and seed drying – multiple bin storages – selection of crop dryers and systems of heated air drying – recommended temperature and depth for heated air drying of various crop seeds in bin – management of seed drying operations
21. Planning, layout and establishment of seed processing plant – factors to be considered in planning and designing a seed processing plant – types of layouts – planning
22. Seed cleaning – principle and method of cleaning seeds – air screen machine – principle of cleaning – parts of air screen cleaner
23. Seed cleaning – upgrading the quality of cleaned seeds – different upgrading machines, their principles of operation and uses
24. Seed treatment – benefits – types of seed treatment – conditions under which seed must be treated – seed treating products – equipment used for seed treatment – colouring of seeds – causes of poor treatments – precautions to be taken during seed treatment

25. Seed packaging – operations in packaging – equipments used for packaging of seeds – types of bags and packing sizes
26. Seed storage – categories of seeds – orthodox and recalcitrant seeds – factors affecting seed longevity in storage and conditions required for good storage – general principles of seed storage
27. Seed marketing – marketing structure and organization
28. Seed testing – objectives of seed testing – International Seed Testing Association (ISTA) and Association of Official Seed Certifying Agencies (AOSCA) – establishment of Seed Testing Laboratory (STL) – seed testing procedures for quality assessment
29. Seed dormancy – seed germination – seed viability – seed vigour – seed health and seed moisture
30. Varietal identification through Grow Out Test (GOT) and electrophoresis
31. Seed Act and Seed Act enforcement – main features of the Seed Act 1966 – Central Seeds Committee – Central Seed Certification Board – State Seed Certification Agency – Central Seed Testing Laboratory – State Seed Testing Laboratory – Appellate Authority – recognition of Seed certification Agencies of foreign countries – notification of standards and procedures – notification of variety – regulation of sale of notified varieties – requirement for sale of seed; Enforcement of the Seed Act – sampling – duties and powers of seed inspectors – offenses of Seed Act and penalties
32. World Trade Organization (WTO) – objectives and functions – Intellectual Property Rights (IPR) – Protection of Plant Varieties and Farmers' Rights (PPV and FR) Act – Plant Breeders' Rights (PBR) – benefits of PBR – disadvantages of PBR

References

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Agarwal, P.K. and Dadlani, M. 1986. *Techniques in Seed Science and Technology*. South Asian Publishers, New Delhi.

Agarwal, R.L. 1996. *Seed Technology*. Oxford and IBH Publication Co., New Delhi.

Thomson, J.R. 1979. *An Introduction to Seed Technology.* Leonard Hill, London.

Lecture No: 1

Introduction – Concept and Goals of Seed Technology

Introduction

The history of agricultural progress from the early days of man has been the history of seeds of new crops and crop varieties brought under cultivation. In the early days it was achieved through the cultivation of indigenous but useful plants and those taken through introductions. Later through the well known techniques of selection, hybridization, mutation, polyploidization and plant biotechnology the scientists made available many new and better varieties. However, to the farmer all this scientific research would be of little value unless he gets seeds, which are genetically pure, high germination percentage and vigour, high purity, sound health etc., When the farmers do not get seeds possessing these qualities the yields they obtain may not be as expected. The pace of progress in production therefore, will largely depend upon the speed with which we are able to multiply and market good quality seeds of high yielding varieties.

Definitions of Seed Technology

Cowan (1973) identified seed technology as "that discipline of study having to do with seed production, maintenance, quality and preservation".

Feistritzer (1975) defined seed technology as the methods through which the genetic and physical characteristics of seeds could be improved. It involves such activities as variety development, evaluation and release, seed production, processing, storage and certification.

Thus seed technology is essentially an inter disciplinary science which encompasses broad range of subjects. In its broadest sense," seed technology includes the development of superior crop plant varieties, their evaluation and release, seed production, seed processing, seed storage, seed testing, seed certification, seed quality control, seed marketing and distribution and research on seed physiology, seed production and seed handling based upon modern botanical and agricultural sciences".

In a narrow sense "seed technology comprises techniques of seed production, seed processing, seed storage, seed testing and certification, seed marketing and distribution and the related research on these aspects".

Concept of seed technology

The distinction between seed and grain is vital, being of seminal importance to agriculture. A seed, strictly speaking, is an "embryo" a living organism embedded in the suppor ting or the food storage tissue. The seed pertains to material (seed, fruit or vegetatively propagating material) meant for saving for planting purposes, the essential function being the reproduction. The seed when scientifically produced (such as under seed certification) is distinctly superior in terms of seed quality, namely, the improved variety, varietal purity, freedom from admixtures of weeds and other crop seeds, seed health, high germination and vigour, seed treatment and safe moisture content etc. A grain on the other hand, includes cereals and pulses meant for human consumption.

Differences between scientifically produced seed and the grain (used as seed)

S. No	(Scientifically produced) seed	Grain (used as seed)
1.	It is the result of well planned seed programme	It is the part of commercial produce saved for sowing or planting purposes
2.	It is the result of sound scientific knowledge, organized effort, investment on processing, storage and marketing facilities.	No such knowledge or effort is required
3.	The pedigree of the seed is ensured. It can be related to the initial breeders seed	Its varietal purity is unknown
4.	During production, effort is made to rogue out off-types, diseased plants, objectionable weeds and other crop plants at appropriate stages of crop growth which ensures satisfactory seed purity and health.	No such effort is made. Hence, the purity and health status may be inferior
5.	The seed is scientifically processed, treated and packed and labeled with proper lot identity.	The grain used as seed may be manually cleaned. In some cases, prior to sowing it may also be treated. This is not labeled
6.	The seed is tested for planting quality namely, germination, purity, admixture of weed seeds and other crop seeds, seed health and seed moisture content.	Routine seed testing is not done.
7.	The seed quality is usually supervised by an agency not related with production (seed certification agency)	There is no quality control.
8.	The seed has to essentially meet the "quality standards". The quality is therefore well known. The labels, certification tags on the seed containers serves as quality marks.	No such standards apply here. The quality is non-descript and not known.

Role of seed technology:

Feistritzer (1975) outlined the following roles of improved seed.

1. Improved seed – a carrier of new technologies

The introduction of quality seeds of new varieties wisely combined with other inputs significantly increase yield levels. In India, the cultivation of high yielding varieties have helped to increase food production from 52 million tonnes to nearly 180 million tonnes over a period of 40 years.

2. Improved seed – a basic tool for secured food supply.

The successful implementation of the high yielding varieties programme in India has led to a remarkable increase in production and food imports from other counters have been brought down inspite of rapid increase in population.

3. Improved seed – the principal means to secure crop yields in less favourable areas of production.

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

4. Improved seed – a medium for rapid rehabilation of agriculture in cases of natural disaster.

In case of floods and drought affected areas the Govt. will provide the improved seeds from national seed stocks to rehabilate the agricultural production of foods grains in the country

Goals of Seed Technology:

The major goal of seed technology is to increase agricultural production through the spread of good quality seeds of high yielding varieties. It aims at the following:

1. Rapid multiplication:

Increase in agricultural production through quickest possible spread of new varieties developed by the plant breeders. The time taken to make available the desired quantities of seeds of improved varieties to farmers should be considered as a measure of efficiency and adequacy in the development of seed technology in the country

2. Timely supply:

The improved seeds of new varieties must be made available well in time, so that the planting schedule of farmer is not disturbed and they are able to use good seed for planting purposes.

3. Assured high quality of seeds:

This is necessary to obtain the expected dividends from the use of seeds of improved varieties.

4. Reasonable price:

The cost of high quality seed should be with in reach of the average farmer.

Lecture No: 2 & 3

History of Seed Industry in India

History and development of seed Industry in India can be discussed under two heads;

1. Pre-independence development
2. Post- independence development

1. Pre -independence development: during early years of 20th century efforts were made to develop improved varieties of cotton, wheat, groundnut and sugarcane. The state department of agriculture adopted two methods for multiplication and distribution of these improved varieties;

1. the seed of improved varieties were multiplied at one location and distributed over a large area to replace local varieties
2. The seed was distributed in small packets to large number of farmers and it was expected that farmers would multiply their own seed.

When the second method was tried in Bengal with improved varieties of jute and paddy it did not give fruitful results, hence the first method was followed.

In **1925 Royal Commission on Agriculture** was constituted and it made the following recommendations for introduction and spread of improved varieties;

1. Separate organization should be there within agriculture to deal with seed testing and distribution
2. The seed distribution should be made through co-operative societies, dept. of agriculture and

seed growers

3. Private seed growers should be given encouragement.

Following the suggestions of Royal commission the Govt. of India established several Research
Institutes, however the seed multiplication and distribution was not encouraging. Later on several
committees were made, notable among them are;

Sir John Russell Committee in 1937

ICAR committee in 1940

Dr. Burns committee in 1944

Famine enquiry committee in 1944 and

Food Grain Policy committee in 1944

These review commissions revealed that;

1. Crop botanist should be involved in development of improved varieties, their testing and demonstration
2. Initial seed should be multiplied on govt. farms and subsequent multiplication in the fields of registered growers
3. Govt. should purchase the seed from registered growers at a premium price and later on distribute to fanners at confessional rates.

Till 1939 vegetable seeds were imported from other countries and due to IInd world war in 1939, the supply of veg. Seeds was stopped. By 1945 private veg. Seed companies had developed facilities for producing veg seed at Quetta in Pakistan and Kashmir valley. In 1946, **All India Seed Growers, Merchants and Nurserymen's Association** was formed with the objective of rapid development of veg. Seed Industry.

Seed Industry after Independence

1948 - 17 Agricultural colleges were under the department of Agriculture

1948-49 - Dr S. RadhaKrishnan recommended the formation of Agricultural Universities and he
called them rural Universities.

1950 - Recommendations were given by experts from foreign countries for the establishment of Agril. Univ.

Until 1951 agriculture was neglected and after the formation of Agricultural Univ. and Research Institutes agriculture development started in India.

First Five Year Plan (1951-56); During this period major emphasis was given for the use of improved seed. The improved varieties were developed and the breeder seed was produced on govt. farms. It was then multiplied in 2 or 3 stages through 2 or 3 classes of cultivators termed as A, B and C. Larger the number of intermediate stags less pure was the seed. In **1952 - Grow More Food Enquiry Committee** was constituted they recommended seed multiplication and distribution schemes. However the progress made during the FFYP was poor and seed was mainly distributed with subsidy.

Second five-year Plan (1956-61): Generally this period is regarded as golden period for Agricultural Development and Research. In 1957 All India co-ordinated maize Improvement Project was started in collaboration with Rockfeller foundation of USA with multidisciplinary approach. Within four years of its establishment four maize hybrids were released. 1961-Deccan Hybrid Makka -Hyd

Ranjit from New Delhi

Ganga -1 from G.B.Pant Agril. Univ. U.P

Ganga -101 from G.B. Pant Agril. Univ., U.P.

By seeing the progress made the Govt. of India started similar projects on Sorghum and Bajra in 1961 and the first sorghum hybrid CSH-1 was released from New Delhi in 1964 and First bajra hybrid HB-1 from Punjab in 1965. Later on the Govt. of India extended it to all crops of economic importance.

During this period importance was given for multiplication of foundation seed from breeder seed at block level. For this a policy was made that each National Extension Service Block should have a seed farm and a seed store. Based on this 4328 seed farms of 10 hectares each were proposed. However by the end of second plan period only 2551 seed farms could be commenced. In 1959 first Indo-American Agriculture Production Team was constituted to examine India's food production problems. The team headed by Dr. Sherman E.Johnson of Ford Foundation made following suggestions;

1. Village Block and district level extension workers should be made responsible for educating
farmers in use of improved seed
2. State Agril. Dept. should be made responsible for seed certification
3. Co-operatives and private seed growers should be made responsible for seed supply
4. Setting up of seed testing laboratories and
5. Development of uniform seed certification standards and seed laws.

In spite of significant developments made, the desired progress could not be achieved during SFYP due to following reasons;

1. Requisite quantities of breeder seed were not availa ble.
2. Only imp. Cereals hybrid maize and bajra were included in seed programs
3. FSP at block level was not organized properly and in some blocks the foundation seed was
not fully utilized.
4. Timely inspections for roughing of undesirable plants was not made.
5. Marketing of improved seed was largely left to seed producers.
6. The seed procurement was unsatisfactory for want of adequate funds.
7. Seed processing was defective and there were large number of complaints regarding purity
and germination of seeds

First Agricultural Univ. in the countrv was started at Pantnnaar in U.P.

Third **Five** Year Plan (1961-66): The release of first four maize hybrids in 1961 necessitated the creation of separate organization for seed production to exploit the full production potential of these hybrids and this gave birth to central seeds corporation in 1963. The main aim of establishing CSC was

1. To establish foundation and certified seed production
2. To assist in the development of seed production and marketing of seeds
3. To encourage and assist in development of seed certification programs, seed law and seed law
enforcement programs.
4. To train personnel involved in seed programs and
5. Co-ordinate the improved seed programs

This marked the beginning of systematic seed production program based on scientific principles. Initially NSC was established for foundation seed production but as there was no other organization NSC has the taken the responsibility of FSP, CSP, seed certification and seed marketing. In addition to these it also assisted in setting up of seed processing plants, helping private seed producers and training individuals in seed production programs. The most significant achievements of NSC in development of seed industry are

1. Establishment of a scientific seed industry in the country
2. Encouragement of Indian manufacturers for seed processing equipment.
3. Development of field inspection methods and seed standards for seed certification and
   labeling
4. Multiplication of pre-released varieties of all India importance
5. FSP of varieties of all India Importance
6. NSC provided expert services to FAO for designing high capacity processing plants in Iran
   and seed storage structures in Malaysia.

!966-69-Annual Plans:

In 1966 High yielding variety program was launched by govt. of India. This program envisaged coverage of 9.2 m.ha. of food crop area by 1968-69 and 25 m.ha by 1973-74 under HYV of bajra, maize, sorghum, paddy and wheat.

On 29^{th} Dec. 1966 Seed Act Bill was introduced in the parliament.

On 2^{nd} Oct, 1969 the Seed Act Bill came into force throughout the country. he 1968 a seed review team was constituted by govt. of India, The team dealt on wide range of topics and 101 recommendations. Some of the important recommendations of the team are;

1. Compulsory registration of varieties marketed as seeds
2. Elimination of varieties of doubtful value
3. Pre-release publicity to be avoided and arrangement should be made for pre-release
   multiplication of promising varieties
4. Persons/institutions in plant breeding research are required to register with ICAR
5. NSC should continue as national agency for foundation seed production and Agril. Univ. also

should be developed for this purpose.

6. Co-operative and private seed growers should be encouraged in seed production, processing and marketing. Govt. agencies should concentrate on planning, research and extension.
7. NSC should assist state govt. in setting up of seed certification agencies and transfer its certification work to them.
8. ICAR should lay down the standards to improve the quality of breeder seed.

Fourth Five-year plan (1969-74): Tarai development corporation was established in 1969 with the assistance from World Bank. The project aimed at integrated agriculture development of Tarai area with the production of quality seed as primary objective. Later on it has been renamed as

U.P. Seeds and Tarai Development Corporation Ltd., w.e.f. 1st July 1978. The unique features of this corporation were;

1. Involvement of G.B.Pant Univ. of Agril. & Tech. The staff were involved in the project to provide technical guidance and supervision to seed growers so that they can produce large quantifies of F/s and C/s required for entire project area.
2. Integrated development approach, main emphasis was given for land leveling, farm mechanization, irrigation development, electrification and adequa te availability of other inputs necessary for raising excellent crop and credit facilities.
3. Participation of seed growers as shareholders of the corporation in contrast to the contact system of seed production.
4. Compact Area Approach: Technical supervision, guidance and certification are time consuming and important tasks. They can be effectively carried out in compact areas. Further it becomes easy to undertake collective plant protection measures, conducting training programs and to arrange credit facilities.
5. Strict quality control: In addition to inspection done by SCA the corporation with the assistance from G.B.Pant Univ. conducts inspection during seed production, marketing and distribution. For the first time they started testing the samples in the laboratory and inferior seed lot were rejected.
6. Money Back Guarantee: Corporation gives the money back if any seed lot is

found to be substandard by the corporation.

7. Integrated approach for marketing seeds: the corporation appointed its dealers only those who are simultaneously marketing fertilizers, pesticides etc. so that the consumers can get most of the inputs at one place.

In 1971 - Indian society of Seed Technology was formed. The society provides opportunities for exchange of experiences and scientific knowledge to persons engaged in seed industry. The ISST publishes Seed Research and Seed Technology Newsletter and usually meets once in a year.

Fifth five-year Plan (1974-77): National Commission on Agriculture carried out A review of seed industry and it gave its recommendations in!976, which are as follows;

1. Seed industry should be expanded on commercial lines and foreign should be invited if necessary.
2. ICAR and the central seeds committee should develop a system of national registry of varieties.
3. Encouragement should be given to small participants to form compact areas for seed production.
4. Promotional measures should be given for seed growers such as seed crop insurance, exemption of taxes etc.
5. Development and fabrication of seed processing equipment.
6. Seed processing should be made compulsory.
7. Storage of breeder seed and nucleus seed should be done under controlled condition.
8. Grow out test should be made an integral part of seed testing.
9. Rigorous enforcement of seed act.
10. Compulsory certification may be desirable for seed material of hybrids and vegetatively propagated crops.
11. Teaching of seed production technology should be introduced in Agricultural Universities.
12. Dept. of Agril. Should have three distinct wings dealing with

    1. Input aspects 2. Law enforcement and 3. Seed certification.

Based on the recommendations of NCA, govt. of India decided to establish seed production agencies in the country for assured supply of seed for increasing agricultural production. Following the recommendations of NCA in 1976, the govt. of India in 1974 decided to launch National Seeds Programme with the assistance of

World Bank. NSP-I was implemented in 1975-76 with actual implementation starting n 1976. During the first phase SSC were established in four states namely Punjab, Haryana, Maharastra and Andhra Pradesh. The programme was further expanded during phase II and SSC were established in another five states namely Karnataka, Rajasthan, U.P., Bihar and Orissa.

Sixth five-year Plan (1980-85): Seed control Order was passed declaring seeds as an essential commodity. GOI started national Agricultural Project (NARP) due to which the entire country was divided into 127 agroclimatic zones and A.P. into seven zones.

Seventh Five year Plan (1985-90): During this period emphasis was given for infrastructure development and facilities for enhancing seed production both in public and private sector. Under the NSP-III, SSC were established in another four states namely, Assam, West Bengal, M.P. and Gujarat. Strengthening of Seed Technology research and training facilities.

New Policy on seed development was passed on 16th Sept. 1988, which came into effect on 1st Oct, 1988. The policy was directed to assure the Indian farmers access to the best seeds available anywhere in the world with a view to maximize the yields of various crops. It laid emphasis on

1. Import of High quality seeds
2. A time bound program to strengthen Plant Quarantine facilities.
3. Effective observance of procedures for quarantine/post quarantine.
4. Incentives to encourage the domestic seed industry.

Eighth five-year Plan (1992-97): Increased seed production targets have been fixed for the 8th plan period.

APSSDC: The APSSDC was established in March 1976 as a result of Govt. of A.P. accepting the
NSP in 1974. The APSSDC was formed by the growers but maintained by state Govt. officials
and is involved in quality seed production and distribution. Each share of the grower is of Rs
500/-.

Govt. of A.P. holds	36.29 %
NSC holds	27.11%
Seed Growers hold	36.60 %

100.00

The main objectives of APSSDC are

1. Breeder seed production in oilseeds
2. Foundation and certified seed production of different crops
3. Seed production of pre-released and non-notified varieties
4. Seed processing, packing, storage and seed marketing and distribution
5. Seed supply to problematic areas
6. Assists in breeder seeds production and acts as nodal agency for BSP and distribution.
7. Acts as nodal agency for maintaining buffer stock of seeds
8. Undertakes collaboration in seed technology research
9. Co-ordinates seed imports
10. Gives constancy services sand conducts training to seed growers
11. Takes up extension programs to enlighten the fanners to use quality seeds.

APSSCA; It was registered under A.P. (Telangana area) public societies registration act with a regd. No. 334/78 to carry out the functions of certification agency under seed act 1966 in A.P. w.e.f. 1.6.1979.

Functions of Seed Certification Agency are

1. To certify seeds of any notified kind or variety
2. Outline the procedure for seed certification to ensure that the seed lot meets the prescribed field and seed standards
3. Verify the eligibility of the variety for certification and to verify the seed source
4. Maintains a list registered plant breeders
5. To conduct field inspection at different stages of crop growth to verify the field standards and genetic contamination
6. Draws samples from seed lots to confirm that the seed meets the prescribed seed standards.
7. Inspect seed processing plants to verify and avoid mechanical mixtures during seed processing.
8. To educate the farmers about the use of certified seed
9. Grant of certificate, labels and tags
10. Maintenance of such records as may be necessary during seed certification.

Lecture No: 4

Importance of Seed Production

Introduction

The primary objective of plant breeding is to develop superior varieties. The benefits from superior varieties can only be realized when they are grown commercially on a large scale. Therefore seeds of improved varieties must be multiplied at a large scale to make them available to farmers for commercial cultivation. During the multiplication of varieties for use as seed, it is essential that genetic purity of the variety must be maintained. For best results the farmer should use new pure seed every few years in case of self-pollinated crops and every year for hybrid varieties or every few years for synthetic and composite varieties in the case of cross pollinated crops. This would require the maintenance of seeds of superior varieties in genetically pure state, which would be multiplied every year to supply new seed to the farmers. It is clear that the seed of new varieties should reach the farmers in a pure and healthy state. To ensure this, elaborate seed programmes exist in most of the countries. India also has a well organized seed production programme in the form of national seeds corporation (NSC), state seeds corporations (SSCS) and state seed certification agencies (SSCAS). These organizations are responsible for seed multiplication, certification and distribution of high quality seed.

Historical

The procedures for seed production and processing and the standards for seed certification developed slowely with the realization of the importance of quality seed in agriculture. Most likely, seed certification began in Sweden during the lost quarter of nineteenth century. In 1886, the Swedish seed association was formed, it undertook the production and distribution of quality seeds of improved varieties of mainly forage crops. Towards the end of 19th century, Dr. E. Helve established a seed testing laboratory in den mark in order to conduct seed tests for certification. In 1917, Dr. J.W. Robertson, a Canadian scientist, proposed the production of foundation seed, which is now a cervical stage in quality seed production. In 1919 the international crop improvement association (ICIA) was formed and renamed as association of seed certification agencies (AOSCA) in 1969. This association has been crucial in the development of procedures and standards for quality seed production and seed certification.

Development of seed industry in India

In India, new improved varieties of same important crops, notably wheat, were developed during the first two decades of the 20th century. Efforts were made by the state depts. of agriculture and same other agencies to disseminate the seeds of these improved varieties among the farmers.

In 1925, the royal commission on agriculture reviewed the production and distribution of seeds in India; it made several notable observations and valuable recommendations other commitments persons who reviewed and made recommendations. For the seed situation in India are as follows sir John Russell (1937), imperial council of agricultural research (1940), Dr. Barnes (1944), the famine commission (1944) and food grains policy committee (1944),

Quality seeds of vegetables were being imported from countries like Australia, UK, U.S.A, Germany etc up to 1939. Several private companies were formed during 1950's onwards and involved in the production and marketing of quality seeds of various crops. Both crop improvement and quality seed production received impacts after independence. In 1952, the Indian council of agricultural research (ICAR) appointed a standing experts committee on seeds, which formulated a programme for strengthening the seed production and distribution systems.

In 1959, the agricultural production team, leaded Dr. Johnson recommended that uniform standards of seed certification and seed laws should be brought into place and that each state should establish seed testing laboratories. The planning commission appointed a seed multiplication team to review the various aspects of seed programmes; this team made several valuable recommendations. Similarly, ICAR set up a committee in 1960 in order to suggest ways for developing a strong seed production programme; this committee suggested the establishment of central and state agencies for the production of foundation seed, the establishment of independent seed certification agency, the enactment of a national seeds act and the creation of agencies for its enforcement and for stimulating the development of private seed industry. Based on these recommendations, the national seeds corporation (NSC) was establishment in 1963 and the Indian seeds act was enacted in 1966. The Govt. of India set up a seeds review team in 1968; the team toured several foreign countries and made some for reaching recommendations. One of the recommendations was that the agricultural universities should also be involved in foundation seed production.

The seed industry developed fairly rapidly with the establishment of NSC. Both the quality seeds produced and the number of crops covered has expanded rapidly.

The Indian Seeds Act (1966)

The Indian seeds act was exacted in 1966 and has been in force since October 2, 1969 in all the states and minor territories. The seeds act was amended on September 9, 1972 [The seeds (amendment) act, 1972). This act aims at regulating the quality of seed sold for agricultural purposes though compulsory labeling and voluntary certification under, compulsory labeling, any one selfing the seed of a notified kind or variety, in the region for which it has been notified most ensure that

1. The seed conforms to the prescribed limits of germination and purity
2. The seed container is labeled in the prescribed manner and
3. The label truly represents the quality seed in the container. Under voluntary certification any one interested in producing certified seed may do so by applying to the seed certification agency

Statuary bodies and agencies established in India under the Seeds Act 1966.

1. **Central Seeds Committee:** It is the main source of advice to central government on administration of seed act and any other matter related to seeds. It consists of a chairman, 2 representatives of seed growers, 8 nominees from central govt. and one representative from state government.

   The main functions are

   1. to advice central and state govt. on all matters related to seeds
   2. To advice the govt. on notification of varieties
   3. To advice the govt. on the minimum limits for germination and purity of kind/variety
   4. To recommend procedure for seed certification, GOT and analysis of seeds
   5. To recommend on rate of fees to be charged for analysis of samples by central and state Seed Testing Laboratories and for Certification by certification agency.
   6. To recommend to central govt. regarding suitability of any seed certification agency established in foreign country for seed act.

7. To advice central and state governments regarding suitability of establishing Seed Testing Laboratories.
8. To send recommendations on proposals related to seed act.
9. To suggest clarification on any matters relating to seed act.

2. **Central Seed Certification Board** : To deal with all problems related to seed certification and to co-ordinate the work of sate seed certification agency.
3. **State Seed Certification Agency** – SSCA are established on the recommendations of Central Seeds committee as a society having governing body and an executive wing. The governing body consists of persons from state government, seed producing agencies, farmers, subject matter specialists and seed law enforcement agencies. The executive wing consists of seed inspectors, seed certification officers and seed analysts.

   Functions:
   1. To certify the seeds of any notified variety
   2. Outline the procedure for submission of application and for seed production.
   3. Maintain a list of recognized breeders
   4. verification of the application for certification
   5. take samples and inspect seed lots to confirm quality of seed lot as per the standards of certification.
   6. To ensure production of quality seed by field inspection, seed processing plant inspection etc. to issue certificate i.e. tags, labels etc.
   7. Undertake educational programmes to promote the use of certified seed.
   8. Maintain records relating to certified seed production.

4. **Central Seed Testing Laboratory**: The Seed Testing Laboratory at IARI, New Delhi has been notified as CSTL. The functions assigned to this laboratory are
   1. Initiate seed testing program in collaboration with state seed testing laboratory to promote uniformity in test results.
   2. Collect data on the quality of seeds found in the market and make this data available to Central Seeds Committee.
   3. Carry out functions assigned by Central government from time to time.

4. Act as referee laboratory in testing seeds.

5. **State Seed Testing laboratory** –
   1. To carry out seed analysis work of the state. To test the seed of dealers for physical purity, germination, inert matter, weed sees, other crop seeds etc.
   2. To test the seed samples of cultivators who wish to get their own seed tested before selling,
   3. to test samples sent by seed inspectors
   4. To test samples of seed for seed certification agency
   5. Testing required for revalidation and other purposes.
6. **Appellate Authority** –
   1. It is appointed by the state government to look into grievances of seed producers against seed a seed certification agency and
   2. To look into the grievances of seed traders against seed law enforcement officials.
7. **Recognition of SCA's of foreign countries** – Central government may establish any seed certification agency established in an foreign country for the purpose of Indian Seeds Act 1966.

Notification of Standards and Procedures. – The central government after consultation with Central Seeds Committee have fixed the standards for certification and standards for labeling by notification.

The certification standards cover overall aspects including genetic purity, physical purity, germination and disease infection etc. the certification standards for physical purity and germination are usually higher by 1-2 % and 5-10% respectively than labeling standards.

Notification of Variety :- Notification is done by the Central sub-committee on crop standards and notification. It is based on the seed demand and popularity of a variety. Notification brings the kind/variety under the purview of seed act.

Under the seed act certification is voluntary but labeling is compulsory.

Regulation of sale of notified varieties: Under section 7 of the act the seed of notified variety can be sold in containers only. The seed may be truthfully labeled or certified but it should meet the minimum prescribed requirements.

Requirement for sale of seed: The seed which is sold should be compulsorily labeled. The colour of the label shall be blue for certified seed and greenish buff colour for truthfully labeled seed. The seed container shall be labeled with following details.

1. Kind
2. variety
3. Lot No.
4. Date of test
5. Inert matter %
6. Pure seed %
7. Other crop seed (No./ Kg.)
8. Weed seed (No./Kg)
9. Germination %
10. Net Contents
11. Sellers name and Address
12. If treated - Do Not Use for food or oil purpose or Poison

When net content is 250 grams or less item no. 5 to 9 may be replaced by the following statement. '**The seed in this container confirms to the minimum limits of germination and purity prescribed under the act**."

Seed inspectors are responsible for the seed law enforcement. The seed samples are tested under the supervision of state seed Analyst at the state seed testing laboratories.

Enforcement of the Seed Act : - Under the seed low enforcement programme the seed offered for sale are subjected to be sample by seed inspector appointed by state govt. under the provisions of the Act. The seed thus sampled by the seed inspector is tested for physical purity & germination % in a state STL. Under the supervision of seed Analyst. Seed production is done by the registered grown for a Company or corporation of the buyer feels that the seed is not to the required quality he may contact the seed inspector for fallow up action.

Sampling : - Samples drawn by the inspector are sub-divided into 3 parts & are sealed in the presents of seller. One sealed cover will be sent to the lab, the 2nd one will be retained by the seller & the third one with inspector. The cost of seed taken through sampling may be paid to the seeds man on demand. The label on any sample should bear.

1. S. No.
2. Name of the sender with official designation
3. Name of the person form when the sample has been taken
4. Date & Place of taking the sample

5. Kind & variety of the seed for analysis
6. Nature & Qty. of preservative added if any

Powers of seed inspectors : - Sector IX Rule 23 specifics duties of seed inspector which may be summarized as follows.

1. He can draw representative samples of any kind / variety from any person selling such seed & send them analysis to the seed analyst.
2. To enter & search any place in which he believes that an offered under thus Act has been committed. He can order not to despise of any stock of such seed for specific period not exceeding 30 days.
3. To examine any record, register or document & seize them, if he feels that they can furnish evidence of an offered punishable under the Act.
4. On demand to pay the cost of seed calculated at the rate at which such seed is sold to the pubic.
5. He can break open the door & premises of seed seller if the seller refuses to open the door.
6. Search seize the stocks & records etc.
7. He can investigate any complaint made to him in writing.
8. He can investiture prosecutions in respect of breach of out & rules
9. Prohibit the sales of such seed which he fee ls are below the minimum limits of germination or improperly labeled & can initiate action against the sellers.

Offenses of Seed Act : - If the seed lot is found to be substandard legal action can be initiated against the seller or if the labels are absent he may be request to label the seeds propels

1. Legal proceedings can be initiated in a court of low for selling sub-standard seed & on conviction a fine upto Rs. 500/- can be imposed to the default.
2. If a same crime is committed for second time – In second convictions the penalty may extend upto 6 months impressments or fine upto Rs. 1000/- or both.
3. Forfeiting of property (Section 20 seeds Act 1966) – When any person has been convicted under the Act, the seed in respect of the contraventions may be for fasted to the Govt.
4. Offences by companies – (Section21) When an offence is committed by a Company every person, who at the time of offered are Incharge & responsible to the Company shall be descend to be surety of the offered & are liable to punishment.

New Seed Policy

A national seeds policy (2001) has been formulated to facilitate development, production and distribution of improved varieties of seeds and planting materials, strengthening and expansion of seed certification system with increased private sector participation and liberalized setup for import and export of seed and planting material. The policy will also outline the role of biotechnology in the development of agriculture sector, clearly defining the regulatory framework for transgenic plant varieties.

The seeds division of Department of Agriculture and Cooperation will supervise the overall implementation of the national seeds policy including PPVFR bill, seeds act, Registration of plant varieties and import and export of seeds.

Lecture No: 5

Testing, release and notification of varieties– CVRC SVRC. NSC APSSDC and APSSCA

Variety:

Botanically a variety is a sub group of a species. According to seed act (1966, sub section 16 of section 2) it is a sub division of a kind identified by its growth, yield, plant fruit, seed or other characters. Where as seed technology considers a group of plants uniform in their morphological, physiological, biochemical and other characters without any variation from generation to generation and can be differentiated from other groups of plants of the same species by some distinguishing characters as variety after its release and notification.

Schematic flow chart indicating the steps involved in the development of a variety

Plant breeding method

↓

Development of a strain

↓

Identification by the workshop for particular zone

↓

Testing under AICRP

↓

Multilocation trials in the state / zone of adoption

↓

Release of variety by state / central Govt.

↓

Notification of the variety by GOI

↓

Seed production through seed multiplication chain

↓

Use of certified seed by the farmers

In India, the release of new crop varieties consists of four major steps viz.

1. Development of new strains
2. Evaluation of performance
3. Identification of superior strains and
4. Release and notification

1. Development of new strains

The new strains are developed by ICAR crop research institutes and state agricultural universities for specific purposes. Various breeding methods are used for development of new strains in self and cross pollinated species

2. Evaluation of performance

The performance of newly developed strains is evaluated in AICCIP, ICAR institutes, SAUs and private registered seed companies enter their improved strains / hybrids in the AICCIP of respective crop for multilocation testing. The new strains are tested at multilocations under the coordinated project for a minimum period of three years / seasons. The new variety is first tested for yield under the initial varietal trials (IVT); the in the second year. The strains that give good performance in AVT for two years are selected.

3. Identification of superior strains

The strains which show good yield performance in AVT are identified as superior strains and are considered for release in the workshop meetings. The new agro and plant protection techniques required to obtain potential yield of new strains are also worked out by that time. The workshop after considering the new promoting varieties recommend them to replace existing varieties.

4. Release and notification

The proposal for release of new varieties is put up in a prescribed proforma to variety release committee. There are two types of variety release committees viz, state variety release committee (SVRR) and central variety release committee (CVRC). Incase of state variety release committee, Director of Agriculture for field crops and Director of Horticulture for vegetable and horticulture crops is the chairman. In central variety release committee, Deputy Director General (Crop Science) of ICAR is the chairman. The release proposal of varieties recommended for All India release is put up before CVRC, while for those recommended for release in a particular state is placed before the SVRC of respective state these committees consist of scientists and representatives of seed producing organizations (NSC, SSC and SSCA) and other related govt. agencies After release, the variety is notified. Seed production can be taken up only after notification of new varieties. The notification is done by the govt. of India.

Seed production organizations

National Seeds Corporation

The national seeds corporation (NSC) was initiated under ICAR and registered on 7th March, 1963 as a limited company in the public sector. NSC handled foundation and certified seeds of many varieties of more than to crops. The present functions of NSC are as follows.

1. Production and supply of foundation seed.
2. Interstate marketing of all classes of seed
3. Export and Import of seed
4. Production of certified seed where required
5. Planning the production of breeder seed in consultation with ICAR
6. Providing technical assistance to seeds corporations and private agencies
7. Coordinating certified seed production of several state seed corporations
8. Conducting biennial surveys of seed demand
9. Coordinating market research and sales promotion efforts
10. Providing training facilities for the staff participating in seed industry development
11. Providing certification services to states lacking established and independent seed certification agencies.

APSSDC: The APSSDC was established in March 1976 as a result of Govt. of A.P. accepting the
NSP in 1974. The APSSDC was formed by the growers but maintained by state Govt. officials
and is involved in quality seed production and distribution. Each share of the grower is of Rs
500/-.

Govt. of A.P. holds	36.29 %
NSC holds	27.11%
Seed Growers hold	36.60 %
	100.00

The main objectives of APSSDC are

12. Breeder seed production in oilseeds
13. Foundation and certified seed production of different crops
14. Seed production of pre-released and non-notified varieties
15. Seed processing, packing, storage and seed marketing and distribution
16. Seed supply to problematic areas
17. Assists in breeder seeds production and acts as nodal agency for BSP and distribution.
18. Acts as nodal agency for maintaining buffer stock of seeds
19. Undertakes collaboration in seed technology research
20. Co-ordinates seed imports
21. Gives constancy services sand conducts training to seed growers
22. Takes up extension programs to enlighten the fanners to use quality seeds.

APSSCA; It was registered under A.P. (Telangana area) public societies registration act with a regd. No. 334/78 to carry out the functions of certification agency under seed act 1966 in A.P. w.e.f. 1.6.1979.

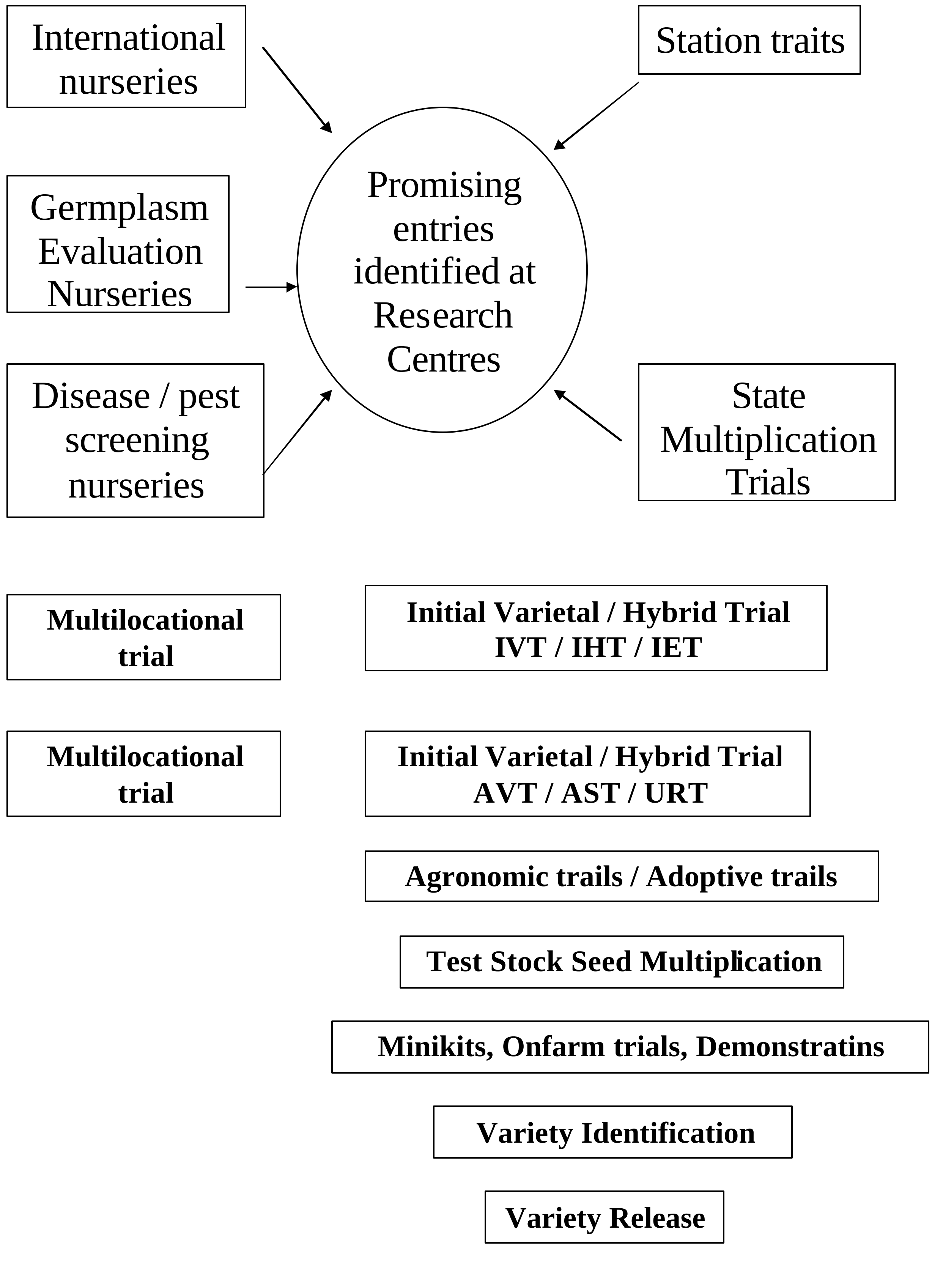
Functions of Seed Certification Agency are

11. To certify seeds of any notified kind or variety
12. Outline the procedure for seed certification to ensure that the seed lot meets the prescribed field and seed standards
13. Verify the eligibility of the variety for certification and to verify the seed

source

14. Maintains a list registered plant breeders
15. To conduct field inspection at different stages of crop growth to verify the field standards and genetic contamination
16. Draws samples from seed lots to confirm that the seed meets the prescribed seed standards.
17. Inspect seed processing plants to verify and avoid mechanical mixtures during seed processing.
18. To educate the farmers about the use of certified seed
19. Grant of certificate, labels and tags
20. Maintenance of such records as may be necessary during seed certification.

GENERAL PROCEDURE FOR VARIETY TESTING



CENTRAL VARIETY RELEASE COMMITTEE

1. **Deputy Director General (Crop Science) - Chairman**
2. **Production Commissioner, Govt. of India - Member**
3. **Project Director – Concerned Crop - Member**
4. **Principle Investigator - Member**
5. **Director of Agriculture of the State - Member**
6. **Director High Yielding Varieties - Member**
7. **Ministry of Agriculture - Govt. of India - Member**
8. **Deputy Secretary Seeds - Govt. of India – Member**

STATE VARIETY RELEASING COMMITTEE

1. **Director of Agriculture – Chairman**
2. **Director of State Seeds Development Corporation – Member**
3. **Director of State Seed Certification Agency - Member**
4. **Additional Director of Agriculture (Inputs) - Member**
5. **Joint Director of Agriculture - Member**
6. **Director of Research of State Agriculture University - Member**

Lecture No: 6

Deterioration of Crop Varieties and Methods to prevent them

Variety: Is a group of plants having clear distinguished characters which when reproduced either sexually or asexually retains these characters.

The main aim of seed production is to produce genetically pure and good quality seed. But why/how the genetic purity of a variety is lost or deteriorated during seed multiplication. The several factors that are responsible for loss of genetic purity during seed production as listed by kadam (1942) are:

1. Developmental Variation
2. Mechanical Mixtures
3. Mutations
4. Natural Crossing
5. Genetic drift
6. Minor Genetic Variation
7. Selective influence of Diseases
8. Techniques of the Breeder
9. Breakdown of male sterility
10. Improper / defective seed certification System

1. **Developmental Variation:** When a seed crop is grown in difficult environmental conditions such as different soil and fertility conditions, under saline or alkaline conditions or under different photo-periods or different elevations or different stress conditions for several consecutive generations the developmental variations may arise as differential growth response.

To avoid or minimize such developmental variations the variety should always be grown in adaptable area or in the area for which it has been released. If due to some reasons (for lack of isolation or to avoid soil born diseases) it is grown in non-adaptable areas it should be restricted to one or two seasons and the basic seed i.e. nucleus and breeder seed should be multiplied in adaptable areas.

2. **Mechanical Mixtures:** This is the major source of contamination of the variety during seed production. Mechanical mixtures may take place right from sowing to harvesting and processing in different ways such as;

a. Contamination through field – self sown seed or volunteer plants
b. Seed drill – if same seed drill is used for sowing 2 or 3 varieties
c. Carrying 2 different varieties adjacent to each other.
d. Growing 2 different varieties adjacent to each other.
e. Threshing floor
f. Combine or threshers
g. Bags or seed bins
h. During seed processing

To avoid this sort of mechanical contamination it would be necessary to rogue the seed fields at different stages of crop growth and to take utmost during seed production, harvesting, threshing, processing etc.

3. **Mutations:** It is not of much importance as the occurrence of spontaneous mutations is very low i.e. 10-7. If any visible mutations are observed they should be removed by rouging. In case of vegetatively propagated crops periodic increase of true to type stock would eliminate the mutants.

4. **Natural Crossing**: It is an important source of contamination in sexually propagated crops due to introgression of genes from unrelated stocks/genotypes. The extent of contamination depends upon the amount of natural cross-fertilization, which is due to natural crossing with undesirable types, offtypes, and diseased plants.

On the other hand natural crossing is main source of contamination in cross-fertilized or often cross-fertilized crops. The extent of genetic contamina tion in seed fields is due to natural crossing depends on breeding system of the species, isolation distance, varietal mass and pollinating agent.

To overcome the problem of natural crossing isolation distance has to be maintained. Increase in isolation distance decreases the extent of contamination. The extent of contamination depends on the direction of the wind flow, number of insects presents and their activity.

5. **Genetic drift:** When seed is multiplied in large areas only small quantities of seed is taken and preserved for the next years sowing. Because of such sub-sampling all the genotypes will not be represented in the next generation and leads to change in genetic composition. This is called as genetic drift.

6. **Minor Genetic variation:** It is not of much importance, however some minor genetic changes may occur during production cycles due to difference in environment. Due to these changes the yields may be affected.

To avoid such minor genetic variations periodic testing of the varieties must be done from breeder's seed and nucleus seed in self-pollinated crops Minor genetic variation is a common feature in often cross-pollinated species; therefore care should be taken during maintenance of nucleus and breeder seed.

7. **Selective influence of Disease:** Proper plant protection measures much be taken against major pests and diseases other wise the plant as well as the seeds get infected.

   a. In case of foliar diseases the size of the seed gets affected due to poor supply of carbohydrates from infec ted photosynthetic tissue.

b. In case of seed and soil borne diseases like downy mildew and ergot of Jowar, smut of bajra and bunt of wheat, it is dangerous to use seeds for commercial purpose once the crop gets infected.

c. New crop varieties may often become susceptible to new races of diseases are out of seed production programms. Eg. Surekha and Phalguna became susceptible to gall midge biotype 3.

8. **Techniques of the Breeder :** Instability may occur in a variety due to genetic irregulaeities if it is not properly assessed at the time of release. Premature release of a variety, which has been breed for particular disease, leads to the production of resistant and susceptible plants which may be an important cause of deterioration.

When sonalika and kalyansona wheat varieties were released in India for commercial cultivation the genetic variability in both the varieties was still in flowing stage and several secondary selections were made by the breeders.

9. **Breakdown of male sterility:** Generally in hybrid seed production if there is any breakdown of male sterility in may lead to a mixture of F1 hybrids and selfers.

10. **Improper Seed Certification :** It is not a factor that deteriorates the crops varieties, but is there is any lacuna in any of the above factors and if it has not been checked it may lead to deterioration of crop varieties.

Maintenance of Genetic Purity during seed Production

Horne (1953) had suggested the following methods for maintenance of genetic purity;

1. Use of approved seed in seed multiplication
2. Inspection of seed fields prior to planting
3. Field inspection and approval of the Crop at critical stages for verification of genetic purity, detection of mixtures, weeds and seed borne diseases.
4. Sampling and sealing of cleaned lots
5. Growing of samples with authentic stocks or Grow -out test

Various steps suggested by Hartman and Kestar (1968) for maintaining genetic purity are as follows;

1. Providing isolation to prevent cross fertilization or mechanical mixtures
2. Rouging of seed fields prior to planting
3. Periodic testing of varieties for genetic purity
4. Grow in adapted areas only to avoid genetic shifts in the variety
5. Certification of seed crops to maintain genetic purity and quality
6. Adopting generation system

Safe guards for maintenance of genetic purity

The important safe guards for maintaining genetic purity during seed production are;

1. Control of seed source
2. Preceding crop requirement
3. Isolation
4. Rouging of seed fields
5. Seed certification
6. Grow out test

1. **Control of Seed Source :** The seed used should be of appropriate class from the approved source for raising a seed crop. There are four classes of seed from breeder seed, which are given and defined by Association of Official Seed Certification agency (AOSCA).

a. **Nucleus Seed:** It is handful of seed maintained by concerned breeder for further multiplication. The nucleus seed will have all the characters that he breeder has placed in it and it is of highest genetic purity. The quantity of nucleus seed is in kilograms.

b. **Breeder Seed :** It is produced by the concerned breeder or sponsoring institute or and which is used for producing foundation seed. It is of 100% genetic purity. The label/tag issued for B/s is golden yellow in color. The quality of breeder seed is assured by the monitoring team constituted by the govt.

c. **Foundation Seed:** It is produced from breeder seed and maintained with specific genetic identity and purity. It is produced on govt. farms or by private seed producers. The quality of foundation seed is certified by certification agency. It has genetic purity of above 98%. The certification tag or label issued for F/s is white in color.

2. **Preceding Crop requirement :** This has been fixed to avoid contamination through volunteer plants and also the soil borne diseases.

3. **Isolation :** Isolation is required to avoid natural crossing with other undesirable types, off types in the fields and mechanical mixtures at the time of sowing, threshing, processing and contamination due to seed borne diseases from nearby fields. Protection from these sources of contamination is necessary for maintaining genetic purity and good quality of seed.

4. **Rouging of Seed Fields:** The existence of off type plants is another source of genetic contamination. Off type plants differing in their characteristics from that of

the seed crop are called as off types. Removal of off types is referred to as roughing. The main sources of off types are

a. Segregation of plants for certain characters or mutations

b. Volunteer plants from previous crops or

c. Accidentally planted seeds of other variety

d. Diseased plants

Off type plants should be rouged out from the seed plots before they shed pollen and pollination occurs. To accomplish this regular supervision of trained personnel is required.

5. **Seed Certification:** Genetic purity in seed productions maintained through a system of seed certification. The main objective of seed certification is to make available seeds of good quality to farmers. To achieve this qualified and trained personnel from SCA carry out field inspections at appropriate stages of crop growth. They also make seed inspection by drawing samples from seed lots after processing. The SCA verifies for both filed and seed standards and the seed lot must confirm to get approval as certified seed.

6. **Grow-out Test :** varieties that are grown for seed production should be periodically tested for genetic purity by conducting GOT to make sure that they are being maintained in true form. GOT test is compulsory for hybrids produced by manual emasculation and pollination and for testing the purity of parental lines used in hybrid seed production.

Lecture No: 7

Seed Quality – Classes of Seed

Objective: Multiplication of quality seed under vigilant supervision of breeder of seed certification agency to distribute quality seed of notified varieties for sowing purpose.

Seed of notified varieties are multiplied in four tier system by the involvement of ICAR Institutes / State Agricultural Universities, State / National Seed Corporation and Seed Certification Agencies.

1. **Nucleus seed:** Nucleus seed: This is cent per cent genetic pure seed with physical purity produced under the direct supervision of the concerned plant breeder.
2. **Breeder's seed:** This is the progeny of the nucleus seed multiplied in large area under the supervision of plant breeder and monitored by a committee. It provides cent per cent physical and genetic pure seed for production of

foundation class. Golden yellow coloured certificate is issued for this category by the producting agency.

3. **Foundation seed:** Progeny of breeder's seed in handled by recognized seed producing agencies in public and private sector under the supervision of Seed Certification Agency in such a way that its quality is maintained according to the prescribed standard. Seed Certification agency issues a white colour certification for foundation class seed. Foundation seed is purchased by Seed Corporation from seed growers. Foundation seed can again be multiplied by Seed Corporation in the events of its shortage with similar seed certification standard.

4. **Certified seed:** Progeny of foundation seed produced by registered seed growers under the supervision of Seed Certification Agency by maintaining the seed quality as per minimum seed certification standards. Seed Certification Agency issues a bleu colour (Shade ISI No. 104, azure blue) certificate.

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

Seed Quality

Thompson (1979) defined seed quality as a multiple concept comprising several components and their relative importance in different circumstances and laid much emphasis on

1. Analytical purity / physical purity
2. Species purity / Genetic purity
3. Freedom from weeds
4. Germination percentage
5. Seed vigour and health
6. Seed Moisture content
7. Seed size, weight and specific gravity

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

1. **Improved variety:** It should be superior to the existing variety i.e. the yield should be higher by 20-25% than the existing variety or it should have some desirable attributes like disease resistance, drought resistance, salt tolerance etc., with good yield potential.

2. **Genetic Purity:** The seed should be true to type. The seed should possess all the genetic qualities / characters, which the breeder has placed in the variety, genetic purity has direct effect on the yields. If there is nay deterioration, there would be proportionate decrease in the yield or performance.

3. **Physical Purity:** Physical purity of a seed lot refers to the physical composition of the seed lots. A seed lot is composed of pure seed, inert mater, broken seeds, undersized seeds, soil and dust particles weed seeds, OCS etc.

Higher the content of pure seed better would be the seed quality. Pure seed together with germination gives the planting value of the seed lot.

4. **Seed germination and vigour:** Seed germination refers to the ability of a seed when planted under normal sowing conditions to give rise to a normal seedling. Seed vigour refers to the sum total of all seed attributes that give effective plant stand in the field.
   Higher germination percentage and vigour gives adequate plant population and uniform growth, which have profound effect on, yield and determine the planting value of the seed.

5. **Freedom from weeds and other crop seeds:** This is an extension of physical purity described earlier. There are certain weed species, which are very harmful to the crop and once established they are difficult to eradicate. An absolute freedom from seed of such species is highly desirable and is one of the important criteria for determining the planning quality of seeds.

6. **Seed health:** Seed health refers to the presence or absence of disease organisms or insect pests on the seed. The quality of a seed lot depends on its health, hence the seed should be free from seed borne disease and insect pests.

7. **Seed moisture:** The seed moisture is the most important factor in determining the seed germination and viability during storage. At high seed moisture content there is high incidence of pest attack and at moisture content above 16% seed get heated and the viability is lost. Hence the seed should be stored at safe moisture levels of 11-13%

8. **Seed size, weight and specific gravity:** Seed size, weight and specific gravity has been found to have positive correlation with seed germination and vigour in many crops. Therefore the seed should be bold with high specific gravity.

9. **Seed Colour:** The colour of the seed often reflects the condition during seed maturation. The farmers from ancient times have regarded good normal shine as invariable quality guides. The colour and shine deteriorates only when the weather conditions are adverse during maturation or when insects infest the crop or when it is handled badly.

The seed lots having high genetic purity, high germination and with a minimum amount of inert matter, weed seeds and other crop seeds and are free from diseases is said to be of high quality and if it is lacking of these it is said to be of low quality.

Lecture No: 8

Maintenance of Nucleus seed and Breeder seed in self and cross pollinated crops

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

Maintenance of nucleus can be divided into 2 groups

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

Maintenance of nucleus seed of pre-released or newly released varieties:

Harrington 1952 has outlined the procedure for multiplication of nucleus seed which is given below;

1. **Sampling of a variety to obtain nucleus seed**: In any crop not more than 15 new varieties should be sampled in any research station. Select approximately 200 plants from one of the yield trials. Discard poor diseased and inferior plants. The selected plants should be harvested 4 to 5 days before harvest to avoid shattering. All the 200 plants should be tied individually and wrapped in a cloth bag and stored till the yield results are obtained. The bundles of high yielding varieties are taken for further examination and the inferior varieties are discarded.
2. **Table examination of samples**: The bundles are threshed separately and the seed should be examined in piles on the purity work board. Piles with undesirable characters (diseased, offtypes etc.) should be discarded. The remaining pure seed of individual plants is sown in a variety purification nursery called as nucleus seed.
3. **Location and seeding of nucleus seed**: Select clean fertile and in the experimental station in which the same crop was not grown in previous one season. The land should be free from volunteer plants and it should be properly isolated. The 200 or less progenies should be sown in 200 double rows in 4 series of 50 double rows in each plot. Sufficient spacing should be there between and within the rows to facilitate examination of each row during the crop growth.
4. **Inspection of nucleus double row plots and removal of offtypes**: the double row plots should be critically examined from the seedling stage until maturity. If any plot differ distinctly from that of the nucleus seed variety it should be removed before flowing stage. After flowering and during maturity plots should be examined critically for other characters like flower colour, ear head shape, seed colour etc. and the offtypes should be removed before harvest. When a plant is removed after flowering all the plants or plots within 3 meters should be removed as they may contaminate the surrounding plants.

5. **Harvesting and threshing**: The remaining plots (between 180-200) should be harvested individually and tied into a bundle. The individual plots are threshed cleaned and dried separately. The seed of each plot should be placed on the purity work board in piles and examined for uniformity of seed characters. If any pile appears to be of off type or diseased it should be discarded. All the remaining plot seed should be mixed together into one lot treated with fungicide and insecticide bagged, labeled and stored as breeder stock seed for next year.

Maintenance of B/s or pre-released or newly released varieties:

1. Breeder stock seed should be sown on clean fertile land on which the same crop was not grown in previous one season.
2. The field should be properly isolated to avoid natural crossing and spread of diseases.
3. Adopt latest farm practices to raise a good crop.
4. B/s should be produced at the experimental station in the area where the variety is to be released.
5. Sufficient spacing should be provided between and within the rows to examine individual plants and for removal of offtypes.
6. Roughing should be done before flowering and when plants are removed after flowering all the surrounding plants within one meter should be removed.
7. Harvesting the B/s should be done with utmost care. The equipment used for harvesting, threshing and cleaning should be clean to avoid mechanical mixtures. The seed should be stored in new gunny bags. The seed produced should be of 99.99 % pure and it is used for producing F/s. A portion of B/s should be retained to sow a continuation of B/s.

Maintenance of breeder seed of established varieties:

The B/s can be maintained satisfactorily by any one of the following methods

1. **By raising the crop in isolation**: B/s can be maintained by growing them in isolated pots and by following rigorous roughing during various stages of crop growth. The methods of handling the B/s is same as that described earlier.
2. **By Bulk selection**: Genetic purity of established varieties could be satisfactorily improved by bulk selection. In this method select 2000 to 2500 plants which are typical to that of the variety. Harvest and thresh them separately. The seed of each plant are examined and any plot which shows

offtypes or dissimilar ones are discarded. The seed of individual plant may be gown in double rows or may be bulked to form the breeder stock seed.

Maintenance of Nucleus and Breeder seed in cross pollinated crops:

The maintenance of varieties of cross pollinated crops is much more complicated than self pollinated crops.

Maintenance of nucleus seed of inbred lines: after a hybrid has been thoroughly tested and if it is suitable the seed of parental lines must be increased in the following manner;

1. **Hand pollination**: method of maintaining nucleus seed of inbred lines involves self pollination, sib pollination of combination of both. Generally maintenance by sibbing is preferred because it does not reduce the vigour. It is also preferable to maintain some parental material by alternate selfing and sibbing from one generation to the next. The individual selfed or sibbed ears should be examined critically. Those which are offtypes or inferior in any regard of differing in any character such as texture, seed size, color, shape etc. should be discarded. The individual selfed or sibbed ears may then be threshed separately and sown in ear to row method in double row plots. The advantage of ear to row planting is that the offtypes from individual ears can be easily detected and controlled.
2. **Seeding of hand pollinated seed**: The hand pollinated seed should be sown in fertile land which is free from volunteer plants. The same crop should not be grown in previous one season. The seed should be sown in the area where the hybrid is to be released.
3. **Isolation**: Proper isolation distance should be provided to avoid natural cross pollination and spread of diseases. The isolation distance varies from crop to crop and depends on nature of contamination and direction of the prevailing wind. Generally more isolation is required at this stage than the later stages. Distance or time isolation can be practiced to avoid contamination.
4. **Inspection of double row plots and roughing**: Despite of making all the efforts taken to maintain purity in inbred lines by hand pollination and adequate isolation distance still it is not possible to achieve perfection. The double row plots must be carefully checked for offtypes prior to pollen

shedding. It is very easy to recognize the offtypes because they are more vigorous than the inbred lines.

5. **Harvesting drying and shelling**: the nucleus seed crop can be harvested soon after it attains physiological maturity if artificial drying facilities exst. It is better to harvest the ear to row lines separately an oils made in front of each progeny. These piles should be critically examined for ear characters and all off colored, off textured and diseased or undesirable ears sorted out. If the overall percentage of offtypes is more than 0.1%, hand pollination should be done again. After discarding the undesirable ones, remaining ears may be bulked and dried in clean dry bin at a temperature not exceeding 43°C. After drying shelling should be done in a cleaned machine to avoid mechanical mixtures at this stage. After shelling the seed may be cleaned treated with fungicide, insecticide, properly labeled and stored under ideal storage condition.

Maintenance of breeder seed of inbred lines: for increasing B/s the breeder stock seed obtained from nucleus seed is planted in an isolated field. During increase of B/s adequate attention must be paid to

1. Land requirement
2. Isolation
3. Roughing
4. Field inspection
5. Harvesting and drying
6. Sorting of the ears.

Care should be taken on the above points so as to produce breeder seed of maximum genetic purity

Lecture No: 9

Development of Hybrids

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

Pure line: It is the progeny of single self-fertilized homozygous plant.

Inbred line: It is a near homozygous line obtained by continues inbreeding in a cross-pollinated crop followed by selection.

Single cross: when two inbred lines or pure lines are crossed to produce the Fl hybrid it is known as single cross.

Double cross: when two single crosses are crossed the resulting hybrid population is known as double cross.

Three-way cross: It is a cross between a single cross and an inbred to give hybrid population.

Top cross: when an inbred is crossed with an open pollinated variety it is known as an inbred variety cross or a top cross. The purpose of top cross is to estimate the GCA of the inbred line crossed with OPV. When the cross is made to assess the combining ability it is known as test cross. A test cross may be made with an inbred (for SCA), hybrid, synthetic or OPV (for GCA). The common parent used in the test cross is known as tester and the progeny derived from these crosses are known as test cross progeny.

Polycross: It is the progeny of a line produced through random pollination by a number of selected lines.

Varietal cross: when two open pollinated varieties are mated it is known as varietal cross or population cross.

History of hybrids: Hybrids were first commercially exploited in maize because the yielding ability Of OPV could not be improved by mass selection or progeny selection. In 1878 Beal had shown that certain varietal crosses showed substantial heterosis and he suggested that such varietal hybrids might be used as varieties.

In 1908 Shull suggested a method for producing single cross hybrids in maize. He suggested that inbreds should be developed from OPV by continues self-fertilization. The inbreds that combined to produce superior hybrids should then be crossed to produce single cross hybrids. Shull's scheme could not be exploited commercially because of the following reasons:

1. Outstanding inbred lines were not available to produce hybrids with higher yields than that of OPV.
2. Since the female parent was an inbred, the amount of hybrid seed produced per acre was low (30-40 % of OPV), consequently the hybrid seed was expensive.
3. The male parent was also an inbred, hence pollen production was poor. So more area was to be planted under the male parent. This made the hybrid seed more expensive.

4. The hybrid seed was poorly developed as it was produced on the inbred line. The seeds were irregular, undersized with poor germination, thus requiring higher seed rate.
5. Cost of hybrid seed was very high.

The last four drawbacks were overcome by the double cross scheme proposed by Jones in 1918. Since in a double cross the female and male parent are single crosses, the seed and pollen production are abundant, seed quality and germination were high as a result the cost of hybrid seed was low.

The first double cross maize hybrid was produced at the Connecticut Agricultural Experimental station and grown in Connecticut in 1921 and was named as Burr Learning Hybrid.

Development of Hybrid: Breeding for hybrids involves three steps:

1. Development of Inbred lines
2. Evaluation of inbred lines
3. Commercial utilization of the crosses for seed production.

1. Development of inbred lines: Inbred lines are developed by continues self fertilization of a cross-pollinated species. Inbreeding of an OPV leads to many deficiencies like loss of vigour, reduction plant height, plants become susceptible to lodging, insects and pests and many other undesirable characters appear. After each selfing desirable plants are selected and self pollinated or sib pollinated. Usually it takes 6-7 generations to attain near homozygosity. An inbred line can be maintained by selfing or sibbing. The purpose of inbreeding is to fix the desirable characters in homozygous condition in order to maintain them without any genetic change.

The original selfed plants is generally referred as S_0 plant and the first selfed progeny as S_1 second selfed progeny as S_2 as so on. The technique of inbreeding requires careful attention to prevent natural crossing. The inbred lines are identified by numbers, letters or combination of both. In India inbred lines are developed and released through co-ordinate maize improvement scheme and are designated as CM (Co-ordinate maize), CS (Co-ordinate sorghum) etc.

CM-100-199 -	Yellow flint
CM-200-299 -	Yellow Dent
CM-300-399 -	White Flint

CM-400-499 - White Dent

CM-500-599 - Yellow

CM-600-699 - White

2. Evaluation of inbred lines: After an inbred line is developed, it is crossed with other inbreds and its productiveness in single and double cross combination is evaluated. The ability of an inbred to transmit desirable performance to its hybrid progenies is referred as its combining ability. GCA: The average performance of an inbred line in a series of crosses with other inbred lines is known as GCA.

SCA: the excessive performance of a cross over and above the expected performance based on GCA of the parents is known as specific combining ability Thus GCA is the characteristic of parents and SCA is characteristic of crosses or hybrids. The inbreds are evaluated in following way.

a. Phenotypic evaluation; It is based on phenotypic performance of inbreds themselves. It is effective for characters, which are highly heritable i.e. high GCA. Poorly performing inbreds are rejected. The performance of inbreds is tested in replicated yield trials and the inbreds showing poor performance are discarded.

b. Top Cross test: the inbreds, which are selected on phenotypic evaluation, are crossed to a tester with wide genetic base eg. An OPV, a synthetic variety or a double cross. A simple way of producing top cross seed in maize is to plant alternate rows of the tester and the inbred line and the inbred line has to be detasselled. The seed from the inbreds is harvested and it represents the top cross seed. The performance of top cross progeny is evaluated in replicated yield trials preferably over locations and years. Based on the top cross test about 50% of the inbreds are eliminated. This reduces the number of inbreds to manageable size for next step. Top cross performance provides the reliable estimate of GCA.

c. Single cross evaluation: Out standing single cross combinations can be identified only by testing the performance of single cross. The remaining inbred lines after top cross test are generally crossed in diallel or line x tester mating design to test for SCA. A single cross plants are completely heterozygous and homogenous and they are uniform. A superior single cross regains the vigour and productivity that was lost during inbreeding and can be more vigorous and productive than the original open pollinated variety. The performance of a single cross is evaluated in replicated yield trial over years and location and the outstanding single cross identified and may be released as a hybrid where production of single cross seed is commercially feasible.

In case of maize the performance of single cross is used to predict the double cross performance.

Number of Single crosses with reciprocals = n(n-l)

Number of single crosses without reciprocals = n(n-l)/2

Prediction of the Performance of Double Cross Hybrids

In a double cross hybrid, four inbred parents are involved. Theoretically, the potential of the double cross will be the function of the breeding value of these four parental inbreds. Therefore, based on the procedure of testing of the breeding value of inbreds, the performance of a double cross hybrid can be predicted through any of the four methods indicated by Jenkins (1934). Starting with the simplest procedure these methods are:

a) Top-cross testing (one cross per inbred) to know the breeding value of each of the four inbreds (total 4 top-crosses per double cross).
b) Mean of the four non-parental single crosses involved in (AXB) X (CXD) double cross, viz., (AXC), (AXD), (BXC) and (BXD) (total 4 non-parental single crosses per double cross).
c) Average yield performance of all possible six crosses [n(n-1)/2], namely AXB, AXC, AXD, BXC, BXD and CXD (total six crosses per double cross).
d) Average progeny-performance of each inbred can be determined by the mean performance of each inbred in all possible single crosses where it occurs (n-1 crosses per inbred). For instance, the mean performance of AXB, AXC and AXD will determine the average breeding value of the inbred A. Similarly, the mean of AXB, BXC and BXD will indicate the potential of the inbred B and so on (total 12 crosses per double cross).

These procedures of predicting the performance of double cross hybrids have been extensively investigated long ago. The available evidence shows that the method (b), i.e. mean performance of non-parental single crosses, is the most adequate and effective, since there is a close correspondence between predicted and realized yields of double crosses in maize. Fortunately, the total number of crosses required to be sampled per double cross is also the minimum, thus greatly facilitating the testing programme.

Lecture No: 10

Male Sterility

For the production of hybrid seed, removal of anthers before fertilization is essential to avoid selfing. Manually removing of anthers is very tedious and time consuming process in almost all the crops except in Maize and Castor which are monoecious. The pre-requisites for successful hybrid seed production in large quantities are:

1. Existence of male sterility or self-incompatibility through which hand emasculation can be avoided.
2. Sufficient cross-pollination should be there to get good seed set.

Male sterility is characterized by non-functional pollen grains while female gametes functions normally. It occurs in nature sporadically due to mutations. MS can be classified into three groups:

1. Genetic 2. Cytoplasmic 3. Cytoplasmic genetic

I. Genetic male sterility: GMS is mostly governed by single recessive gene ms, but dominant genes governing male sterility are also known eg: Safflower, MS alleles arise spontaneously or can be induced artificially. A GMS line can be maintained by crossing it with heterozygous male fertile plant. Such mating produces 50% m.s. & 50% MF plants

msms x Msms
(Male sterile) (Male fertile)

msms : Msms (1:1)
(Male sterile) (Male fertile)

Identifying the male fertile plants from the above progeny is difficult and time consuming. Hence GMS is not commonly used in hybrid seed production.

In USA it is used in Castor. In India it was being used in Redgram, but presently it is being used in safflower.

Marker genes which are linked to male sterility/fertility can be used to identify the male fertile plants before flowering stage. For example in Maize there is a gene, pigmented hypocotyl(P) and green hypocotyl (P) which is closely linked with sterility locus

P S - Pigmented & Sterile

P F – Green & Fertile

At seedling stage all the green plants are to be removed and pigmented plants are retained, as they are sterile.

II. Cytoplasmic Male Sterility: In crops like Maize, Bajra and Sorghum, two types of cytoplasms were noticed. One is normal cytoplasm and the other is sterile one which interferes with the formation of normal pollen grains. This follows maternal inheritance therefore all the off springs will be male sterile.

As the F_1 is male sterile, this system cannot be used in crops where the seed is economic part. Hence its utility is confined to certain ornamental species or where a vegetative part is of economic importance. Eg: Onion, Fodder Jowar, Cabbage, Palak etc.

III. Cytoplasmic Genetic Male Sterility System: This is a case of cytoplasmic male sterility where a nuclear gene for restoring fertility in MS line is known. The fertility restorer gene 'R' is dominant and is found in certain strains of species or may be transferred from a related species. This gene restores fertility in the MS line hence it is known as restorer gene. The cytoplasmic MS can be included in CGMS system as and when restorer genes for them are discovered. Restorer genes can be found for all the cases of cytoplasmic MS if thorough search is made. This system is used in almost all seed crops.

This system involves

1. Cytoplasmically determined MS plants known as A line in the genetic constitution.
2. Fertile counter parts of A line known as maintainer line or B line with the genetic constitution.
3. Restorer plants used to restorer the fertility in commercial seed plots known as R lines in the genetic constitution.

Transfer of Male Sterility from Exotic lines to Nature lines:

Most of the times the MS lines obtained from other countries may not be suitable to our condition. Examples are:

Crop	**Source of cytoplasm**	**Drawbacks**
Maize	Texas Cytoplasm	Susceptible to *Helminthosporium* leaf blight
Sorghum	Combined kafir	Black glumes and chalky endosperm
Pearlmillet	Tift 23 A (Tifton)	Susceptible to Green ear & downy mildew
Rice	Wild abortive	Incomplete panicle exertion

Sunflower	*H petiolaris* *H gigantis*	
Tobacco	*Microcephalan*	Reduced vigour in F_1 hybrids
Wheat	*Aegilops caudata*	Susceptible to pistiloidy

Due to these drawbacks, the well adapted local lines should be converted into male sterile lines. This can be done by repeated back crossing of the local lines to the exotic MS lines.

Transfer of Male Sterility to a New Strain

Maintenance of Male Sterile Line or A line: Since A line does not produce pollen, seed is not formed for maintaining A line. It has to be crossed with its fertile counter part having similar nuclear genes with fertile cytoplasm which is known as B-line.

Production of Hybrid seed: For production of hybrid seed, A-line has to be kept as female parent and the pollen parent should posses the restorer genes in order to induce fertility and seed development in the next generation. Such line is known as restorer line and denoted as ‘R'line. The A line & R line should be of different genetic constitution and should be able to give maximum heterosis.

Limitations in using Male Sterile Systems:

1. Existence and maintenance of A, B & R Lines is labourious and difficult
2. If exotic lines are not suitable to our conditions, the native/adaptive lines have to be converted into MS lines
3. Adequate cross pollination should be there between A and R lines for good seed set.
4. Synchronization of flowering should be there between A & R lines.
5. Sterility should be stable over the environments.
6. Fertility restoration should be complete otherwise the F_1 seed will be sterile
7. Isolation is needed for maintenance of parental lines and for producing hybrid seed.

Lecture No. 11

Seed Production of Rice

The student should write the important varieties and hybrids that have been released along with their characters, date of release and station from where it is released.

Seed Production of Varieties:

Land requirement: The same crop should not be grown on the same piece of land for the last one season, unless it is the same variety and certified by seed certification agency for its purity. The land requirement should be followed for nursery and the main field.

Isolation Requirement: Paddy is highly self-pollinated crop, however, some cross-pollinated does occur. The extent of natural cross-pollination varies from 0-6.8%. For pure seed production the seed fields must be isolated by atleast 3m for both foundation and certified seed production from other varieties and same varieties not confirming to varietal purity.

Source of seed: Obtain appropriate class of the seed from the source approved by seed certification agency.

Brief cultural practices: Paddy can be cultivated as direct sown, puddle seeding or by transplanting. For seed production it is desirable to grow paddy under transplanting system so as to avoid the weed problem. The seed rate required is 30-40 kgs/ha. The spacing adopted is 10x15 cm for early duration varieties and 15x15 and 20x15 for medium and late duration varieties. Transplanting should be done when the seedlings are 3-4 weeks old. Follow all the recommended package of practices and take necessary prophylactic measures so as to raise a good crop.

Rouging: Rouging of offtypes should be done once prior to flowering then at flowering and maturity. Major rouging should be done before flowering. The offtypes should be identified based on morphological characters such as plant type, plant height, days to flowering, leaf color, flag leaf shape, flag leaf angle, shape of the panicle, color of glumes, color of apiculus etc. rogue out the wild rice plants, plants infested by stem borer and diseased plants such as false smut, paddy bunt etc.

Number of field inspection: the numbers of field inspections required are two and they should be done between flowering and harvesting. During field inspection verification should be done for isolation requirement, volunteer plants, offtypes and diseased plants. The field standards required are as follows;

	Foundation class	certified class
Offtypes	0.05 %	0.20 %
Objectionable weed plants	0.01 %	0.02 %

Diseases plants 0.10 %

0.50 %

(Paddy bunt – *Neovossia horrida*)

Harvesting : The crop should be harvested when the grains are hard and yellow with a moisture percentage of 23-24 %. For combine harvesting the moisture percentage should be in the range of 16-18% . the crop is cut at the base with the sickle and the plants are left in the field for 2-3 days. Then they are threshed on clean threshing floor or tarpaulin. After winnowing and cleaning the seed should be dried to safe moisture limits of 13% before storage.

Seed Yield: The seed yields are in the range of 5.0 to 6.0 t/ha depending up on the variety and the management practices adopted.

Hybrid Seed Production

Prof. Yuan Long Ping is the father of hybrid rice in China. The successful development and use of hybrid rice technology in China during 1970's led the way for development and release of rice hybrids in India. In general the hybrid rice gives 1.0 ton more yield than the best variety available. At present more than 10 rice hybrids have been developed in the country from different states. However the first rice hybrid have been developed in the country by ANGRAU. Methods of Hybrid rice seed production

Hybrid rice can be produced by three different methods

1. **Three line system**: In this method hybrid rice is produced by utilizing cytoplasmic genetic male sterile system. The source of male sterile cytoplasm used is wild abortive. In this method there are three different lines i.e. A-line or male sterile line, B-line or maintainer line and restorer line or R-line. For maintaining A-line it has to be crossed with B-line and for producing hybrid seed A-line has to be crossed with R-line.
2. **Two line system**: This method of hybrid rice seed production involves the use of photoperiod sensitive genetic male sterile system or temperature sensitive genetic male sterile system. In this method any normal line can be used as restorer line.
3. **By Using chemical emasculants**: The chemicals which kills or sterilise the male gamete with little no effect on the normal functioning of the female gamete can be used to emasculate female parental line in hybrid seed production. In China chemical emasculants are commonly used in hybrid seed of rice. In India they are not used commercially for hybrid seed production, but they are used in academic

studies. The chemical which can be used as potent gametocides are etheral, maleic hydrazide, etc.

Hybrid seed production (using three line system)

The hybrid rice seed is produced by utilizing cytoplasmic genetic male sterile system. The source of cytoplasm used is wild abortive. One of the drawbacks of wild abortive cytoplasm is incomplete panicle exertion from the flag leaves. Hybrid seed production involves two steps;

1. Maintenance of parental lines (A-line, B-line and R-line)
2. Commercial hybrid seed production (AxR).

Maintenance of parental lines is generally referred as foundation seed production and hybrid seed production as certified seed class. The A-line can be maintained by crossing with B-line in an isolated plot, while in hybrid seed production A-line is crosses with R-line or fertility restorer line. The B-line and the R-line can be maintained just like normal varieties by following the required isolation and field standards. As the maintenance of B-line and R-line is just like normal varieties it is not discussed in detail.

Maintenance of A-line or Hybrid seed Production:

Land requirement: The same crop should not be grown in the same piece of land in the previous one season. The land requirement should be followed for nursery as well for the main field.

Isolation requirement: The hybrid paddy fields should be isolated from the other paddy fields, including commercial hybrids and same hybrid not confirming to varietal purity requirements for certification by atleast 200 meters for seed classes A, B & R-line production and by 100 meters for hybrid seed production (AxR). For hybrid seed production (A x R), if space isolation is a problem we can go for time isolation or barrier isolation. For time isolation the difference between the flowering of seed plot and the contaminating plot should be atleast 4 weeks. When both space and time isolation is not possible we can go for barrier isolation. In barrier isolation a barrier crop which is of 6-8 feet height should be grown around the seed plot for 10 to 10 meters. The commonly used barrier crops are daincha, sugarcane, sorghum etc.

Brief cultural practices: The success in hybrid seed production depends on synchronization of flowering between male and female parent. For maintenance of A-line synchronization of flowering will not be a problem as both A and B-lines are iso-genic and come to flowering at the same time, while in hybrid seed production synchronization will be a problem as A-line and R-line have different genetic constitution. Generally the A-line is sown once while the B-line or R-line is sown three times at an interval of five days.

When both A and R-line are of same duration sowing of A-line should be adjusted with second sowing of R-line. If A and R lines are of different growth duration, the difference in duration should be adjusted with second sowing of R-line.

(For example if A-line comes to flowering in 65 days and R-line in 72 days then the difference is 7 days. After second sowing of R-line adjust the sowing of A-line with a gap of 7 days I.e. if First sowing of R-line is done on 1st June, Second sowing on 5th June and third sowing on 10th June, then sowing of A-line should be done on 12th June)

Planting ratio: The row ratio of female and male parental varies from region to region depending on weather conditions and potentiality of parental lines. The commonly adopted planting ratios of male and female are 2:8, 2:6 or 3: 8. Factors influencing the row ratio are;

There can be more than 8 A lines in relation to 2 R-lines,

1. If R-lines are taller than seed parent
2. Have good growth and vigour
3. Have large panicles and
4. Shed a large amount of residual pollen.

The Character of A-line should be

1. It should be shorter than pollen parent
2. Has long duration of floret opening and stigma receptivity
3. Should have wide angle of floret opening and
4. Should have a higher percentage of stigma exertion

Transplanting should be done when the seedlings are 25-28 days old. Before transplanting mix all the B or R-lines sown on three different dates. All the missing hills should be replaced within seven days. The spacing adopted for A-line is 15x15 cm and for B or R-line is 20x15 or 30x15 cm. All the recommended package of practices should be followed to raise a good crop.

Number of Field Inspections: A minimum of four field inspections should be conducted. The first field inspection should be conducted before flowering stage, second and third during flowering stag and fourth before harvesting. During the first field inspection verification should be done for volunteer plants, isolation requirement, errors in planting and the actual acreage sown. During the second and third field inspection verification should be done for isolation requirement, offtypes, diseased plants, pollen shedders and objectionable weed plants. Actual counts should be taken during second or third field inspection. Fourth or final field inspection should be done to verify for all the above factors and the offtypes can be identified based on panicle or seed characters.

	Foundation class	certified class
Offtypes	0.05 %	0.20 %
Pollen shedders	0.05 %	0.10 %
Objectionable weed plants	0.01 %	0.02 %
Diseases plants	0.10 %	0.50 %
(Paddy bunt – *Neovossia horrida*)		

Rouging: Roughing should be done in both male and female parental lines. Remove all the offtype and volunteer plants from both male and female parental line. During flowering period rouging should be done daily to remove the pollen shedders from female parental line. The male sterile plants have shriveled anthers and they do not shed pollen while the pollen shedders have yellow colored plumpy anthers, which shed large amount of residual pollen. The off type plants should be identified based on morphological characters like plant height, plant type, flag leaf shape, flag leaf angle and other characters. Remove all the plants, which are infected with stem borer, and diseased plants like paddy bunt.

Methods of increasing out-crossing rate: Paddy is highly self-pollinated crop and the extent of natural cross—pollination is very less. Hence to increase the out-crossing rate certain methods should be followed like Flag leaf clipping, spraying of GA_3 and rope pulling.

a. **Flag leaf clipping**: Flag leaves are taller than panicles and are the main obstacles for pollen dispersal and cross-pollination. Hence the flag leaves should be removed so as to improve cross-pollination and seed set. The flag leaves should be clipped one or two days before heading so that it enhances uniform pollen movement and wide dispersal of pollen grains to give higher seed set. First cut the flag leaf of the main tiller at the flag leaf joint and use it as a guide in clipping the rest of the plants. The flag leaves should be cut to half or 2/3 of the blade from the tip. Do not clip the flag leaves in plants, which are infected with bacterial leaf blight or sheath blight. The cut leaves can infect other plants or contaminating tools used for flag leaf clipping can spread infection. The infected plants may be clipped after completing the clipping of healthy plants.

b. **GA_3 application**: Application of GA3 increases the internode length and the panicles will be fully exerted from the flag leaves. It increases the duration of floret opening and stigma receptivity. Helps in adjusting the plant height of both the parents. It also increases the growth rate of secondary and tertiary tillers so that they bear productive panicles.

   Spraying of GA3 should be done twice first when 15-20% of the plants started heading with 40% of the chemical and second at 50% flowering with 60% of the chemical. The dosage required is 50 grams with knapsack sprayer and 25 grams with ultra low volume sprayer. For first spray use 20 g GA3 in 500 litres of water and for second spray use 30 g in 500 litres of water.

c. **Rope Pulling**: Rope pulling should be done during the peak flowering time, which helps in shaking of the male plants and dispersal of pollen grains. Rope pulling should be done daily during peak flowering stage at 8.30 AM and it should be repeated 3-4 times a day at an interval of half an hour.

Harvesting and threshing: Harvest the male row first and remove them from the field so a to avoid mechanical mixtures. Then harvest the female rows. Precautions should be taken while harvesting not mix male and female plants. Threshing should be done on a clean threshing floor and the seed should be winnowed and dried to safe moisture limits before storage.

Seed Yield: Depending on the management practices adopted and the potentiality of the parental line the seed yield may be in the range f 0.5 to 1.5 t/ha.

Lecture No: 11

Seed Production of Sorghum

Seed Production of open pollinated varieties

Land requirement: Land should be free from volunteer plants, Johnson grass, Sudan grass and other forage types. The same crop should not be grown on the same piece of land in the previous one season unless it is the same variety and certified by certification agency for its purity.

Isolation requirement: sorghum is a self-pollinated crop but cross-pollination up to 8-10 % may occur. In some of the varieties with loose or lax panicle types the extent of natural cross-pollination may go up to 50 %. Hence the seed fields must be isolated from other varieties of grain and dual-purpose sorghum and same variety not confirming to varietal purity by 200m for foundation seed class and 100 m for certified seed class. An isolation of 400 m is required from Johnson grass (Sorghum halepense) and other forage sorghums with high tillering and grassy panicles. Differential blooming for modifying isolation distance are not permitted (i.e. time isolation is not permitted)

Brief Cultural Practices: Obtain appropriate class of the seed from the source approved by seed certification agency. The seed rate required is 12-15 kg/ha and the spacing adopted is 45cm between the rows and 15cm between the plants. Other cultural practices are similar to raising a commercial crop. Necessary prophylactic measures should be taken so as to raise a good crop.

Rouging: remove all the offtypes and volunteer plants before they start shedding pollen. The rouged plants must be cut from the bottom or uprooted to prevent regrowth. Offtypes can be identified based on morphological characters like plant height, leaf shape, leaf colour, stem pigmentation, days to flowering etc. Rogue out other related plants like Johnson grass, Sudan grass, forage plants and plants affected by kernel smut and head smut from time to time.

Number of field Inspections: A minimum of three field inspection should be done. First inspection should be done during vegetative stage to determine isolation, volunteer plants and designated diseases etc. Second inspection shall be made during flowering to check isolation, offtypes and other relevant factors. Third inspection shall be made at maturity prior to harvest to verify designated diseases true nature of plants, head and seed.

	Foundation class	certified class
Offtypes	0.05 %	0.10 %
Diseases plants	0.05 %	0.10 %
(Kernel smut or grain smut and head smut)		

Harvesting and threshing: The seed crop must be harvested when it is fully ripe. The harvested heads should be sorted out to remove the diseased or otherwise undesirable. The heads should be dried on the threshing floor or tarpaulin for a couple of days before threshing. Threshing can be done by threshers or manually. The seed should be thoroughly cleaned and dried to 10 % moisture before storage.

Seed Yield: Depending up on the potentiality of the variety and the management practices adopted, seed yield may be in the range of 35-40 q/ha.

Hybrid Seed Production

In sorghum hybrid seed is produced by utilizing cytoplasmic genetic male sterile system. The source of male sterile cytoplasm used is Combined kafir. Hybrid seed production involves two steps;

1. Maintenance of parental Lines (A-line, B-line and R-line)
2. Commercial hybrid seed production (AxR)

Maintenance of parental lines is generally referred as foundation seed production and hybrid seed production as certified seed class. The A-line can be maintained by crossing with B-line in an isolated plot, while in hybrid seed production A-line is crosses with R-line or fertility restorer line. The B-line and the R-line can be maintained just like normal varieties by following the required isolation and field standards. As the maintenance of B-line and R-line is just like normal varieties it is not discussed in detail.

Seed Production of B-line and R-line: The seed is produced in an isolated plot and it is similar to seed production of open pollinated varieties. However the isolation distance required and the fields standards are similar to that of maintenance of A-line.

Maintenance of A-line or Hybrid seed Production (AxR):

Land requirement: Land should be free from volunteer plants, Johnson grass, Sudan grass and other forage types. The same crop should not be grown on the same piece of land in the previous one season unless it is the same variety and certified by certification agency for its purity.

Isolation requirement: The isolation distance for maintenance of A-line (AxB) is 300 m from fields of other varieties of grain and dual purpose sorghum and same variety not confirming to varietal purity and 400 m from Johnson grass, Sudan grass and other forage types. For commercial hybrid seed production (AxR) the isolation distance required is 200 m from fields of other varieties of grain and dual purpose sorghum, and same hybrid not confirming to varietal purity requirements of certification, 5 m from other hybrid seed production plot having the same male parent and 400 m from Johnson grass, Sudan grass and other forage types. Differential blooming dates for modification of isolation distance are not permitted.

Planting ratio: The planting ratio of female to male plants is 4:2 with two rows of male parent all around the field.

Brief cultural practices: The success in hybrid seed production depends on synchronization of flowering between male and female parent. For maintenance of A-line synchronization of flowering will not be a problem as both A and B-lines are isogenic lines and come to flowering at the same time, while in hybrid seed production synchronization will be a problem as A-line and R-line have different genetic constitution.

If there is any difference between the male and female parent for days to flowering the sowing dates should be adjusted for proper synchronization of flowering. The seed rate required is 8.0 kgs/ha of A-line and 4.0 kgs/ha of B or R-line. Other cultural practices similar to commercial crop production should be adopted for raising a good crop.

Cultural manipulation for nicking: Proper synchronization of flowering between A-line and R-line is a common problem. In-spite of taking the precautions like adjusting the sowing dates some times synchronization may be a problem. If the difference between the male and female parent is less than a week it can be manipulated by cultural practices. The parent which is lagging should be sprayed with 1 per cent urea solution 2-3 times at an interval of 2-3 days or additional irrigation should be given to the Lagging parent. Blowing air by operating empty duster with the mouth directed horizontally to the male ears, will help to disseminate pollen.

Rouging: Before flowering remove all offtypes from both seed parent and pollen rows based on morphological characters. Some of the precautions to be taken while rouging are

1. Start rouging before offtypes, volunteers and pollen shedders in female rows start shedding pollen

2. Out crosses can be easily identified because of their greater height and more vigorous growth and should be removed
3. At flowering rouging should be done every day to remove pollen shedders from female parent rows. The sterile types have only stigma or a pale aborted anthers without pollen, while the fertile ones have yellow colored plumpy anthers which shed large amount of residual pollen.
4. Remove all plants out of their place (i.e. plants in between the lines), and male plants in female rows and vice versa. Special attention should be given at the ends where there is a chance of male seed falling in female rows.
5. Remove other sorghum related plants like Johnson grass, Sudan grass and other forage types from the seed plot and from within the isolation distance.
6. Remove the plants affected by kernel bunt ands head smut.
7. Preharvest rouging may be done based on grain and ear characters.

Number of Field Inspections: A minimum of four field inspections should be conducted. The first field inspection should be conducted before flowering stage, second and third during flowering stag and fourth before harvesting. During the first field inspection verification should be done for volunteer plants, isolation requirement, errors in planting and the actual acreage sown. During the second and third field inspection verification should be done for isolation requirement, offtypes, diseased plants, pollen shedders and objectionable weed plants. Actual counts should be taken during second or third field inspection. Fourth or final field inspection should be done to verify for all the above factors and the offtypes can be identified based on panicle or seed characters.

	Foundation class	certified class
Offtypes	0.05 %	0.10 %
Pollen shedders	0.05 %	0.10 %
Diseases plants (kernel smut or grain smut and head smut)	0.05 %	0.10 %

Harvesting and threshing: Harvest the male rows first and keep their heads separate to avoid mixture male and female seed. Then harvest the female parental line and thresh it separately. Precautions may to taken while harvesting and threshing to avoid mechanical mixtures.

Seed Yield: the seed yield may be in the range of 46 q/ha depending on the parent line and the cultural practices adopted.

Lecture No: 12

Seed Production of Maize

Open Pollinated varieties (Synthetic's and Composites):

Land requirement: No specific land requirements are there for maize seed production, however the field should be free from volunteer plants and have good drainage facility.

Isolation distance: Maize is a highly cross pollinated crop, therefore for pure seed production the fields of maize should be isolated from other varieties of maize and same varieties not confirming to varietal purity by 400 m and 200 m foundation and certified seed production reciprocally.

Brief Cultural Practices: obtain appropriate class of the seed from the source approved by seed certification agency. Seed rate required is 15 kgs/ha and the spacing adopted is 60-70 cm between the rows and 20 cm between the plants in a row. The recommended package of practices should be adopted for raising a good crop.

No of Field inspections: A minimum of two field inspections shall be made in such a way that one is conducted before flowering and the other during flowering stage so as to check for isolation distance, offtypes, designated diseases and other relevant factors.

	Foundation class	Certified class
Offtype plants that have shed or are Shedding pollen at any one inspection during Flowering when 5% or more plants in the seed Field are with receptive silks	1.0	1.0

Rouging: Not much rouging is required in open pollinated varieties has they have broad genetic base and are phenotypically uniform for most of the characters. However rouging for offtypes such as very tall or dwarf should be completed before pollen shedding. Remove malformed and diseased plants affected by stalk rot from time to time. At harvest sorting should be done remove off-colored and off-textured ears.

Harvesting of maize ears: Maize ears can be harvested at high moisture content (30-35 %) when artificial heated air drying facilities are available, otherwise harvest the crop when the seed moisture content is 15-16 %. After harvest sort out all off-type maize ears, particularly those showing different colour and texture and the diseased ears before placing them in bins for drying.

Shelling: After drying, the ears are once again examined and any offtypes or diseased ears are removed before shelling. The certification standards require bin inspection of maize ears before shelling. Therefore shelling should be undertaken after taking the approval from seed certification agency.

Seed Yield: Depending upon the management practices adopted and the potentiality of the variety the yield may be in the range of 25-30 q/ha.

Hybrid seed production

In maize we are having single cross, double cross and three-way cross hybrids. Maintenance of parental lines/inbred lines and single cross seed production is considered as foundation seed class and commercial hybrid seed production or double cross seed production or three-way cross seed production as certified seed production.

Maintenance of Parental lines/ Inbred lines:

Land requirement: same as open [pollinated varieties.

Isolation requirement: 400 m of isolation is required from other maize varieties and hybrids with same kernel colour and texture as that of the seed parent and 600 m from other maize varieties and hybrids with different kernel colour and texture. In case where space isolation is a problem we can go for time isolation. Time isolation is provided 5% or more plants in the seed field should not be with receptive silks when more than 0.1% of plants in the contaminating field is shedding pollen.

Brief Cultural practices: Obtain appropriate class of the seed from the source approved by seed certification agency. The seed rate required is 15 kgs /ha and the recommended cultural practices should be followed as that for raising a commercial crop.

Number of field inspections: A minimum of four field inspections shall be made in such a way that first field inspection is done before flowering stage an the remaining three during flowering stage to verify isolation distance, offtypes and other relevant factors.

Offtypes plants that have shed or are shedding pollen when 5.0 % or more of the plants in the seed field have receptive silks.	0.20 %

Rouging: the inbred lines are true breeding strains and rigorous rouging should be done to remove offtypes before they shed pollen. Remove tall and vigorous growing plants from the knee-high stage onwards. At preflowering stage rogue out offtypes based on morphological characters such as leaf shape, tassel color and silk color. Final rouging should be done to remove disease-affected plants.

Harvesting & Shelling: Similar to open pollinated varieties.

Seed Yield: depending upon the yield potentiality and the management practices adopted the yield may be around 5-6 Q/ha.

Single cross seed production:

The single cross seed is produced by crossing two specific inbred lines by following a planting ratio of 2 lines of male parent and 4 lines of female parent in alternate rows with 46 male parents around the seed production plot. The female parent has to be detasselled before shedding pollen to ensure cross-pollination with male line. The seed harvested from female rows is the single cross hybrid seed.

Land requirement and isolation requirement: same as maintenance of inbred lines. Depending on the differences in duration adjust the sowing dates of male and female inbred line. Necessary precaution may be taken to avoid mixing of male and female lines. The male lines have to marked on both the ends by a label or tag or by sowing the seed of other crops like sannhemp or daincha.

Cultural Practices: The seed rate required is 10 kgs/ha for female parent and 5 kgs/ha for male parent. After adjusting the sowing dates the recommended package of practices should be followed.

Number of field inspections: A minimum of four field inspections shall be made in such a way that first field inspection is done before flowering stage an the remaining three during flowering stage to verify isolation distance, offtypes and other relevant factors.

	Foundation class
Offtypes plants that have shed or are shedding pollen when 5.0 % or more of the plants in the seed field have receptive silks.	0.20 %
Shedding tassels in female parent any inspection During flowering when 5.0% or more of the plants In the seed parent have receptive silks	0.50 %
Total pollen shedding tassels including tassels that	1.00 %

Have shed pollen fro all three inspections conduced during flowering on different dates.

Detasselling: when Cms line is not used the seed parent has to be detasselled so that it will be fertilized by the pollen from the male parent. Removal of the tassel from the female parent before shedding pollen is called as detasselling. For detasselling hold the stalk by left hand and take a firm grip of the entire tassel in the right hand and pull it gently to detassel.

Precautions to taken while detasselling

1. Remove all tassels from seed parent before they shed pollen.
2. Detasselling should be done when the tassel is completely out of the flag leaf but before anthers shed pollen
3. Remove the entire tassel
4. Avoid immature detasselling as they cause injury to the top leaves.
5. Once detasselling starts in the field it must be repeated daily in all weather conditions at a fixed time. Detasselling should be done from the same side every day in case of large fields.
6. Precaution may be taken not to detassel in male rows.
7. Lodged plants in female rows must be detasselled as they are likely to pass un-noticed during detasselling.
8. After detasselling drop the tassel immediately on the ground and they should not be carried till the end of the row as they contaminate receptive silks.

Rouging: Rouging should be done both in male and female parental lines. Remove the offtypes from both male and female parental lines before they start shedding pollen. Shedding tassels should not be there in female rows. Offtypes can be identified based on morphological characters like plant height, leaf shape, tassel and silk color etc. remove all the plants affected with stalk rot and other diseases.

Harvesting and shelling: Harvest the male rows first and remove them from the field to avoid mechanical mixtures. Then harvest the female rows. After harvesting sorting should be done to remove off-colored, off textured and diseased ear heads. Before shelling approval should be taken from the seed certification agency.

Seed Yield: average seed yield of a single cross varies from 4-6 Q/ha.

Double cross hybrid seed production / Commercial hybrid seed production

The double cross hybrid seed is produced by using high yielding single cross as the female parent. The planting ration adopted is 2line of male parent and 6 lines of female parent. The female single cross has to be detasselled before pollen shedding to ensure cross-pollination with male parent (single cross).

Land requirement: Same as open pollinated variety

Isolation requirement:

200 m From any maize with same kernel color and texture of seed parent
300 m From maize with different kernel color or texture of that of seed parent
5 m From other hybrid seed production plot having same male parent.

Differential blooming dates are permitted for modifying isolation distance provided 5% or more plants of the seed parent should not have receptive silks when more than 0.5% pf plants in the contaminating field shed pollen. Or

Distance less than 200 m may be modified by planting additional border rows of male parent if the kernel color and texture of the contaminating maize are same as that of seed parent.

For area upto 4 hectares and with decrease in isolation distance by 12.5 m an additional border row of male parent should be planted.

Isolation distance	No of male rows
200.0 m	1
187.5	2
175.0	3
167.5	4
150.0	5
..	..
..	..
50.0	13

1. Border rows must be planted in continuation to the seed field at the same time and with same seed rate and spacing.
2. Seed fields having diagonal exposure to the contaminating field should be planted with border rows in both the directions of exposure.
3. Natural barriers like thick trees and buildings cannot be substitute the border rows.
4. when two seed fields with different pollinators are within the isolation distance both are to be provided with border rows.
5. Modification of isolation distance with boarder rows is not permitted if the contaminating field parent is of different kernel color or texture if it is popcorn or sweet corn

Lecture No: 12

Seed Production of Bajra

Seed Production of Synthetics & Composites

Land requirement: Land to be used for seed production of bajra open pollinated varieties should be free from volunteer plants

Isolation requirement: Bajra is predominantly a cross pollinated crop with 80% cross pollination due to protogynous condition. Therefore for pure seed production the seed field should be isolated by 400 and 200 m for foundation and certified seed respectively from other varieties of bajra and from same variety not confirming to varietal purity requirements.

Brief Cultural Practices: Obtain appropriate class of seed from the source approved by seed certification agency. Bajra can be directly sown in the field or a nursery can be raised and transplanted after 20-25 days. The seed rate required is 3-4 kgs/ha. Transplanting is generally useful under following conditions.

1. there is shortage of seed and when assured yield is required.
2. when the main field is occupied by previous crop, we can save upto 1 month time.

Number of field 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 to determine isolation, volunteer plants, offtypes, downy mildew incidence and other relevant factors
2. The second inspection shall be made during 50 % flowering to check isolation, offtypes, downy mildew/green ear (*Sclerospora graminicola*) 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 the true nature of plant and other relevant factors.

Factor	Foundation class	Certified class
Offtypes at any one inspection at & after flowering	0.05 %	0.10%
Plants affected by downy mildew/green ear disease at any one inspection	0.05 %	0.10 %
**Ergotted earheads at final inspection.	0.02 %	0.04 %
***Earheads infected by grain smut at final inspection stage	0.05 %	0.10 %

** Seed from such fields that have been reported to contain the ergot infection even within the prescribed

limits at final stage shall be subjected to floatation treatment with brine to become eligible for certification

*** Seed fields with incidence of grain smut more than the maximum permissible level can however be certified if

such seed is treated with appropriate organo-mercurial fungicide not earlier than a month prior to sowing.

Roughing: Rogue out offtypes and volunteer plants before they begin to shed pollen. The rogues must be cut from the base or uprooted. The offtypes can be identified based on morphological characters like leaf shape and color, hairiness, anthocyanin pigmentation on the stem and leaves, plant height etc. at harvest offtypes can be identified by panicle characters. Remove the plants affected by green ear, ergot and grain smut disease from time to time.

Harvesting: Bajra should be harvested when the grains are fully mature. After harvesting remove the ear heads infected with ergot and green ear disease before drying and threshing. Care should be taken during harvesting, threshing and drying to a void mechanical mixtures.

Seed yield: Depending upon the variety and the management practices adopted the seed yield may vary from 20–25 Q / ha.

Hybrid seed Production

The hybrid seed in bajra is produced by utilizing cytoplasmic genetic male sterile system. The cytoplasmic male sterile source used in bajra is Tift 23A identified by G.W.Burton. The hybrid seed production in bajra can be discussed under to heads

1. Maintenance of parental lines (A-line, B-Line and R-line)
2. Commercial hybrid seed Production (Crossing A X R)

Maintenance of A-line or male sterile line: For maintenance of A-line it has to be crossed with male fertile, non-pollen fertility restoring strain i.e. B-line in an isolated plot. The usual planting ratio adopted is 4 lines of A-line and 2 lin e of B-line with 4-6 borders of B-line around the field.

Isolation Requirement: Isolation required is 1000 m from other bajra fields. Time isolation is not permitted in bajra.

Cultural practices: obtain appropriate class of the seed from the source approved by seed certification agency. The seed rate required for drilling is 1.5 Kgs/ha of A-line and 0.75 kgs /ha of B-line, for transplanting the seed rate required is 600-650 gms of A-line and 200-300 gms of B-line. The spacing adopted is 70-90 cms between the row and 20-25 cm within the row. Follow the recommended package of practices as that of normal cultivation.

Number of field Inspections: A minimum of four field inspection shall be made as follows;

1. The first inspection shall be made before flowering preferably within 30 days after planting to determine isolation, volunteer plants, offtypes, planting ratio, planting errors, incidence of downy mildew and other relevant factors
2. The second and third inspection shall be made during flowering to check isolation, pollen shedders, offtypes, downy mildew/green ear (*Sclerospora graminicola*) and other relevant factors.
3. The fourth 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 the true nature of plant and other relevant factors.

Factor	Foundation seed	Certified seed
Offtypes in seed parent at and after flowering	0.05 %	0.10 %
Offtypes in pollen parent at and after flowering	0.50 %	0.10 %
Pollen shedding heads in seed parent at any one inspection at flowering	0.50 %	0.10 %
Plants infected by downy mildew /green ear at any one inspection	0.50 %	0.10 %
** Ergotted earheads in seed parent at final inspection	0.02 %	0.04 %
*** Ear heads infected by grain smut in seed parent at final inspection	0.05 %	0.10 %

** Seed from such fields that have been reported to contain the ergot infection even within the prescribed limits at final stage shall be subjected to floatation treatment with brine to become eligible for certification

*** Seed fields with incidence of grain smut more than the maximum permissible level can however be

certified if such seed is treated with appropriate organo-mercurial fungicide not earlier than a month

prior to sowing.

Roughing: Roughing should be done frequently to produce high quality seed. Following precautions should be taken while rouging.

1. Roughing should be started before flowering to avoid contamination with foreign pollen
2. Remove offtypes and volunteer from seed parent and pollen parent by uprooting to prevent re-growth.
3. Female parent rows should be roughed daily during flowering to remove pollen shedders
4. Remove plants in between the lines or male plants in female rows and vice-versa. Remove the plants affected with green ear, ergot and grain smut.
5. Remove offtypes and volunteers from within the isolation distance.
6. Before harvest rouging should be done based on seed characters.

Harvesting: Harvest the male rows first and keep them separate to avoid mechanical mixture. Then harvest the female rows and sort out the undesirable heads and reject them before drying and threshing.

Seed Yield: Depending on the potentiality of the inbred line and the management practices adopted the seed yield may be 3-4 Q/ha.

Maintenance of restorer line: It is produced in an isolated field just like normal varieties as it is male fertile, by following the standards given for maintenance of A-line.

Commercial Hybrid seed Production:

The hybrid seed is produced by crossing male sterile line (A-line) with the restore line in an isolated field. The planting ratio adopted is 4 lines of A-line and 2-lines of R-line.

Isolation requirement: 200 m from fields of other varieties of bajra and 5 m from fields of other hybrid seed production plots having the same male parent.

Cultural practices: the spacing and seed rate are same as that of maintenance of male sterile line. If male and female parents of different durations then the sowing dates should be adjusted accordingly for proper synchronization of flowering between male and female parent. If the difference in flowering is 3-4 days it can be adjusted by cultural practices. The parent, which is late, should be sprayed with 2.0 % urea solution, which enhances flowering.

Number of field Inspections: A minimum of four field inspection shall be made as follows;

1. The first inspection shall be made before flowering preferably within 30 days after planting to determine isolation, volunteer plants, offtypes, planting ratio, planting errors, incidence of downy mildew and other relevant factors
2. The second and third inspection shall be made during flowering to check isolation, pollen shedders, offtypes, downy mildew/green ear (*Sclerospora graminicola*) and other relevant factors.
3. The fourth 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 the true nature of plant and other relevant factors.

Factor	Foundation seed	Certified seed
Offtypes in seed parent at and after flowering	0.05 %	0.10 %
Offtypes in pollen parent at and after flowering	0.50 %	0.10 %
Pollen shedding heads in seed parent at any one inspection at flowering	0.50 %	0.10 %
Plants infected by downy mildew /green ear at any one inspection	0.50 %	0.10 %

** Ergotted earheads in seed parent at final inspection	0.02 %	0.04 %
*** Ear heads infected by grain smut in seed parent at final inspection	0.05 %	0.10 %

** Seed from such fields that have been reported to contain the ergot infection even within the prescribed limits at final

stage shall be subjected to floatation treatment with brine to become eligible for certification

*** Seed fields with incidence of grain smut more than the maximum permissible level can however be certified if

such seed is treated with appropriate organo-mercurial fungicide not earlier than a month prior to sowing.

Roughing: Roughing should be done frequently to produce high quality seed. Following precautions should be taken while rouging.

1. Roughing should be started before flowering to avoid contamination with foreign pollen
2. Remove offtypes and volunteer from seed parent and pollen parent by uprooting to prevent regrowth.
3. Female parent rows should be roughed daily during flowering to remove pollen shedders
4. Remove plants in between the lines or male plants in female rows and vice-versa. Remove the plants affected with green ear, ergot and grain smut.
5. Remove offtypes and volunteers from within the isolation distance.
6. Before harvesting rouging should be done based on seed characters.

Harvesting: Harvest the male rows first and keep them separate to avoid mechanical mixture. Then harvest the female rows and sort out the undesirable heads and reject them before drying and threshing.

Seed Yield: Depending on the potentiality of the inbred line and the management practices adopted the seed yield may be 3-4 Q / ha.

Lecture No: 13

Seed Production of Sunflower

Seed Production of Open Pollinated varieties

Land requirement: Select the fields in which sunflower was not grown in the previous year unless it is the same variety and certified by the seed certification agency for its purity. In addition to that the seed field should have good drainage and the soil should be deep fertile and with neutral pH.

Isolation requirement: Sunflower is partially self and cross pollinated crop. The extent of natural cross pollination varies from 17-62% according to insect activity. The fields must be isolated by atleast 400 meters for foundation seed class and 200 meters for certified seed class from fields of other varieties, same varieties not confirming to varietal requirement and wild sunflower.

Brief cultural practices: Obtain appropriate class of the seed from the source approved by seed certification agency. The seed rate required is 8-10 kgs/ha and the spacing adopted is 60x20 cm. Other cultural practices similar to commercial crop production should be adopted for raising a good crop. Follow the recommended package of practices and take necessary prophylactic measures so as to raise a good crop.

Number of Field Inspection: A minimum of three field inspection should be done. First inspection should be made at he stage of 6-7 pairs of leaves are present to determine isolation, volunteer plants and designated diseases etc. Second inspection shall be made during flowering to check isolation, offtypes and other relevant factors. Third inspection shall be made at maturity prior to harvest to verify designated diseases true nature of plant, head and seed.

		Foundation class	certified class
Offtypes		0.10 %	0.20 %
Objectionable weed plants	(Wild Helianthus)	Nil	Nil
Diseases plants	(Downy mildew)	0.05 %	0.50 %
Orabanche		Nil	Nil

Rouging: Generally two to three rougings are necessary. First rouging should be done at pre-flowering stage and other rouging during flowering stage. Before flowering remove tall, very early and very late flowering plants, branched plants with multiple heads and diseased plants. At maturity remove offtypes, diseases plants and wild sunflower plants, plants affected by wilt, charcoal rot, blight etc. Sunflower continues to shed viable pollen even after removal from stalks. Therefore the heads should be thrown on the ground with face downward towards the soil.

Suppleme ntary pollination: supplementary pollination is done by gently rubbing the palm with a muslin cloth on the heads, so that all the flowers will be fertilized and increases seed setting.

Harvesting and threshing: Sunflower should be harvested when the back side of the head turns to lemon yellow in colour. The heads are to be removed form the plants and dried in sun for a couple of days. Then threshing is done by gently beating with sticks.

Seed yield: Depending up on the variety and management practices adopted the seed yield may be around 15 q/ha.

Hybrid Seed Production

In Sunflower hybrid seed is produced by using cytoplasmic genetic male sterile system. The source of cytoplasm used is Helianthus peteolaris. Hybrid seed production involves two steps

3. Maintenance of parental Lines (A-line, B-line and R-line)
4. Commercial hybrid seed production (AxR)

Maintenance of parental lines is generally referred as foundation seed production and hybrid seed production as certified seed class. The A-line can be maintained by crossing with B-line in an isolated plot, while in hybrid seed production A-line is crosses with R-line or fertility restorer line. The B-line and the R-line can be maintained just like normal varieties by following the required isolation and field standards. As the maintenance of B-line and R-line is just like normal varieties it is not discussed in detail.

Seed Production of B-line and R-line: The seed is produced in an isolated plot and it is similar to seed production of open pollinated varieties. However the isolation distance required and the fields standards are similar to that of maintenance of A-line.

Maintenance of A-line or Hybrid seed Production (AxR):

Land requirement: Select the fields in which sunflower was not grown in the previous year unless it is the same variety and certified by the seed certification agency for its purity. In addition to that the seed field should have good drainage and the soil should be deep fertile and with neutral pH.

Isolation requirement: The seed fields must be isolated from other sunflower fields, increase of same line seed fields not confirming to varietal purity requirements of certification and from wild sunflower species by 600 meters for maintenance of A-line and 400 meters for hybrid seed production or AxR.

Planting ratio: The proportion of female (A-line) and male line (B or R-line) should be 3:1 with two border rows of male parents on the sides of seed production plot.

Brief Cultural Practices: The success in hybrid seed production depends on synchronization of flowering between male and female parent. For maintenance of A-line synchronization of flowering will not be a problem as both A and B-lines are isogenic lines and come to flowering at the same time, while in hybrid seed production synchronization will be a problem as A-line and R-line have different genetic constitution.

If there is any difference between the male and female parent for days to flowering the sowing dates should be adjusted for proper synchronization of flowering. The seed rate required is 7.5 kgs/ha of A-line and 2.5 kgs/ha of B or R-line. Other cultural practices similar to commercial crop production should be adopted for raising a good crop.

Roughing: Rouging should be done in both male and female parental line. Remove the volunteer plants and offtypes from both male and female parental line. During flowering period roughing should be done daily to remove the pollen shedders. Pollen shedders should be removed in the morning hours before the bee activity starts. Precautions to be taken while rouging.

1. Start rouging before offtypes, volunteers and pollen shedders in female rows start shedding pollen
2. Remove plants with pink or purple colored centre in the heads. As the cultivated forms have greenish yellow in the center.
3. Remove plants showing branching and multifloret types
4. Remove diseased plants and plants which are too early or too late in flowering
5. Before threshing remove the heads with white seeds or seeds with prominent white streaks.

Number of Field Inspections: A minimum of four field inspections should be conducted. The first field inspection should be conducted before flowering stage, second and third during flowering stag and fourth before harvesting. During the first field inspection verification should be done for volunteer plants, isolation requirement, errors in planting and the actual acreage sown. During the second and third field inspection verification should be done for isolation requirement, offtypes, diseased plants, pollen shedders and objectionable weed pla nts. Actual counts should be taken during second or third field inspection. Fourth or final field inspection should be done to verify for all the above factors and the offtypes can be identified based on panicle or seed characters.

	Foundation class	certified class
Offtypes	0.20 %	0.50 %
Pollen shedders	0.50 %	1.00 %
Objectionable weed plants (wild sunflower)	Nil	Nil
Diseases plants (Downy mildew)	0.05 %	0.50 %
Orabanche	Nil	Nil

Supplementary Pollination :

a. Hand pollination: Rub the palm with muslin cloth on the male parental line and then on female parent so as to transfer the pollen from male to female parent during peak flowering time. This as to be repeated daily during the flowering period in the morning hours

b. Bee Hives: Bee hives may be kept at 200 feet distance at 3-4 places in the field to increase bee activity.

Harvesting and threshing : Harvest the male parent first and remove them from the field to avoid mechanical mixtures. Then harvest the female rows. Harvesting and threshing will same as that of open pollinated varieties.

Seed Yield: Depending on the inbred line and the management practices adopted seed yield may be in the range of 4-5 q/ha.

Seed Production Castor

Castor is most difficult crop for seed production as there is lot of variation in a variety when grown in different seasons for plant height, node number upto primary raceme and other characters. Due to this reason, they have given a range for node number in different classes of seed.

Variety	No. of Nodes upto Primary raceme	Range for Foundation seed	Range for Certified seed
Aruna	12	10-14	9-15
Bhagya	11	9-13	8-15
Sowbhagya	15	13-17	13-18

Land requirement: Land for seed production of castor should be free from volunteer plants.

Isolation requirement: Castor is cross-pollinated crop. Cross-pollination by wind varies from 5-36% according to the prevailing climatic conditions. For pure seed production the seed crop must be isolated from other variety fields and same variety not confirming to varietal purity by atleast 300m and 150 m for foundation and certified seed classes respectively.

Cultural practices: Obtain appropriate class of the seed from the source approved by seed certification agency. The seed rate required is 11-18 kgs / ha. The recommended package of practices for commercial cultivation should be followed for raising a good crop.

Number of field inspections: A minimum of two field inspections are to be made from the time the crop approaches flowering until it is ready for harvest. During field inspection verification should be done for isolation requirement, offtypes and other relevant factors.

	Foundation class	Certified class
Offtypes	0.10 %	0.20 %

Roughing: Remove the offtypes based on morphological characters like stem color, internode length, shape of the leaf, bloom type and remove them before flowering. After initiation of primary spike, examine the plants for number of nodes upto primary raceme, type of internode, proportion of male to female in the spike and remove all undesirable plants not confirming to standards. Any delay in roughing adversely effect the seed quality hence during flowering roughing may be done 3-5 times at an interval of 2-3 days. Remove the plants affected by diseases like phytophthora blight and cersospora leaf spot.

Bloom types:

No bloom – bloom absent on all the above ground plant parts

Single bloom – bloom only on the stem

Double bloom – bloom on stem, fruits, petioles and on lower side of leaves

Triple bloom – Bloom on stem, fruits, petioles and both sides of leaves

Harvesting: the crop is generally harvested in 3-4 pickings. The spikes should be harvested when the fruits start turning to light yellow and should be dried in sun until they are blacken and get dried.

Seed Yield: Depending upon the potentiality of the variety and the management practices adopted the seed yield ma be around 8-10 Q/ha.

Hybrid seed production:

In castor different types of sex phenotypes are observed like;

Monoecious plants: Plants bearing female and male flowers on upper and lower parts of the raceme respectively.

Pistillate/Female parent: Plants containing variable proportion of stable pistillate flowers.

Male parent: Monoecious inbred line used as pollen parent in hybrid seed production.

Bisexual flowers: Under certain environmental conditions the female parent (VP-1) produces 2-5 bisexual flowers per spike

Environmentally sensitive staminate flowers: Interspersed staminate flowers which develop all along the length of female raceme usually after the failure of first developed female flowers to set fruits. The intensity of interspersed staminate flowers is more conspicuous in male promoting environment.

In hybrid seed production of castor environmentally sensitive genetic male sterility system is used. Castor is monoecious and under certain environment conditions it produces only female flowers. Presence of male and female flowers in the inflorescence is influenced by temperature and nutrient management. In general when the daily mean temperature is above 32^{o}C favors production of male flowers and temperature below 32^{o}C favors production of female flowers. Similarly good crop management with adequate fertilizer management produces more number of pistillate flowers.

Hybrid seed production in castor can be discussed under two heads

1. Maintenance of parental lines (Female and male parental line)
2. Hybrid seed production (Crossing of female and male parent)

Maintenance of female parental line :

The female parent should be grown in Kharif or Summer season when the daily mean temperatures are above 32^{0}C to promote more number of male flowers. Under this male promoting environment selection should be made for pistillate lines and interspersed staminate flowered plants. There are two methods for maintenance of female parental line conventional method and renovated method.

Conventional method: In conventional method we have to maintain 75% of pistillate lines and 25% of monoecious lines. During flowering period observe the plants regularly and remove all the plants with more than three whorls of male flowers in primary raceme and retain only 25% monoecious plants with male flowers in 2-3 whorls. At flower initiation in primary raceme identify the female plants with pistillate inflorescence with well-defined characters and tag them with red tape. Examine all the monoecious plants and remove those with male flowers beyond three whorls from the base. Count the number of female and monoecious plants in each row and remove the monoecious plants over and above 25%. Examine the tagged plants regularly for reversion to monoecious condition in 2nd, 3rd and 4th order racemes. Remove the tag as and when a female plant reverts to monoecious condition upto 4th sequential order branches. On maturity harvest the female plants bearing the tape and keep the picking wise seed in separate lots after proper drying, packing and labeling. To avoid any possibility of mixing, delay the harvest of monoecious plants and early reverts by 3-4 days.

Renovated method: In renovated method 100 % plants should be pistillate lines. When ever a plants turn to monoecious condition in 2nd , 3rd or 4th order racemes it should be removed. As all the plants are pistillate the first flush of female flowers do not get the pollen and they drop off and 50 - 55% of the plants will produce interspersed staminate flowers, these interspersed staminate flowers supply the pollen required for self pollination and help in fertilization. Here in renovated all the plants are 100 % pistillate upto 4th order raceme. Remove all the plants, which are monoecious, and plants deviating from female parental line.

Isolation: The isolation required is 300m from other varieties and hybrids of castor.

Number of field inspection: A minimum of four inspections shall be made as follows;

1. the first inspection shall be made before flowering in order to determine isolation, volunteer plants, outcrosses, planting ratio, errors in planting, stem color, types of leaves and other relevant factors.
2. The second and third inspections shall be made during flowering to check isolation, offytpes, nature of bloom, petiole, leaves, raceme, sex expressivity, number of nodes upto primary raceme and other relevant factors.
3. the fourth inspection shall be made prior to harvesting after the seed has attained maturity so that true nature of the plant can be verified.

Factor	Foundation seed
Offtypes including plants found to flower over the main stem	0.50 %
Male variants (more then 3 whorls of male flowers)	1.00 %
Female variants	1.00 %
Monoecious plants and the racemes reverted to monoecism on female plant before anthesis	Nil

Harvesting: Harvest the crop when the panicles are fully mature. In general harvesting is done in two or three pickings.

Maintenance of Male parent: It is similar to that of maintenance of varieties but the isolation and field standards are to be maintained as that of foundation seed class.

Commercial hybrid seed production / certified seed production:

The planting ratio adopted is 3 lines of female parent and 1 line of male parent. Commercial hybrid seed production should be taken up during rabi season when the daily mean temperatures are less than 32°C. Adjust the sowing dates of male and female parent for proper synchronization of flowering.

Isolation: isolation required is 150 m from other varieties and hybrids of castor

Number of field inspection: A minimum of four inspections shall be made as follows;

1. The first inspection shall be made before flowering in order to determine isolation, volunteer plants, outcrosses, planting ratio, errors in planting, stem color, types of leaves and other relevant factors.

2. The second and third inspections shall be made during flowering to check isolation, offytpes, nature of bloom, petiole, leaves, raceme, sex expressivity, number of nodes upto primary raceme and other relevant factors.
3. The fourth inspection shall be made prior to harvesting after the seed has attained maturity so that true nature of the plant can be verified.

Factor	Certified seed
Offtypes including plants found to flower over the main stem	1.00 %
Male variants (more then 3 whorls of male flowers)	2.00 %
Female variants	2.00 %
Monoecious plants and the racemes reverted to monoecism on female plant before anthesis	2.00 %

Roughing:

1. Remove all offtypes from male and female parents.
2. Identify the monoecious plants in female rows before flower initiation as well as the deviants for node number upto primary raceme, uproot and destroy them.
3. Continue this process everyday till all plants in female rows commence flowering.
4. Rogue out male parent for variants depending on node number upto primary raceme.
5. Reversion in female rows to monoecism in 3rd or 4th order racemes should not be uprooted but nipped off.

Harvesting: harvest the male rows first and remove them from the field. Then harvest the female rows picking wise. Care should be taken to avoid mechanical mixtures during harvesting, threshing and drying.

Lecture No: 14

Seed Production of Red gram (Pigeon Pea)

Seed production of OPV:

Varieties: ICPL – 87 (Pragati): ICPL – 151 (Jagriti), Pusa – 33, JA – 4, JKM – 7, Asha (ICPL – 87119); LRG – 30, LRG – 38, LRG – 41

Land Requirements

Land to be used for seed production of pigeon pea shall be free of volunteer plants. In addition the soil should be light, well drained and with a neutral ph.

Isolation requirements:

Red gram is partially self and cross pollinated. Although anthers burst before flowers open, there is considerable cross-fertilization by bees and other insects. Natural crossing to the extent of sixty five percent has also been recorded. Therefore, for maintaining variety purity an isolation of 200 mts. for foundation seed class and 100 mts. for certified seed class is necessary from fields of other varieties and of the same variety not confirming to varietal purity requirements of certification.

Brief cultural practices:

Obtain appropriate class of seed from the source approved by seed certification agency. The seed rate required is 12-15 kg/ha and the spacing adopted is 60 x 25 cm to 75 x 30 cm. Other cultural practices are similar to raising a commercial crop. Necessary prophylactic measures should be taken so as to raise a good crop.

Roguing:

Rogue the off type plants and diseased plants affected by wilt, leaf spot and stem canker, yellow mosaic virus and sterility virus from seed field from time to time, as required.

Number a field inspections:

A minimum two and maximum four field inspections are standardized for certification of different seed production programmes. For red gram, a minimum of two field inspections are required i.e. first one before flowering and second inspection during flowering and fruiting to determine isolation, volunteer plants, off types and diseased plants etc.

		F/s	C/s
Off types	(%)	0.1 %	0.2 %

Harvesting and threshing:

The crop is harvested soon after the seed is mature. Harvesting is normally done with sickle and the crop is left in the field to dry for about one week. Threshing is done by beating the plants with sticks. After threshing and cleaning the seed should be dried to 8 to 10 percent moisture before storage. Necessary precautions should be taken to avoid mechanical mixtures during these operations.

Seed yield

The average seed yield varies from 20 to 25 quintals per hectare.

Redgram Hybrid Seed Production:

Hybrids : ICPH – 8 : PPH – 4, COH – 1, COH – 2,: AKPH – 2022, AKPH – 4101

To produce hybrid seed in bulk, male sterile lines are planted in the ratio of six male sterile rows (Female): one pollinator row (Male). The hybrid seed plot is surrounded by four pollinator rows to provide sufficient pollen load. In genetic male sterility (GMS) system 50% plants appears male fertile in the female (MS) rows. Therefore, these fertile sibs needs to be uprooted immediately as the first bud appear on the plant. The male sterile sibs those remain are to be tagged in the female rows. Periodic picking of immature pods from the pollinator rows may prolong their flowering time. It is possible to produce several hybrids in one isolation block using a common male parent and several male sterile, if their flowering can be synchronized. Appropriate isolation distance of 200 m between two seed blocks should be maintained to avoid contamination.

Lecture No: 14

Seed Production of Green gram and Black gram

Green gram Varieties: WGG-2, WGG-37, MGG-295, MGG-348, LGG-450, LGG-460.

Black gram Varieties for Kharif and Rabi : T-9, LBG-623, LBG-20, WBG-26

For Rabi only: LBG-752, LBG-648, LBG-645, LBG-402 LBG-17

Land Requirements

Land to be used for seed production shall be free of volunteer plants. In addition the soil should be light, well drained and with a neutral ph.

Isolation requirements:

Green gram and Black gram are highly self-pollinated. Natural cross pollination to the extent of 0 to 5% has been recorded. Therefore, for maintaining variety purity an isolation of 10 m. for foundation seed class and 5 m. for certified seed class is necessary from fields of other varieties and of the same variety not confirming to varietal purity requirements of certification.

Brief cultural practices:

Obtain appropriate class of seed from the source approved by seed certification agency. The seed rate required is 15-20 kg/ha for kharif and 20-25 kg/ha for summer and the spacing adopted is 30 x 10 cm. Other cultural practices are similar to raising a commercial crop. Necessary prophylactic measures should be taken so as to raise a good crop.

Roguing:

Rogue the off type plants and diseased plants affected by leaf spot and stem canker, yellow mosaic virus and sterility virus from seed field from time to time, as required. Roguing should be done once before flowering and once after flowering based upon varietal morphological characters

Number a field inspections:

A minimum two field inspections are standardized for certification of different seed production programmes. For green gram and black gram, a minimum of two field inspections are required i.e. first one before flowering and second inspection during flowering and fruiting to determine isolation, volunteer plants, off types and diseased plants etc.

		F/s	C/s
Off types	(%)	0.1 %	0.2 %

Harvesting and threshing:

The crop is harvested soon after the seed is mature. Threshing is done by beating the plants with sticks. After threshing and cleaning the seed should be dried to 8 to 10 percent moisture before storage. Necessary precautions should be taken to avoid mechanical mixtures during these operations.

Seed yield

The average seed yield varies from 10 to 15 quintals per hectare.

SEED PRODUCTION OF BENGAL GRAM

Bengal gram Varieties: Jyothi, Annagiri, ICCC37, ICCV2, JG11,

Land Requirements

Land to be used for seed production shall be free of volunteer plants. In addition the soil should be light, well drained and with a neutral ph.

Isolation requirements:

Bengal gram is a highly self-pollinated crop. Natural cross pollination to the extent of less than 5% has been recorded. Therefore, for maintaining variety purity an isolation of 10 m. for foundation seed class and 5 m. for certified seed class is necessary from fields of other varieties and of the same variety not confirming to varietal purity requirements of certification.

Brief cultural practices:

Obtain appropriate class of seed from the source approved by seed certification agency. The seed rate required is 50 kg/ha (small seed), 75 kg/ha (medium seed), 100 kg/ha (bold seed), 120kg/ha (kabuli) and the spacing adopted is 30 x 10 cm. The planting time is second fortnight of October to first week of November. Other cultural practices are similar to raising a commercial crop. Necessary prophylactic measures should be taken so as to raise a good crop.

Roguing:

Rogue the off type plants and diseased plants affected by wilt, root rot leaf spot and stem canker, yellow mosaic virus and sterility virus from seed field from time to time, as required. Roguing should be done once before flowering and once after flowering based upon varietal morphological characters

Number a field inspections:

A minimum two field inspections are standardized for certification of different seed production programmes. For Bengal gram a minimum of two field inspections are required i.e. first one before flowering and second inspection during flowering and fruiting to determine isolation, volunteer plants, off types and diseased plants etc.

		F/s	C/s
Off types	(%)	0.1 %	0.2 %

Harvesting and threshing:

The crop is harvested soon after the seed is mature. Threshing is done by beating the plants with sticks. After threshing and cleaning the seed should be driedto 8 to 10 percent moisture before storage. Necessary precautions should be taken to avoid mechanical mixtures during these operations.

Seed yield

The average seed yield varies from 10 to 15 quintals per hectare.

Lecture No: 15

Seed production of Cotton

Land requirement: The land should be free from volunteer plants, soil should be fertile, moisture retentive with good drainage.

Isolation requirement: Cotton is self-pollinated crop but natural cross-pollination may occur from 10-50% in Gossypium hirsutum, 1-2 % in *G. arboreum* and 5-10% in *G. barbadense*. It is desirable to produce only one variety at a time. For pure seed production the isolation distance required is 50 m and 30 m for foundation and certified seed respectively from other varieties and same varieties not confirming to varietal requirements.

Cultural practices: Obtain appropriate class of the seed from the source approved by seed certification agency. The seed rate required is 8-10 kg/ha. The package of practices recommended for commercial cultivation should be followed for raising a good crop.

Number of field inspection: A minimum of two-field inspection is required. First field inspection should be done at vegetative stage and the other at flowering stage to verify isolation requirement, offtypes and diseased plants.

	Foundation seed	Certified seed
Offtypes	0.1 %	0.2 %

Rouging: remove the offtypes and diseased plants first at seedling stage and then at vegetative stage. Subsequent rouging for offtypes and diseased plants should be done at square initiation and flowering stage.

Harvesting and Picking: Picking is commenced when cotton is fully mature i.e. when the bolls begin to open. Several pickings are necessary since the bolls ripen over a period of 2-3 months. In general early pickings give better germination and good quality seed, however the planting seed is mostly gathered from the cotton harvested during peak period. The cotton picked from late-formed bolls (last picking) should not be used for seed purpose.

Precautions:

1. Start picking when the bolls are fully mature.
2. Picking should not be done when the bolls are wet due to rain or dew.
3. Bolls damaged by rains or insects or otherwise should not be used for seed.
4. The cotton should be clean with minimum amount of leaves and plant barks, so that the seed is not damaged during ginning.
5. Moist cotton with 12 % or more moisture content should not be stored because heating may occur which damages the seed.

Seed yield: Seed yield may be around 3-6 Q/ha depending upon the variety and management practices adopted.

Delinting is the removal of seed coat hairs and short fibers that remain after ginning. Delinting can be done by machine, acid or flame delinting. For acid delinting the seeds are treated with concentrated sulfuric acid and then washed with water 3 or 4 times.

Hybrid seed Production

Land requirement: Same as varieties.

In cotton hybrid seed is produced by manual hybridization i.e. emasculation and pollination. Individual flower buds are emasculated in the evening and pollinated next day morning. The male and female are planted in a ratio of 1:4 or 1:5. The first $4/5^{th}$ of area are sown with female line and the remaining $1/5^{th}$ by male line. For example if there are 50 lines then 40 lines are sown with female parent and 10 lines with male parent. Male parent is sown 3-4 times at an interval of 6-8 days while the female is sown only once, so that sufficient number of male flowers should be available when the female flowers are receptive. The seed rate required for female parent is 3.75 kgs/ha and that of male parent is 2.5 kgs/ha. The spacing adopted for female parent is 150 x 100 cm and for that of male parent is 150 x 50 cm.

Isolation requirement: Isolation distance required is 50 m and 30m for foundation and certified seed respectively and 5 m between the parental lines.

Number of field inspections: A minimum of four inspections shall be made as follows:

1. the first inspection shall be made before flowering to verify isolation, volunteer plants, outcrosses and other relevant factors.
2. The second and third inspections shall be made during flowering to verify isolation, offtypes and other relevant factors. In case male sterile is used for producing hybrid seed, the number of pollen shedding plants in female parent shall also be verified.
3. The fourth inspection shall be made during picking of cotton in female parent in order to determine that selfed bolls are eliminated and only cotton from crossed bolls is picked.

	Foundation seed	Certified seed
Offtypes	0.10	0.5 %
Pollen shedding plants in female parent	0.05	0.1 %

Organizing an efficient crossing program:

1. Rogue out all offtypes from both male and female parental lines before starting the crossing program.
2. Emasculation should be done between 2.00 to 6.00 PM and pollination next day morning between 8.00 to 12.00 AM.
3. Select the bud that will open next day and emasculate it by removing the calyx, corolla and the monodelphous stamens without causing injury to the style and stigma.

4. Emasculate and pollinate all the flower buds appearing during the first seven weeks of reproductive phase to ensure good seed setting and development of the bolls.
5. Emasculation should be perfect and complete.
6. Cover the emasculated flower bud with butter paper bag and pollinate next day morning. (As per certification standards it is not necessary to cover the flower bud with butter paper bag as we are following the required isolation distance)
7. Remove all the unemasculated flower buds next day morning before fertilization.
8. Tie a thread to the pedicel of the bud after each pollination.
9. Crossing program should be stopped after the 11th week and remove all buds and flowers appearing subsequently to facilitate better development of the crossed buds.
10. Nip the terminal shoots to stop further growth and to support the development of crossed bolls.

Harvesting and Picking : Pick up the ripe and completely opened bolls along with pedicel and thread and collect in the basket. The bolls may be sorted once again to assure that they are crossed. Sun dry them for 1or 2 days and store in gunny bag until supplied to the processing plants. Care should be taken to avoid mechanical admixtures during picking and there after. Grow out test is generally carried for hybrid seed of cotton produced by manual emasculation and pollination to ascertain the genetic purity.

Seed Production of Okra

Land requirement: No specific land requirements are there for okra seed production. However the land should be fertile, well drained and free from soil borne diseases.

Isolation requirement: Okra is self and cross pollinated crop. The extent of natural cross pollination varies from 4-19 %. The seed fields must be isolated from fields of other varieties and fields of same variety not confirming to varietal purity requirements for certification and w ild Abelmoschus species at least by 400m and 200 m for foundation and certified seed production respectively.

Brief Cultural Practices:

Sowing time : the crop can be grown round the year but it should be seen that harvesting does not coincide with heavy rains. Further rabi sown crop is heavily infested by insects and pests. Early kharif sown crop or summer sown crop is good for seed production.

Seed rate: Kharif crop: 8-10 Kgs/ha

Summer crop 10-15 kgs/ha

Method of sowing: sowing should be done in rows by following a spacing of 60 x 30-45cm for kharif season and 45 x 30 cm for summer season.

Field Inspection: A minimum of three inspection shall be made. First inspection should be done before flowering, second during peak flowering and fruiting stage and third at mature fruit stage or prior to harvesting. The field standards are as follows;

	Foundation	Certified
Offtypes	0.10	0.20
Objectionable weed plants	None	None

Rouging: Rouging of the seed crop should begin with uprooting and destroying the yellow vein mosaic affected plants soon after they are noticed. This should be continued up to 3 fruit stage. Subsequent rouging for offtypes and wild Abelmoschus species should be done prior to flowering. This should continue during the flowering stage also. The offtype plants are easily distinguished on the basis of plant height, leaf and stem characteristics, pigmentation, flower size, shape, color and fruit shape. All the offtypes and diseased plants should be identified and removed before flowering stage.

Harvesting and threshing: Pods should be harvested when they have dried (about 35 days old). The pods are usually picked by hand, dried and threshed by beating with sticks. The seed should be dried to at least 10% moisture content before storage.

Seed Yield: the average seed yield is 12 quintals per hectare.

Seed Production of Okra (Bhendi)

Land Requirement There is no specific land requirement as per the previous crop but the land should be free from volunteer plants. The soil should be fertile, well drained and aerated.

Isolation requirement: Chilli is both self and cross pollinated crop. Cross pollination is mainly due to insects. The extent of cross pollination is from 7-36 per cent has been recorded. The seed fields must be isolated from other varieties of pepper (both hot and sweet pepper/chilli) and fields of same variety not confirming to varietal purity requirements of certification by at least 400 m for foundation seed production and 200 m for certified seed production.

Brief Cultural Practices:

Source: Obtain appropriate class of seed from the source approved by seed certification agency.

Seed Rate : 1-2 kgs /ha

Sowing of Nursery: Nursery should be raised on raised beds of 15-20cm high. Each bed should be of 2-2.5 m in length and 1-1.25 m width. The seeds should be broadcasted or sown in lines on the raised beds. Approximately 25 beds are required for planting one hectare of main field. The seedlings should be transplanted when they are of 15-20 cm height after 4-5 weeks.

Spacing : Hot pepper 60 x 45 cm, Sweet pepper 45 x 45 cm

Field Inspection: A minimum of three field inspections are required. First field inspection should be done at vegetative stage, second at flowering stage and the third at post flowering or fruiting stage.

	Foundation	Certified
Offtypes	0.10 %	0.20%
Plants affected by seed borne diseases (Leaf blight, anthracnose)	0.10%	0.50%

Roguing: Removal of the offtype plants has to be done at various stages of crop growth. First Roguing should be done at vegetative stage. The offtypes can be identified based on morphological characters like plant types, lea shape, leaf color etc. second roguing should be done at flowering stage and the offtypes can be identified based on earlier described characters and flower color and shape. Final Roguing should be done at fruiting stage. Remove all the diseased plants from time to time.

Harvesting and extraction of seed: Chilli fruits are picked at red ripe stage. The fruits are either dried and crushed and the seed is separated by winnoeing or the seed is extracted manually from the freshly harvested fruits. An axial flow vegetable seed extracting machine can also be used for extracting the seeds from chilli fruits. Mechanical extraction is more quicker cheaper and had no adverse effect on seed quality.

Seed yield: the average seed yield of sweet pepper is 105 kg/ha where as hot chilli yields 400 – 750 kgs/ha. here is lot of varietal variations in seed yield.

Work to be done by students

1. Give at least 5 varieties and hybrids and their important characters.
2. Field layout for hybrid seed production (Planting ratio)

Draw Field layout for Bhendi Hybrid Seed Production and write down 5 varieties and hybrids in Bhendi

Okra (Bhendi)

Land requirement: No specific land requirements are there for okra seed production. However the land should be fertile, well drained and free from soil borne diseases.

Isolation requirement: Okra is self and cross pollinated crop. The extent of natural cross pollination varies from 4-19 %. The seed fields must be isolated from fields of other varieties and fields of same variety not confirming to varietal purity requirements of certification and from wild Abelmoschus species by at least 400 and 200 m for foundation and certified seed production respectively.

Brief Cultural Practices:

Sowing time : the crop can be grown round the year but care should be taken that harvesting does not coincide with heavy rains. Further rabi sown crop is heavily infested by insects and pests. Hence, early kharif sown crop or summer sown crop is good for seed production.

Seed rate: Kharif: 8-10 Kg/ha

Summer: 10-15 kg/ha

Method of sowing: sowing should be done in rows by following a spacing of 60 x 30-45cm for kharif season and 45 x 30 cm for summer season.

Field Inspection: A minimum of three inspections should be made. First inspection should be done before flowering, second during at peak flowering and fruiting stage and third at mature fruit stage or prior to harvesting. The field standards are as follows;

	Foundation	Certified
Offtypes	0.10	0.20
Objectionable weed plants	None	None

Roguing: Roguing of the seed crop should begin with uprooting and destroying the yellow vein mosaic affected plants soon after they are noticed. This should be continued up to 3 fruit stage. Subsequent Roguing of offtypes and wild Abelmoschus species should be done prior to flowering. This should continue during the flowering stage also. The offtype plants are easily distinguished on the basis of plant height, leaf and stem characteristics, pigmentation, flower size, shape, color and fruit shape. All the offtypes and diseased plants should be identified and removed before flowering stage.

Harvesting and threshing: Pods should be harvested when they have dried (about 35 days old). The pods are usually picked by hand, dried and threshed by beating with sticks. The seed should be dried to at least 10% moisture content before storage.

Seed Yield: the average seed yie ld is 12 quintals per hectare.

Hybrid seed production: Similar as that of cotton. In Bhendi hybrid seed is produced by hand emasculation and pollination technique.

Lecture No: 16

Seed production of Tomato

Land Requirement: There are no specific requirements as to the previous crop, but the land should be free from volunteer plants.

Isolation requirement: Tomato is predominantly a self-pollinated crop but crossing does takes place to a negligible extent. Seed fields should be isolated from other varieties of tomato by at least 50 and 25m for foundation and certified seed production respectively.

Brief cultural Practices:

Source: Obtain appropriate class of seed from the source approved by seed certification agency.

Seed Rate : 500 g per hectare.

Sowing of seed in nursery: The nursery grown in late October and transplanted in the first week of December produces excellent seed crop. Seeds may be sown on raised nursery beds (15-20cm high from the ground) in rows 3-4 cm apart. Twenty five nursery beds of size 2-2.5 m long and 1 to 1.25 m wide will raise enough seedlings to transplant one hectare.

Transplanting: Transplant the seedlings when 7.5 – 10 cm height, preferably at evening time.

Spacing: 75 x 40 – 50 cm

Field Inspection: Seed crop should be inspected at least three times during the crop season, the first before flowering, second during flowering and fruiting stage and third at mature fruit stage prior to harvesting.

	Fundation	Certified
Offtypes	0.10	0.20
Plants affected by seed borne diseases (Early blight, leaf spot and TMV)	0.10	0.50

Rouging: Careful rouging on individual plant basis is essential. Plants which are differing in morphological characters from that of the seed crop should be removed to avoid cross pollination and at maturity color and shape of the fruit is checked for offtypes. In addition to offtypes, diseased plants affected by early blight leaf spot and mosaic from the field.

Harvesting: In tomato germination of seed is effected by stage of fruit maturity. Fruits on turning to ripe red, red and over ripe stages are found to be good for extracting good quality seed.

Seed Yield: 100 – 120 kgs/ha

Seed Extraction: Tomato seed can be extracted manually using acid or fermentation methods or mechanically method using axial – flow vegetable seed and seed extraction methods.

Seed Drying and Storage: Seed should be dried by spreading in thin layer on the drying floor. In case temperature exceeds 40^{o}C the seed drying under partial shade is desirable. Under artificial conditions the seed should be first dried at low temperature and then the temperature should be gradually increased to 40^{o}C. The seed should be dried to a moisture level of 6-8% and packed in cloth bags or moisture proof containers and keep it in cool and dry place. Careful and properly dried seed can retain its viability for 2-3 years even under ambient conditions.

Hybrid Seed Production

For hybrid seed production hand emasculation pollination is carried out. The male and female parents are sown in separate blocks. During flowering period buds that are to flower next day are selected in female parent and hand emasculated. While doing emasculation care should be taken not to damage the flowers. After emasculation the flower buds are covered with butter paper bag to avoid pollination/fertilization with foreign pollen.

Isolation distance: The isolation distance required are 200 and 100 for foundation and certified seed class respectively from other varieties and hybrids.

Field Inspection: The number of field inspections required are four. The first field inspection should be done before flowering stage, second and third during flowering stage and fourth one before harvesting.

	Foundation	Certified
Offtypes in seed parent	0.10	0.50
Offtypes in male parent	0.10	0.50
Plants affected by seed borne diseases (Early blight, leaf spot, TMV)	0.10	0.50

Roguing: Roguing should be done in both male and female parental line before starting the crossing program. Offtypes can be identified based on morphological characters like leaf shape, plant type, flower color etc.

Harvesting: Harvesting should be done when the fruits are fully mature. Harvest only the crossed fruits and the seed should be extracted manually using acid or fermentation methods or mechanically method using axial – flow vegetable seed and seed extraction methods.

Seed Production of Brinjal

Land Requirement: There is no specific land requirement to previous crop but the land should be free from volunteer plants. The soil should be fertile, rich in organic matter sandy loam and well drained.

Isolation Requirements: Brinjal is partially self and cross pollinated but self pollination is more common. The extent of natural cross pollination depends on insect activity and has been recorded from 0-48%. For pure seed production seed fields must be isolated from other variety and fields of same variety not confirming to varietal purity requirements of seed certification at least 200 m for foundation seed production and 100m for certified seed production.

Brief cultural practices:

Source: obtain appropriate class of seed from the source approved by seed certification agency

Seed Rate : 375 – 400 g per hectare

Sowing of seed in nursery: sowing time varies with the region and it should be adjusted in such a way that maturity should not be coincide with rains. The winter crop needs special protection from frost. Seeds are sown on raised nursery beds 15-20 cm high from ground level in rows of 2-3 cm apart. Twenty five beds of 2-2.5 m long and 1-1.25 m wide will raise enough seedlings to plant one hectare.

Transplanting: The seedlings should be transplanted when they are of 12-15cm height.

Spacing : for non spreading type 60 x 60 m

Spreading type 75 x 60 cm

Field inspection: A minimum of three field inspections are required. First inspection should be done at vegetative stage so as to verify isolation distance, presence of volunteer plants and other requirements. The offtypes at this stage can be identified by morphological characters. Second and third inspection should be done at flowering and fruiting stage. At this stage offtypes can be identified by colour of the flower, fruit shape , size etc.

	Foundation	Certified
Offtypes	0.10	0.20
Plants affected by seed borne diseases	0.10	0.50

Roguing: At least three roguings should be done. First roguing should be done at vegetative stage. Offtypes at this stage can be identified by plant type, leaf shape, leaf colour, presence of thorns etc. second and third roguing should be done at flowering and fruiting stage. Remove all the diseased plants at each stage of the crop growth.

Harvesting: Brinjal fruits are allowed to mature beyond the edible stage before harvesting for seed purpose. Seeds obtained from the fruits harvested at completely yellow color stage recorded the highest fruit seed yield per hactare and germination.

Seed Extraction: Usually the fruits are cut and crushed and seed is extracted by washing and seiving. Extraction should be started in the morning hours so that the seed is atleat half dried till evening, else there is danger of germination in the process.

Seed yield: 100 – 120 kg/ha

Hybrid Seed Production: In brinjal hybrid seed is produced by manual emasculation and pollination technique. The variety which gives large fruits and more number of seeds per fruit should be taken as female parent. The male and female parent should be planted in separate blocks by following the same management practices. Before hybridization program starts remove all the offtypes from both male and female parental lines. During hybridization select a flower bud in female parent which opens next day morning and the emascualtion should be done in the evening time between 3.00 to 6.0 PM. After emascualtion the flower buds should be bagged with a butter paper bag to avoid contamination. Next day morning bring the male flowers and pollinate the emsaculated flower buds between 7.0 to 11.00 AM. After pollination the crossed flower bud should be bagged and a tag should be attached at the pedicel. At the time of harvesting collect all the crossed fruits along with the tag and extract the seed.

Seed Production of Chilli

(*Capsicum annuum* L. & *Capsicum frutescens* L.)

Land Requirement There is no specific land requirement as to previous crop but the land should be free from volunteer plants. The soil should be fertile, well drained and aerated.

Isolation requirement: Chilli is self and cross pollinated. Cross pollination is mainly done by insects. The extent of cross pollination is from 7-36 per cent has been recorded. The seed fields must be isolated from other varieties of pepper (both hot and sweet pepper/chilli) and fields of same variety not confirming to varietal purity requirements of certification by at least 400 m for foundation seed production and 200 m for certified seed production.

Brief Cultural Practices:

Source: Obtain appropriate class of seed from the source approved by seed certification agency.

Seed Rate : 1-2 kgs /ha

Sowing of Nursery: Nursery should be raised on raised beds of 15-20cm high. Each bed should be of 2-2.5 m in length and 1-1.25 m width. The seeds should be broadcasted or sown in lines on the raised beds. Approximately 25 beds are required for planting one hectare of main field. The seedlings should be transplanted when they are of 15-20 cm height.

Transplanting: After 4-5 weeks the seedlings grow about 15-20 cm tall are ready for transplanting.

Spacing: Hot pepper 60 x 45 cm

Sweet pepper 45 x 45 cm

Field Inspection: A minimum of three field inspections are required. First field inspection should be done at vegetative stage, second at flowering stage and the third at post flowering or fruiting stage.

	Foundation	Certified
Offtypes	0.10 %	0.20%
Plants affected by seed borne diseases (Leaf blight, anthracnose)	0.10%	0.50%

Rouging: Removal of the offtype plants has to be done at various stages of crop growth. First rouging should be done at vegetative stage. The offtypes can be identified based on morphological characters like plant types, lea shape, leaf color etc. second rouging should be done at flowering stage and the offtypes can be identified based on earlier described characters and flower color and shape. Final rouging should be done at fruiting stage. Remove all the diseased plants from time to time.

Harvesting and extraction of seed: Chilli fruits are picked at red ripe stage. The fruits are either dried and crushed and the seed is separated by winnling or the seed is extracted manually from the freshly harvested fruits. An axail flow vegetable seed extracting machine can also be used for extracting the seeds from chilli fruits. Mechanical extraction is more quicker cheaper and had no adverse effect on seed quality.

Seed yield: the average seed yield of sweet pepper is 105 kg/ha where as hot chilli yields 400 – 750 kgs/ha. There is lot of varietal variations.

Lecture No: 17

Seed Production of Onion

Land Requirement: Select fields in which an onion crop was not grown in the previous year unless it is the same variety and certified by seed certification agency for its purity. The soil should be rich in organic matter and have good water holding capacity.

Isolation requirement: Onion is largely cross-pollinated crop with up to 93 per cent natural crossing. It is chiefly pollinated by honeybees. For pure seed production the seed fields should be isolated by at least 1000 m for foundation seed production and 400 m for certified seed production.

Methods of seed production;

There are two methods of seed production 1. Seed to seed method and 2. Bulb to seed method.

1. **Seed to seed method**: The bulbs of first season 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 selection 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.

Brief cultural Practices:

Sowing time (Nursery): Mid of October to Mid of November. Around 2000 square meters of nursery is sufficient to plant one hectare.

Seed rate: 8-10 kgs /ha

Transplanting: 8-10 weeks old seedlings are planted in small seed beds in well prepared fields by following a spacing of 10-15cm depending upon the bulb size.

Field Inspection: A minimum of two field inspections shall be made as follows;

1. The first inspection shall be made after transplantation of seedlings in order to determine isolation, volunteer plants, offtypes including bolters and other relevant factors.
2. The seed inspection shall be made after the bulbs have been lifted to verify true characters of bulbs.

Harvesting and curing of bulbs: well-matured bulbs should be harvested. Maturity is indicated by the tops drooping just above the bulb, while the leaves are still green. After harvesting the bulbs should be topped leaving an half-inch neck. Before storage a through selection and curing of bulbs should be done. The length of time required for curing depends on weather conditions and may take 3-4 weeks.

Storage: The essentials of successful storage are

1. The bulbs should be well matured dried and cured before storage.
2. Storage should be well ventilated.
3. Storage should be done in shallow trays with perforated bottoms
4. Storage temperatures should be 0-4.5^{o}C until three to 4 weeks prior to planting. Then it is increased to 10^{o}C.

Planting of bulbs and seed Production (Second Year)

1. **Time of planting bulbs**: second fortnight of October
2. **Seed Rate**: bulb size 2.5 3.0 cm diameter – 15 q of bulbs /ha

   Bulb size 3.0 – 4.0 cm diameter – 40 - 50 q of bulbs /ha
3. **Spacing**: 8-10 cm deep at 45 x 30 cm

Field Inspection: a minimum of four inspections shall be made. The first inspection should be made before flowering to determine isolation distance, volunteer plants, offtypes including bolters and other relevant factors. The second and third inspection shall be made during flowering to check isolation, offtypes and other relevant factors. The fourth inspection shall be made at maturity to verify the true nature of plant and other relevant factors.

	Foundation	Certified
Offtypes	0.10	0.2
Bulbs not confirming to varietal characters	0.10%	0.2%
	(by number)	(by number)

Rouging of seed crop:

First year: It is desirable to begin rouging in the field before bulbs are harvested, look for plants having different foliage or plant type or late maturing bulbs. After harvesting, the bulbs should be rouged for color and such offtypes a thick necks, doubles, bottlenecks or any other type.

Second Year: Plant only selected true to type bulbs and remove plants not confirming to varietal characters before flowering.

Harvesting and threshing: seed is ready for harvest when first formed seed in the heads get blackened. 2-3 pickings are necessary to harvest the heads. Seed heads after harvest are thoroughly dried with sir circulation. Heads are threshed when seeds separate easily. Before storage seed must be dried to 6-8% moisture.

Seed Yield: 850-1000 kg/ha.

Seed Production of Cucurbits

Land requirement: there is no land requirement as to the previous crop but the and should be free from volunteer plants and the soil should be well drained and aerated.

Isolation requirement: The isolation distance required for foundation and certified seed class are 1000 m and 500 m.

Source seed: Obtain appropriate class of the seed from the source approved by seed certification agency.

Brief Cultural Practices:

Sowing time : Most of the cucurbits can be sown in kharif, rabi or summer season. The seed rate required are different for different cucurbit species

Field Inspection: A minimum of three field inspections are required. First field inspection should be conducted before flowering stage, second during flowering and fruiting and third at fruit maturity. The final field inspection stage the offtypes should not be more than 0.10 and 0.20 % in foundation and certified seed class.

Roguing: All the plants which do not confirm to varietal purity standards should be removed as soon as it is seen. The entire plant should be removed. In most of the cucurbits identification of an offtype can be established only after fruit setting. Removal of the offtypes even at this stage is helpful in preventing further genetic contamination and mechanical admixtures of pure seed. In muskmelon and water melon edible fruit should be examined for internal fruit characters and sweetness.

Harvesting: The fruits should be harvested when they are fully mature. In each species the maturity indices are different. Bitter gourd should be harvested when the entire fruit is changed to red from green while in bottle gourd it should be harvested when the skin becomes tough and dull in color

Seed Extraction: The seed is extracted manually from ridge gourd and bottle gourd.

Lecture No: 18

Seed Certification

Objectives:

Upon completion of this exercise the student should know about

1. The procedure for seed certification
2. Differentiate between truthfully labeled seed and certified seed
3. The history of seed certification
4. Should know the procedure to conduct field inspection in important crops

Seed certification is a legally sanctioned system for the quality control of seed during seed multiplication and production. As per Indian Seed Act seed certification is voluntary and it is not compulsory. The seed that is sold in the market is of two types certified seed or truthfully labeled seed. The seed, which is being certified by seed certification agency, is called as certified seed. The certification agency is a separate organization meant for certifying the quality of the seed and it has nothing to do with seed production. The seed certification agency maintains certain strict standards before issuing the certification tag or label. Where as truthfully labeled seed is one which is being produced and marketed by the producing company by maintaining the labeling standards. The farmer or the user of the seed does not know the pedigree of the truthfully labeled seed and he has to relay on the seed producing company. Where as the certified seed has to maintain both field and seed standards and if the seed lot meets both the field and seed standards then only the certification tag or label is issued.

History of seed certification

Exactly where and how the concept of seed certification was originated is not clear. But the credit of seed certification goes to Swedish people. In 20th century the newly developed varieties lost their identity due to genetic contamination and mechanical mixtures. To avoid this, Agronomist and breeders started visiting the fields of progressive farmers and educated them to avoid mechanical mixtures and keep the seed genetically pure. This process slowly led to field inspection. The farmers and the scientists thought that field inspection could be useful in maintaining genetic purity of crop varieties. But other problems started like to what extent the mechanical mixtures or genetic contamination should be permitted etc. To overcome these problems representatives from USA and Canada met in Chicago Illinois in 1919 and organised the International Crop Improvement Association (ICIA). The ICIA, which later in 1969 changed its name to Association of Official Seed Certification Agency (AOSCA), laid the beginning of modern day seed certification.

Procedure for seed certification: Seed certification is voluntary and that too for the kind and variety notified by the government of India. It can be completed in six broad phases.

1. Receipt and scrutiny of the application.
2. Verification of seed source, class and other requirements.
3. Filed inspection should be conducted to see that fields are up to the prescribed field standard.
4. Post harvest inspection, including processing and packing.

5. Seed sampling and testing to confirm that the seeds are up to the prescribed seed standards.
6. Grant of certificate, tagging and sealing.

1. **Receipt and scrutiny of the application**: All those persons who are interested in seed certification should submit an application in Form No 1 to the concerned seed certification officer with the prescribed fees of Rs 25/-. The fee is for one season for a single variety and for an area up to 25 acres (10 ha.) If the area is more than 25 acres or if more than one variety is planted separate applications should be made for each variety. If the area is less than 25 acres under one variety but if the fields are scattered and separated by more than 50 meters separate applications should be made. On receiving the applications the seed certification agency verifies for the following conditions:
   1. Eligibility of the variety: Only those varieties that are notified by the central govt. are eligible for certification.
   2. Establishing the seed source: The seed producer should submit the tag, in-voice, and a copy of Form No2.)
   3. There should not be any difficulty in reaching the field for carrying out timely field inspection.
   4. Whether the required isolation and land requirement is followed or not.
   5. Whether the processing plant facility is available to the applicant.
   6. Whether the applicant has paid the requisite registration fee or not.

If all the six conditions are fulfilled then the seed producer has to pay the field inspection fees as given below:

Various certification Charges

1. Cost of the form No 1	: Rs 2.00
2. Registration fee (per unit)	: Rs 25.00
3. Inspection fee (per ha.)	
a. Self-pollinated Crops	: Rs 125.00
b. Cross Pollinated Crops	: Rs 175.00
c. Other than Cotton hybrids/parents	: Rs 175.00
d. Cotton Hybrids	: Rs 800.00
e. Vegetable Crops	: Rs 150.00
4. Grow Out Test (per sample)	: Rs 150.00
5. Seed Testing	
a. Routine tests	: Rs 30.00 per sample

b. Health tests	: Rs 5.00 per sample
c. Revalidation Charges (sample)	: Rs 30.00
6. Revalidation fees per quintal and part thereof	: Rs 10.00
7. Reprocessing/ Re grading fee (per quintal of part thereof)	: Rs 5.00
8.Cost of Application form for registration / renewal of processing plant	: Rs 5.00
9. Processing / Ginning Plants	
a. Registration fee	: Rs 1000.00
b. Renewal fee	: Rs 500.00
10. Repackaging charges per quintal	: Rs 10.00
11. Cost of seed certification tags per 1000 nos	: Rs 60.00
12. cost of cotton seed tags (with hologram) per 1000	: Rs 80.00
13. Appeal fee per case	: Rs 100.00

2. **Verification of seed source, class and other requirements**. The seed should be from authentic source and from appropriate class and should be in accordance with Indian Minimum Seed Certification Standards.
3. **Inspection of Seed Fields**. The certified seed producers should grow and harvest the crop as per the guidelines issued by the seed certification agency. They must carefully and faithfully carry out the roguing and other operations as per the directive of the certification agency.

The certification staff conducts field inspections at appropriate stages of crop growth to ensure that minimum standards of isolation, preceding crop requirement, roguing and other special operations are maintained at all times. The inspection of seed crop is done at different stages of crop growth such as at the time of sowing (when new crop is introduced), vegetative stage or preflowering stage, flowering stage, post flowering or preharvest stages and at the time of harvest. The contaminants to be observed during field inspections are offtypes, pollen shedders, shedding tassels, inseperable other crop plants, objectionable weed plants and diseased plants. The field inspections are designated to ensure that the crop is up to the prescribed field standards. All the seed fields, which do not meet the required field standards, are eventually rejected.

Method of taking field counts

The method of taking field counts involves following steps:

1. **Determine the number of field counts**. For all crops a minimum of five counts are to be taken for an area up to two hectares, and an additional count is to be taken for each additional two hectares or part thereof as given below.

Area of the field in hectares	**Minimum number of counts to be taken**
Up to 2	5
2-4	6
4-6	7
6-8	8
8-10	9
Above 10	10

In any inspection, if the first set of counts show that the seed crop does not confirm to the prescribed standards for any factor, a second set of counts should be taken for that factor, if the percentage of first set of count for that factor is not more than twice the maxmimum permissible level. Two sets of counts are called as double counts. In hybrid seed production plots the number of counts must be taken separately for both the parents.

2. **Number of plants to be observed for completing one count**. The number of plants to be observed for completing a single count varies from crop to crop. The number of pla nts/heads to be observed for completing a single count is given below.

Crop	**Number of plants/heads per count**
Wide spaced crops : Bhendi, brinjal, Bulb crops, Chillies, Cole crops, Cotton, Cucurbits, Groundnut, Maize, Potato, Redgram, Tomato, root crops, etc.	100 plants
Medium spaced crops: Beans, cowpea, gram, leaf crops, moong, urad, mustard, peas, sesame, sunnhemp, etc.	500 plants
Thickly sown crops: Berseem, jute, lucern, mesta, soybean Bajra, paddy, wheat, sorghum, etc	 1000 plants 1000 heads

The required number of field inspections specified in the seed certification standards should be conducted. The purpose of these filed inspections is to properly guide and advise the seed producer, but at the same time to do the necessary inspections so that the ultimate buyer can be assured that the seed crop has met all the necessary standards.

3. **Taking of Filed Counts**: The procedure for taking filed counts differs for different crops.
4. **Rejection of seed fields**: All the seed fields, which do not confirm to the required standards for any of the factors should be rejected. The rejection letter should be immediately communicated to the seed grower stating the reasons for the rejection. As far as possible the seed growers should be convinced for rejecting the seed fields by showing the contaminants.
5. **Post Harvest Inspection**: The personnel from the seed certification agency should inspect the fields during harvesting or post harvesting, so that there are no mechanical mixtures and the seed is not handled badly during threshing or afterwards. Then the seed is sent to seed processing plant with a threshing certificate. The personnel from the seed certification agency will be inspecting the seed processing plant to avoid mechanical mixtures and damage caused to the seed during processing.
6. **Seed Sampling and Testing**: The representative from seed certification agency draws a representative sample from the seed lot at the time of processing or after processing and sends the sample to official seed testing laboratory for evaluation. In the seed testing laboratory the samples will be evaluated for seed standards such as pure seed, inert matter, other crop seed, weed seeds, germination percentage and moisture percentage etc.
7. **Grant of certificate, tagging and sealing**. After receiving a satisfactory report from the seed testing laboratory, tagging and sealing of bags will be done under the supervision of seed certification agency. Under special circumstances, advance tags will also be issued to the extent of 75 per cent of the seed lot. Tags and seals should be in accordance with general seed certification requirements. Affixing of tags and seals on the containers completes the process of certification of seeds.
8. **Control Plot testing**. The seed certification agency should arrange for a post-season grow-out test for all hybrids as prescribed in the standards. Randomly samples should be drawn from certified seed lots and sent to grow-out test to check the efficiency and accuracy of the work done.

9. **Validity period**. The seed is initially valid for a period of nine months from the date of testing the samples. If the seed is not sold within the stipulated period, it can be revalidated for a period of six months if the seed lot meets the required seed standards. The seed can be revalidated as long as it meets the prescribed seed standards and for each revalidation the validity period will be extended for six months.
10. **Revocation of certificate**. If the certification agency is satisfied that the certificate granted by it has been obtained by misrepresentation of essential facts, or the holder of the certificate has failed to comply with the conditions subject to which the certificate has been issued, can revoke the certificate. The certificate can be revoked only after giving a show cause notice to the holder of the certificate.
11. **Appeal against seed certification agency**: If any certified seed grower is not satisfied by the decision taken by the seed certification agency (in rejecting the seed plot), he can make an appeal to the appellate authority specified by the state government. The appeal should be made within 30 days from receiving the rejection letter. The appeal should be made in written along with a copy of the rejection letter and a treasury fee of Rs 100/- (Rupees one hundred only). The application should be submitted personally or it should be sent through registered post. The decision of the appellate authority will be final and it is binding on the seed certification agency and the seed grower. The appellate authority for Andhra Pradesh is Additional Director of Agriculture (inputs).

Lecture No: 19&20

Seed Drying

Lowering down the seed moisture content to safe moisture limits is very important in order to maintain seed viability and vigor, which may other wise deteriorate fast due to mold growth and increased micro-organism activity. The advantages of seed drying are it permits early harvest, so that land and manpower can be used efficiently, permit long term storage and maintains the seed quality.

Methods of seed drying

1. Sundrying
2. Forced air drying

Sundrying: the moisture of seed is generally reduced in the field before harvest and later by sun drying on the threshing floor. The system involves harvesting of crops when they are fully dried in the field, leaving the harvested produce in the field for a couple of days for sun drying and later spreading the threshed and winnowed produce in thin layer on threshing floors of sun drying. The main advantages of sun drying are No additional expenditure or special equipment is required. The Disadvantages are delayed harvesting, risk of weather damage, and increased possibilities of mechanical admixtures.

If sundrying is done following precautions should be taken.

1. Do not spread the produce on wet, dirty and kaccha, threshing floors.
2. Only one crop variety should be handled at a time and care should be taken to avoid mechanical mixtures.

Forced Air Drying: In this system natural air is forced into seeds. The air passing through damp seeds pick up the water. The evaporation cools the air and the seed. The heat necessary for evaporating the water comes from the temperature drop of the air.

Principle of Forced Air-Drying

Seeds are highly hygroscopic living material and their moisture content depends upon temperature and relative humidity of surrounding air. Whenever the vapour pressure in the seed is greater than that of the surrounding air vapour pressure will move out of the seeds i.e. the seeds will loose moisture. If however, the vapour pressure gradient is reversed, the moisture move into the seeds and the seed will gain the moisture. When the two vapour pressures are equal the moisture content of seed is in a state of equilibrium with the surrounding atmosphere. Seed drying takes place when there is a net movement of water from the seed into surrounding air.

The rate of seed drying depends on rate of moisture migration from the centre of the seeds to surface and by the speed at which surface moisture is evaporated in the surrounding air. The temperature of the seed, physical structure of the seed, chemical composition of the seed and the seed coat permeability influence the rate of moisture migration from the centre to the surface of the seed. Surface saturation, relative humidity and temperature of drying air influence removal of the moisture from the surface.

How Drying Proceeds in the Seeds

When air is forced through the seed for drying, all the seeds do not dry uniformly at the same time. Actually all the seeds in the drying bin may be considered to be in the three zones a. the dried zone, b. the drying zone and c. the wet zone.

1. **The Dried Zone**: As the air enters the seeds, the zone nearest to the inlet gets dried first with either natural air or heated air. The seeds will dry below the desired level to some degree. The dried zone will gradually move upwards as drying proceeds.
2. **Drying Zone**: The air passing through the dried zone picks up moisture in the next region, the drying zone, until it reaches moisture equilibrium or saturation in case of very wet seeds. How much moisture it can pick up before it reaches equilibrium is determined by the width of the drying zone. The lower edge of the drying zone at the interface with dried zone is called as drying front.
3. **Wet Zone**: Refers to the region above the drying zone i.e. the seed in-between top of drying zone and the top surface of the seed, which is wet 16-20 % moisture. The top most layer will be wettest and last to dry. The drying front will not always be a parallel plane except when there is parallel airflow from all parts of the perforated floor below the seed. Generally the ducts are very commonly used and hence a covered drying front will be observed surrounding each inlet.

The difference in moisture content of the air entering and leaving the seed is known as stratification. The amount of stratification and width of drying zone depends upon the volume of air flowing through the seed and its relative humidity.

At high airflow rates or with air of low relative humidity the drying zone may extend the entire bin except at bottom dried zone there will be reduced stratification (ie. Difference between moisture content of upper most and lower most layers). The out-let should be twice the size of the inlet so that backpressure is not exerted.

Forced Air Drying

There are three major drying methods for drying with forced air:

1. Natural air drying – Natural air is used in this type of drying method.
2. Drying with supplemental heat – In this method temperature of the air is raised to about 10 to 20 ^{o}F for reducing relative humidity of the air.
3. Heated Air drying – In this method the drying air is heated to 110^{o}F.

The first two methods require more than 2 to 3 weeks reducing the moisture content to safe limits. These methods are mostly used in western countries for drying grains and seeds, which are stored on the farm and these methods, are rarely used in India. Heated air-drying is mostly favored and used for seed drying. In this method the seed is dried in special drying bins or wagons using heated air. After drying the seed is moved into processing assembly or storage bins, if processing is not done immediately.

Heated Air Drying Systems

The heated air drying system can be conveniently discussed under following heads:

1. Building requirements: This involves construction of bins/storage structures for drying and air distribution system.
2. Selection of crop dryers and systems of heated air drying
3. Management of seed drying operations.

1. Building Requirements

The building for seed drying system depend upon:

1. size of operation
2. Number of different kinds of seeds to be dried
3. Level of mechanization desirable and
4. Future expansion

Different types of structures can be used for storage of seeds to be dried with forced air-drying. The storage structures are made of steel, wood, concrete or plywood and they may be in cylindrical or rectangular in shape.

Requirements of storage bin for seed drying

1. Adequate strength. Seeds of small grains in bulk exert large pressure against the sidewalls. A sound foundation is necessary since, the side pressure of the seed is converted into a vertical load on the foundation
2. Weather tight. The roof and walls must keep out rain and snow, which are important causes for the damage of stored seed. For drying the seeds satisfactorily the walls must be airtight.
3. Easy to fill and empty. The openings for filling and removal of seed should be large enough and so situated that minimum time is lost in filling and unloading the seed. A full size entrance door is desirable.
4. Convenient to inspect, fumigate and clean. For easy inspection there should be 60-120 cms. of headspace above the seed. Cleaning and spraying are made comparatively easy if sharp corners are avoided. For fumigation the structure should be airtight, with provisions for temporary sealings of all openings.

5. Multiple Use. The structure should be usable for drying and storage of more than one kind of crop.
6. Good air distribution system. The air distribution system should be able to carry adequate quantities of air for the drying of seed, and distribute it as uniformly as possible through all portions of the seed bulk.
7. Adequate air venting. Flow of air to the outside, after it leaves the seed should proceed rapidly enough so that back pressure do not hinder flow of drying air into the seed. For this the size of the outlet should be more than twice the cross section area of the main duct of air distribution system.

Types of Air distribution systems for seed Drying.

There are three main types of air distribution systems.

1. Main and lateral duct system
2. Single central perforated duct and
3. Perforated false floor system

1. **Main and lateral duct air distribution system**: In this system the main duct can be located in the centre of the bin, or it can be located at one side of the bin. When the central duct is located outside the bin under the floor it can also serve to empty the bin. When the main duct is located on the side of the bin it can be located inside the bin or on outer wall of the bin.
2. **Single central perforated duct system**: For this air distribution system there must be equal thickness of seed not exceeding 6 feet, around the duct, which is made of perforated metal. For drying the air should be forced upwards through the seed. The sidewalls of the bin must be perforated so that air can flow laterally through the seed. This type of air distribution system is more commonly used for drying maize cobs.
3. **Perforated false floor air distribution system**: This is most commonly used air distribution system for heated air-drying. In this method the air is introduced under the perforated false floor, the air passes up through the perforations and through the seed. The false floor can be made of hardware cloth, screen or perforated metal sheet. The metal false floors are more durable and convenient to use. It is recommended that this type of flooring must be supported on concrete blocks placed at every 3 to 4 ft. interval. It is followed the floor will support load upto 500 lbs/square ft. The channels and openings for the flow of air must be carefully designed too carry the air stream satisfactorily. When perforated metal

flooring is used the total area of all the openings in the steel sheet should not be less than 8-10 % of the storage floor area. This is important when the drying floor does not extend completely to the sidewalls.

4. **Multiple Storage Bins**: These are used to dry several types of seeds simultaneously using the same drying fan or fans. In this method sliding air gates are there for controlling the flow of air to the respective bins. Multiple bin arrangements are advantageous when 2 or more kind of seeds are grown.

Selection of crop dryers and system of heated air-drying

Dryers for heated air drying unit consists of a heater unit where the fuel is burned and a fan to force the heated air through a canvas connecting duct into the air distribution system of the drying bin. The drying bin is connected to an automatic thermostat, which controls the temperature at higher limit and cuts off the burner flame if the air temperature exceeds the safe limit.

There are two types of dryers according to the manner in which heat is supplied to the air.

1. Direct fired
2. Indirect fired

1. **Direct fired**: In this the fuel is burned and the hot combustion gasses are thrown directly into the air stream which goes into the air distribution system. The fuel used is liquid propane gas, butane gas or natural gas. Advantages of this system are it is highly heat efficient. The disadvantages are there is possibility of blowing soot entering into the air distribution system. Unburnt fuel and objectionable fumes may enter the seed bin. With some fuels there is also danger of blowing small sparks into the seed, leading to fire hazards.
2. **Indirect Fired**: The hot combustion gasses pass into a chamber. The drying air circulates around this chamber and picks up the heat and enters the air distribution system. The fuel used is kerosine oil or rarely coal. The fan may be driven by either an electric motor of oil engine. The advantages of this system are, there is no possibility of combustion gasses or soot entering the bin and it safe with respect to fire hazards. One of the disadvantage is it is less efficient in use of heat.

Types of seed dryers for heated air-drying.

There are four types of seed dryers.

1. **Layer in Bin Dryer**: In this method the bin is filled to a specific depth depending upon seed moisture, the drying unit and bin sizes. After drying this seed to safe moisture level for storage, next level is added. The diameter of the bin will range from 21 to 40 ft. and requires 5 to 20 HP motors. It is most efficient but slow drying method. The seed is uniformly dried between the top and bottom of the bin.
2. **Batch in bin dryer**: In this type the high moisture seed is loaded in the drying bin. The seed is dried to safe moisture level, cooled and removed to storage bin. The drying equipment used is similar to that of layer drying but requires high capacity of heater and fan. Seed depths are typically 2.5 to 4.0 ft. the deeper the seed depth lower is airflow and slow is the drying process.
3. **Batch Dryer**: These are bins with inner air chamber (plenum) surrounded by two parallel perforated steel walls to contain a desired thickness of seed. The fan heater unit is connected to one end or side of the plenum as heated air for drying and natural air for cooling can be forced through the seed. Batch dryers are generally rectangular or cylindrical. Fan power ranges from 3 to 40 HP. The number of batches per day may be 8-10 for small dryers and 2-3 for large units.
4. **Continuous Dryers**: In this method there is a continuous flow of seed through heating and cooling sections. The flow of the seed can be regulated. Heated air is forced through the upper 2/3 or ¾ of the seed column. The dried seed is removed for storage continuously.

Recommended temperature and depth for heated air drying of various crop seeds in bins.

Crop	Max. depth in inches	Recommended drying temperature in ^{o}F
1. Shelled Corn	20	110
2. Wheat	20	110
3. Grain Sorghum	20	110
4. Soybeans	20	110
5. Oats	36	105
6.Rice	18	110
7.Peanuts	60	90

Procedure for heated air drying in bins

1. Put the seed into the bin to the recommended depth and there should be uniform distribution of trash and broken seeds.
2. Operate the dryer at recommended temperature for that seed using a thermostat.
3. When drying is completed, continue blowing air through seed without heat to bring the seed temperature down to air temperature or to 50°F if air temperature is lower. This may require around 30 minutes to 2 hours depending on the quantity being dried and the air temperature.

   The seed must be dried to safe moisture levels as given below.

   Wheat, sorghum and rice to 12 %

   Oats, barley and corn to 13 %

   Soybeans to 11%

Wagon Drying: It is a special type of batch drying with heated air. The seed is directly loaded from a combine into a wagon that is specially built for drying. The wagon is drawn to the dryer and connected to the canvass distribution duct. Three to four wagons can be dried at a time. The heated air is forced through the perforations of the wagon floor for drying the seed. After drying is over it is disconnected from the heating system and the seed is cooled with a small fan of half to three and half HP as required. After cooling the wagons are taken to storage bins. Advantages of wagon drying are

1. Drying is continuous
2. It is versatile
3. Low initial cost
4. Saves on seed handling and
5. Can be used for other purpose

Bag Drying: The drying is carried out in bags when many varieties are to be handled simultaneously or when seed lots are small in size and when the seed is received from the field in jute bags. The drying depth is one sack deep in a typical design of 25-40 cu.m. of air per minute per cu.m. of seed at a static pressure of 3 cm or even less.

Box Drying: It is a modified bag drier. The identity of small seed lots can be maintained despite bulk handling. The boxes are made locally with perforated bottoms. Hot air is forced through the bottoms. After drying the boxes are shifted to storage area.

Management of seed drying operations

1. Dry the seed soon after it is received. If there is any delay aerate the bin by fitting with a fan. Aeration prevents heating of the seed.
2. Care may be taken not to accumulate trash at one place. This problem is more when the seed is discharged through conveyor. Using a spreader can solve it. Small trash has high resistance to sir flow.
3. Observe the temperature in different drying zones. When the temperature of the top layer is equal to incoming air, drying of the entire bin is completed. Moisture content should be tested at random through out the bin to ensure that no wet spots are present. If germination percentage falls 1-2 % during drying check for the following:
    1. Excessive holding time before drying commences
    2. Insufficient air flow
    3. Excessive static pressure
    4. High relative humidity of drying air
    5. Drying air temperature may be more than 43°C
    6. Excessive seed depth
    7. Uneven air flow through the seeds.

Lecture No: 21

Planning, layout and establishment of seed processing plant

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; uniform size grading and seed treatment to upgrade the over all seed quality. 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.

Factors to 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.

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.

a) 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.

b) 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.

c) 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.

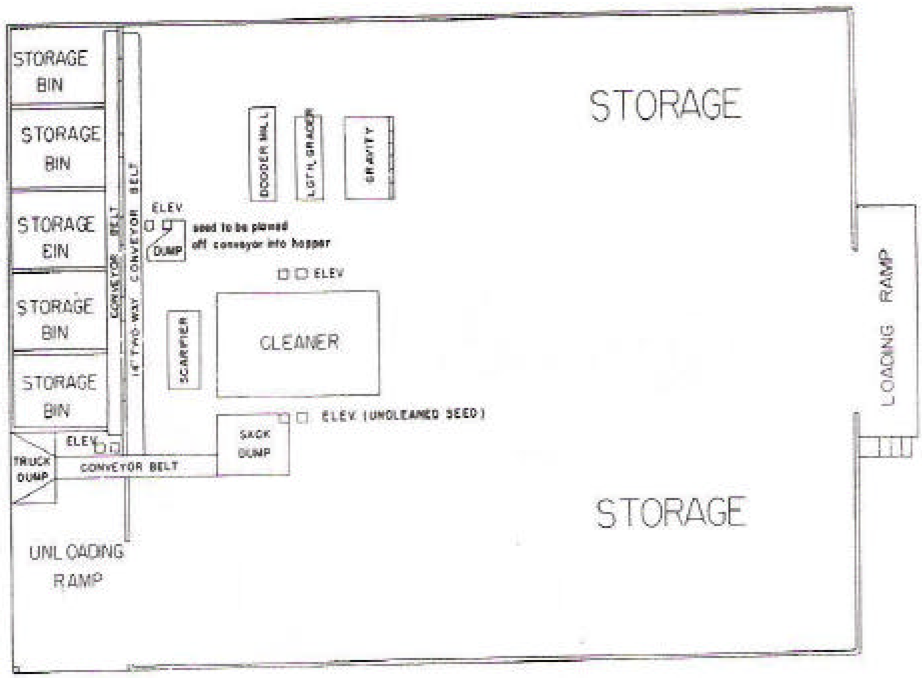
Layout planning today is a science in itself, and is a valuable tool of processing industries, Equipment representatives are often trained in plant layout and the seeds man planning a new plant should take full advantage of their special knowledge.

Design of Seed Processing Plants

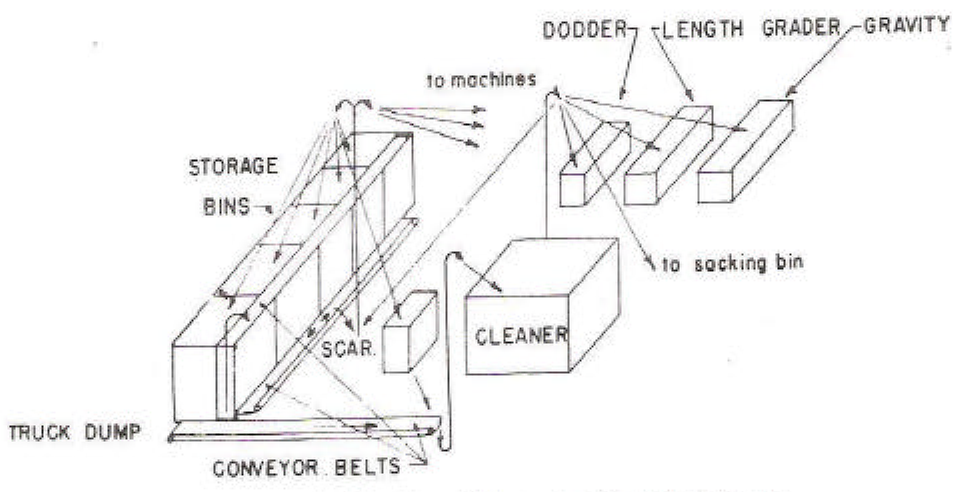
The design and layout of seed processing plants should be carefully planned to ensure that: (1) the seed receives the necessary conditioning in the proper sequence, (2) there are no bottlenecks, (3) operating costs are kept to a minimum, (4) the seeds are not injured from excessive handling, (5) facilities are completely cleanable, and (6) the chance of contamination is kept to a minimum.

If possible, the seed should be elevated only once to overhead storage bins, where it can be held until conditioning. From there it should be allowed to flow by gravity between the various pieces of conditioning equipment. In order to accomplish this, an initial elevation of about 40 to 60 ft is needed. Mistakes is design will require two or more vertical elevations and increase the opportunity for seed injury and seed lot contamination, as well as require extra maintenance.

Shows a suggested design for a seed processing layout that can handle most crops, including small-seeded grasses and legumes. Shows the seque4nce of conditioning operations for cleaning seed of various species.

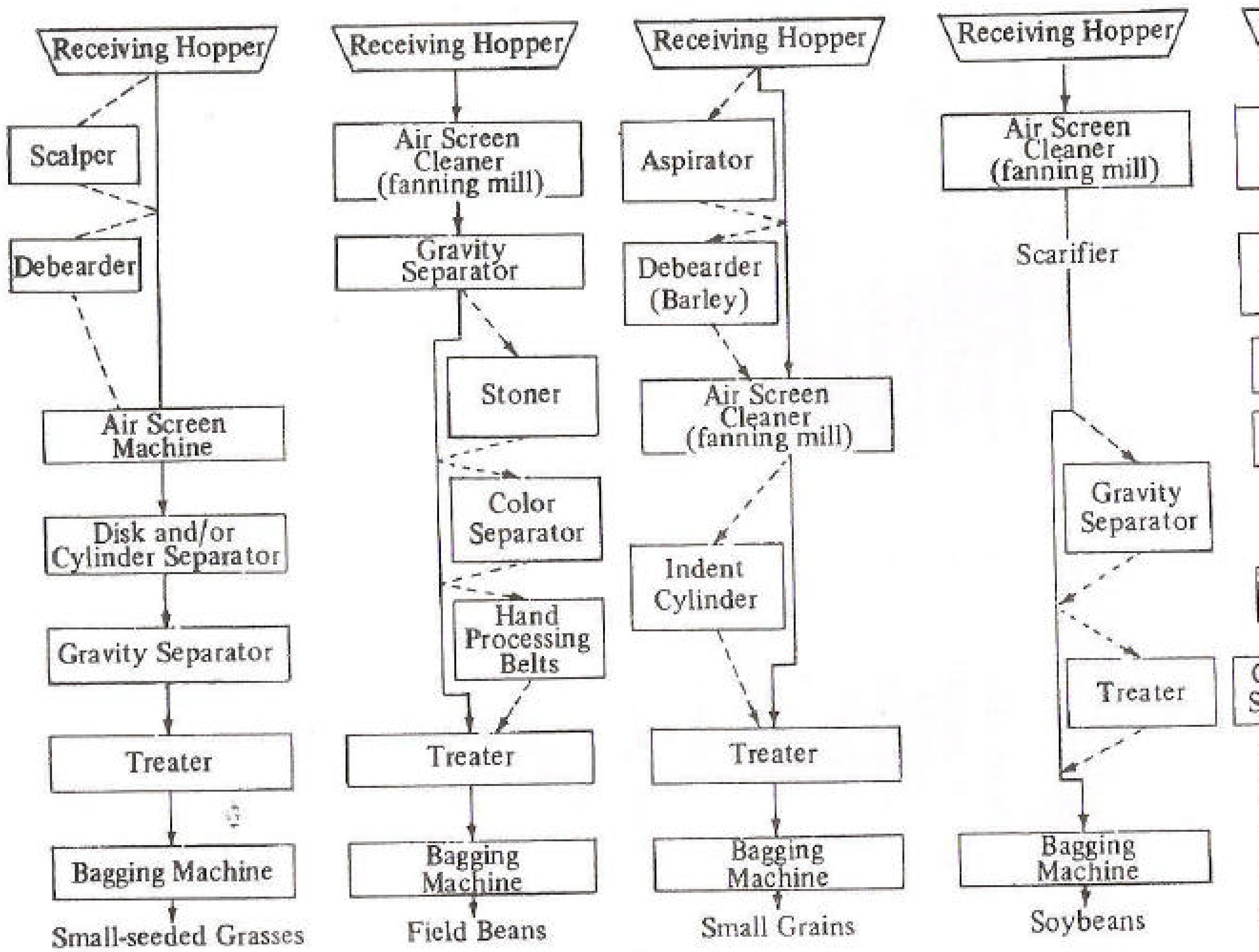


A-Floor plan for seed processing plant



B. – Isometric drawing of flow plan illustrated above.

Layout for a single-story seed processing plant



Suggested sequence for processing seeds for various kinds. Discontinuous lines indicat

Lecture No: 22&23

SEED CLEANING

In seed cleaning the seed is separated from undesirable material (i.e. inert matter, weed seeds, other crop seeds, light and chaffy seeds, deteriorated and broken seeds) on the basis of physical differences like density, surface texture, affinity to liquids and electric conductivity is known as seed cleaning. Physical differences like length, width, shape, weight etc are common in crop species and they form the basis for seed cleaning operations. Cleaning of seeds involves three steps.

1. Pre-cleaning and pre-conditioning

2. Basic cleaning
3. Seed upgrading

1. Pre-cleaning & Pre-conditioning: It refers to the operations such as shelling, debearding etc. that prepares the seed lots for basic cleaning and also for the removal of particles such as trash, stones, clods etc. larger than crop seed. Some pre-cleaners also remove particles that are lighter in weight and smaller in size than the crop seed. Pre-cleaning is not required for hand harvested and winnowed seed lots.

Equipment used for pre-cleaning and pre-conditioning are

1. Scalper or Rough Cleaner
2. Huller Scarifier
3. Debearder
4. Maize Sheller

Scalper or Rough Cleaner: Scalpers are used to remove large trash. They consist of a vibrating screen and the screen perforations are large enough to allow the seeds to pass through and retains the large inert matter on the screen, which is scalped off and removed from the seed lots. The single sieve pre-cleaners are called as scalpers and the multiple sieve units are referred as rough cleaners.

The rough cleaners are the simple air screen seed cleaners that separate large trash over a large hole screen and separation of small foreign material through a small hole screen. Most scalpers are arranged to make the air separation before the seed reach the screen.

Huller – Scarifier: Huller is a device to remove husk or outer seed coat. Scarifier scratches the seed coat. These usually abrade the seeds between two rubber-faced surfaces or impel the seeds against rough surfaces such as sandpaper. In a huller scarifier, the seed falls from the feed hopper on to a rotating disc, where they are thrown against the hulling and scarifying surface by centrifugal force either once or twice and the seed is hulled or scarified to the desired extent. After this operation the seeds are moved into a suction chamber where the suction removes the light, fine dust and the seed is discharged at the bottom of the chamber. The severity of aberration or impact can be controlled accurately to prevent damage.

Hulling (removal of an outer coat or husk) and scarification (scratching of the seed coat) can be done separately or jointly with a huller scarifier.

Debearder: The Debearder removes the hair like structures present on the seeds. The Debearder machine has a horizontal beater with arms rotating inside a steel drum. The machine rubs the seeds against the arms and against each other. The degree of action is determined by the processing time, beater clearance and beater speed.

Maize Sheller: The size of maize sheller's vary from small hand operated ones to large motor driven shellers. Hand operated maize sheller are used for shelling small seed lots like breeders seed and nucleus seed, while the Power operated maize shellers are used for high capacity shelling specially for foundation seed lots and certified seed lots.

2. Basic Seed Cleaning: It refers to actual cleaning and grading of seeds and is essential process in seed cleaning operation. The basic seed cleaning is done over an air screen machine commonly referred to as an air screen cleaner. It is the basic equipment in all seed processing plants.

Air Screen Machine

Principle: The separation of undesirable material from seed is done on the basis of differences in seed size and weight. The air screen machine uses three cleaning elements:

1. **Aspiration**: the light seed and chaffy material is removed from the seed mass through aspiration.
2. **Scalping**: Good seed are dropped through screen openings but large material (trash, clods etc.) are scalped off over the screen into a separate spout.
3. **Grading**: The good seed ride over the screen openings, while smaller particles (undersized, weed seeds, shriveled) drop through the screen perforations.

Parts of air screen cleaner:

1.Feed hopper: It consists of a container to receive the seed, hopper flights and augers to spread the seed across the width of the hopper and a feed control at the bottom of the hopper for steady flow of the seeds.

2. Screens: screens perform both scalping and grading operations. They separate crop seed from foreign material, other crop seeds and weed seeds. Screens are constructed of either perforated metal sheet or wire mesh. The openings in the perforated metal sheet may be rounding, oblong or triangular. Openings in wire mesh screens are square or rectangular.

3. Clay crushing rolls: these are installed to crush clay lumps without damaging the seed. These are two rubber rolls made of hard rubber to crush clay lumps without damaging the seed. The rolls are adjustable to various opening width or they be left apart when not needed.

4. Brushes: Brushes are used to clean the screens and they travel back and forth under each screen. Cleaning efficiency is directly related to the percentage of the perforations that remain open.

5. Tappers or screen knockers: These are used over scalping screens to keep them clean.

6. Shoes: the vibrating or shaking sections of the machines into which the screens are fitted are called shoes. A shoe contains fittings of two screens one for scalping and the other for grading.

7. Eccentrics: the device used for shaking the shoes is called eccentrics.

8. Fans: Number of fans range form one in small cleaners to four in large cleaners. But most of them have two air systems, which are called as upper and lower air systems. The upper air systems removes light chaffy and dust from the seed before they reach the first screen. The lower air blast removes light seed and trash not removed by the upper air or screen.

9. Air Chest: Air passageways from the fans are connected to air chamber, which allow the material lifted by the air stream to settle. This is done by decreasing the air velocity as it passes through air chest or air chamber. The lifted material settles down by gravity and is spouted out of the air chest.

Principle of Operation of air screen machine:

1. The air blast removes lightweight seed and chaffy seed.
2. Scalping screen removes material larger than the crop seed.
3. Grading screen drop out material smaller than crop seed.
4. Eccentrics do the shaking motions of the screens.
5. The two shoes in 4 screen cleaner move in opposite direction to balance each other also to reduce machine vibrations to minimum.
6. In four screen cleaner, the screens do the following

   First screen does scalping
   Second screen does grading
   Third screen does close scalping
   Fourth screen does close grading

The seed to be cleaned is fed from the feed hopper which passes through the upper air which removes light seed, chaffy seed and dust particles. The top screen is used for rough scalping. Its perforations are large enough so that good seeds will be dropped through screen perforations and material bigger than seed like trash, stems, sticks, mud particles etc. are scalped off on the screen.

The second screen is used for grading. Its perforations are smaller than the seed size so that good seeds are retained on the screen and small dust particles, inert matter and weed seeds drop through the perforations and are separated.

The third screen is used for close scalping and fourth screen is used for final close grading. The fourth screen has perforations slightly larger than those in second screen. Seed or other material which is smaller than crop seed but not removed in second screen are removed here.

As the crop seed is dropped from fourth screen, they fall through the lower air separation. This air removes light seed and trash, which was not removed by the upper air and the screens. For efficient cleaning the lower air blast should be strong enough to blow out a few good seed.

Upgrading the quality of cleaned seed

In certain instances it is necessary to remove specific contaminants by precise size grading. The various processing operations conducted after basic cleaning to further improve seed quality are regarded as upgrading operations. The choice of upgrading operations however shall depend upon the type of contaminants and crop seed. The various types of upgrading operation equipment, their principle of operation and specific uses are given below:

Type of upgrading Operations & types of Machines	Principle of operation of the equipment	Uses of the machine
1. **Sizing and Grading**		
a. Width and Thickness sizing and grading 1. Horizontal flat screen separator eg. Clipper corn sizer, superior cork-it-corn grader 2. Vertical ribbed screen separator eg. Dockins seed grader	These machines make extremely sensitive separations on the basis of differences in width and thickness. The seeds are sized for width by using round hole screen openings and for thickness by using slotted screen openings. The separators employ gravity, centrifugal force, product pressure or a combination of these forces to make the separation.	1. Removal of splits from soybeans, peanuts etc. 2. The removal of chips and splits from sorghum seeds. 3. Removal of cheat from wheat. 4. Removal of cockleburs from cotton seed, wild onion from fescue, and wild oats from

3. Cylindrical screen separator		barley.
b. Length sizing and grading	Seeds are separated on pure length basis	1. removal of weed seeds 2. cross broken crop seeds 3. to upgrade general appearance 4. Size grade for precision planting.
1. disc Separator	In disc separator the disc lift uniformly shaped and sized and under sized particles out of a mass of seed. The separation is not effected by seed coat texture, weight or moisture content.	
2. Cylinder separator	The cylinder separator operates on a centrifugal force principle in which the speed of the cylinder holds seed in the indents, lifting them out of the mass until the indents are inverted to the point where gravity causes the particles to fall. Shape and size of the indents and seed, seed coat texture moisture content and weight of seed all combine to affect seed separation.	
2. Gravity or Weight separations		
1. Gravity separator	The gravity separator employs a flotation principle. In this separation seeds are vertically stratified in layers on the deck according to density. Seeds of same size are stratified and separated by differences in their specific gravity. The oscillating movement of the table walks the heavy seeds in contact with the deck uphill while the air floats the light seeds downhill. The seeds travelling to the edge of the table range from light at the lower end to heavy at the upper end. The discharge can be divided into any number of density fractions.	1. Removal of badly deteriorated diseased seed and insect damaged seed. 2. Removal of empty or sterile seed. 3. Removal of soil particles and gravel and send mixed with certain kind of seeds. 4. Removal of contaminating crop or weed seed.
2.Stoners	It is a modified gravity separator designated to make two parts of separations by differences in gravity.	Removal of heavy inert material from a larger volume of seed.
3. Air separations		
1. Pneumatic Separator	It uses the movement of air to divide seeds according to their terminal velocities. Terminal velocity refers to	1. general cleaning 2. close grading 3. Specific separation.

	the velocity of air required to suspend particles in a rising air current. Many factors such as density shape and surface and texture effect resistance of a particle to airflow. When the seed is introduced into an air stream all the particles with lightweight are lifted by the velocity of the air, while the seeds with heavy weight fall below. In pneumatic air separator the air is blown through the fan which lifts the light material and the seeds which are light in weight.	
2.Aspirator	In aspirator the fan is at discharge end and induces a vacuum, which allows the atmospheric pressure to force air through the separator.	
3. Fractional Aspirator	In fractional aspirator when a seed mixture is introduced into the lower end of an expanding air column, heavy seeds fall against the airflow and light seeds are lifted. Air velocity through the expanding columns lessens and gradually drops out seeds with lower terminal velocities. Each outlet along the column receives a lighter fraction of seeds the mixture is thereby separated into several grades.	
4. Surface Texture Separation		
1.Roll Mill	The velvet roll mill classifies seeds according to a difference in texture of seed coat. When a seed mixture is fed on to the upper end of the rolls, the smooth seeds travel down hill between them and are discharged at the lower end. Rough-coated seeds caught in the velvet take a bouncing path between shield and rolls and are thrown over sides. The discharge from the sides of the rolls is caught is several directions. The roughest seeds are ejected first.	Separation of smooth clover seeds eg. From rough seed coats, seeds with irregular shape, wrinkle or shriveled seeds, broken, clipped or damaged seeds rough or irregular shaped inert material.
2. Magnetic separator	Magnetic superiors take advantage of the surface texture and stickiness of seed to make a separation. A seed mixture and proportionate amount of water and finely ground iron powder are mixed in a screw conveyor or other	

	mixing device. In the presence of moisture, the iron powder will adhere to rough cracked and sticky seeds. When the mixture is fed to the top of a horizontal revolving magnetic drum smooth or sticky seeds that are relatively free of iron powder all from the drum, while the rough textured seeds with iron powder stick to the drum until they are removed by a rotary brush.	
3.Inclined Draper	The inclined draper separator senses differences in shape and surface texture to separate seed on an inclined plane. A mixture to be separated is metered on to the center of an inclined draper belt travelling in an uphill direction. Round or smooth seeds, which roll or slide down the draper, faster than the draper travelling upwards. Flat or rough-coated seeds are carried to the top of the inclined plane and dropped into a separate hopper.	Separation of smooth or round seeds from rough, flat or elongated seed.

5.**Electronic separation**

Electric color sorters	The electric color sorter separates the seeds on the basis of difference in color brightness. One type of machine picks up the seeds on a series of suction fingers and carries them to a phototube where they are judged for colour brightness and ejected into separate containers one at a time.	Separation of off coloured seeds

6. Other Separators

1.Spiral separator	The spiral separator makes a division of seed according to shape or the degree of its ability to roll. The separator resembles a stationary open screw conveyor standing on end. The mixture fed onto the spiral at the top, slides or rolls down the inclined surface. The fast rolling seeds gain speed and are thrown by centrifugal force into an outer housing, which directs them to a chute below. The slow rolling seeds remain on the inner inclined surface and enter a second chute at the bottom.	Separation of rape and soybean seeds from wheat, oat and rye grass. Similarly separation of flat and wrinkled seed of soybean from smooth seed.

2.Polishers	Polishers use a polishing agent such as sawdust or bran to remove discoloration. In some of the polishers mild mechanical rubbing action is provided.	To improve the lusture of the seeds. Eg. Beans peas, popcorn etc.
3.Picker belts	Separations that cannot be made by machines may be made by hand on hand picker belts. The maize cobs are fed on one end of the moving belt. Operators examine the cobs and that which are of offtypes are removed by hand.	Removal of undesirable ears of corn, pods from shelled peanuts and other specific contaminants.

Lecture No: 24

SEED TREATMENT

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

Benefits of seed treatment:

1. Prevention of spread of plant diseases both systemic and non-systemic. Seed treatments is effective in controlling systemic diseases like smut of wheat, Helminthosporium blight of barley, loose and covered smuts of oats etc.

   Non systemic diseases that infect seed during harvest or storage period such as Fusorium with blight of barley oats, rice, sorghum etc can be effectively controlled by appropriate seed treatment.
2. Seed treatment protects seed from seed rot and seedling blights. Once the seed is planted the protective coating around the seed, acts as a barrier against seed borne and soil borne organisms.
3. Improves germination – Seed treatment improves the germination through the control of surface moulds and flora, which are not pathogenic but may infect the seed during moist harvesting and storage condition. In the germination test thus may kill or cover the seed before it has germinated.
4. Provides protection from storage insects and pests. For complete protection it is necessary to treat the seeds with insecticide also.

Types of seed treatment

1. **Seed disinfection**: It refers to eradication of fungal spores present within the seed coat or more deep seated tissues. For effective control the fungicide must penetrate into the seed to kill the fungus.
2. **Seed disinfestations**: It refers to the destruction of surface borne organisms that contaminated the seed surface but not infected the seed. Chemical dips, soaks, fungicides applied as dust, slurry or liquids have been found successful.
3. **Seed protection**: To protect the seed and young seedling from organisms in the soil which might otherwise cause delay of the seed before germination.

Conditions under which seed must be treated

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

1. **Diseased seeds**: Seed may be infected by disease organisms at the time of harvest or during processing in storage.
2. **Undesirable soil conditions**: Seeds are sometimes planted under unfavourable soil conditions such as cold and damp soils, which favours the growth and development of certain spores enabling them to attack and damage the seeds.
3. **Disease free seed**: Seed treatment provides a good insurable against diseases, soil borne organisms and thus protects weak seeds enabling them to germinate and provide seedlings.

Chemicals used for Seed treatment

A) Mercurial Compounds

1. **Organo mercurials** – used for small grains, flax cotton, and safflower. Proper dosage is critical over dosage results in seed injuring and under dosage fails to control the disease.

   Eg: Phenyl Mercuric acetate (PMA) Methoxy ethyl Mercury chloride (MEMC)
   Ethyl Mercuric chloride (EMC)
2. **Inorganic mercurials**: Are limited to mercuric chloride, mercurious chloride and mercuric oxide. These materials are used to treat the seeds, roots, tubers and vegetable crops.

B) Non Mercurials

1. **Organic Non Mercurials**: such as thiram and captan are widely used. They are less effective than the organic mercurials less damaging to the seeds and less dangerous to the persons handling the seeds. These fungicides act as seed disinfestants and or seed protectants. Over dosage is not harmful and viability is not effected.

   Eg: Thiram, Captan, Carbendazim, Metalaxyl.

2. **Inorganic Non Mercurials**: Copper carbonate, Copper sulphate, Cuprous oxide are the major inorganic Non Mercuric compounds used as fungicides. Copper carbonate and Copper sulphate are used on wheat for prevention of bunt diseases. Cuprous oxide prevents seed decay and damping of in vegetables.

Insecticides: These are used individually or in combination with fungicides

Equipment for seed treatment:

1. Slurry treater
2. Direct treaters
   a. Panogen
   b. Mist-O-Matic treater
3. Drum mixer
4. Grain auger
5. Shovel.

1. **Slurry treater**: A slurry is prepared by mixing the chemical with water. The treatment material to be applied as slurry is accurately measured through a simple mechanism compised 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 the seeds are mixed thoroughly.
2. **Direct treater**: These are the recent ones and include panogen and Mist-O-Matic treater. Of these the Misto-O-Matic treaters are widely used.

   The Misto-O-Matic treater applies the chemical in the form of a mist directly to the

3. **Drum Mixer**: A simple mixer can be made by running a pipe through a drum at an angle. The drum is then mounted onto a stand. The seed and

treatment are placed in the drum and it is rotated slowly until all the seeds are corned with the chemical.

4. **Grain Auger**: Liquid materials can be dripped on the seed as they enter a grain auger or straw conveyer. By the time seeds have left the auger the chemical is spread on the seeds.
5. **Shovel**: Seeds are spread on a clean dry surface 10-15cm in depth. The proper amount of chemical is diluted with water and sprinkled over the seed. Mixing is done with shovel or sloop turning the seed atleast 20 times.

Precautions in seed treatment:

1. Extreme care is required to ensure that the treated seed is never used for animal or human consumption.
2. Care must be taken to treat the seeds at correct dosage.
3. Do not treat the seed with high moisture content as it may be injured when treated with some of the concentrated liquid products.

Coloring of Seeds

Most seeds treatments contain dyes, and some companies add their own 'colour brand' dye to seed treatments. Dyes serve two purposes.

1. As a warning that the seeds have been treated to prevent inadvertent contamination of food or feed; and
2. As a visible means of evaluating the completeness of treatment coverage.

The dyes, if used for treating formulation of dry seed, are mixed with fungicide and insecticide treatment

Causes of Poor Treatments

1. **Wrong fungicides.** Use of inappropriate fungicides, old dusts, etc., may prove relatively ineffective for protection against soil fungi.
2. **Inadequate dosages.** Failure to get sufficient fungicide on the seed results in poor seed treatment.
3. **Carelessness.** The use of the best available fungicides and the latest equipment for treating seeds does not by itself guarantee proper seed treatment. Adequate care is necessary regarding machine adjustments, etc., to treat seeds effectively.

Lecture No: 25

SEED PACKING AND HANDLING

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

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

Equipment Used for Packaging of Seeds

A) Bagging

(i) Bagger–weigher: These are small machines which, when properly mounted beneath a bin, will fill and weigh a bag accurately in a single operation. Operational steps include.

a) The empty bag is suspended on the bagger weigher by a bag clamp.
b) Seed flow into the bag is begun, usually by a trip lever
c) As seed flows into the suspended bag, a scale-type counter-balance mechanism is actuated, so that when the proper weight of seed is in the bag, the seed flow lever is tripped and seed flow is automatically stopped.
d) The bag now filled with the exact weight of seed is removed from the bagger weigher and is closed.

Bagger weigher and bagging scales used in seed packaging may be manual, semi-automatic or automatic.

Manual weighing: This type of scale, usually a portable platform, is considered inefficient for volume weighing operations because of high labour requirements and relatively low capacity, in terms of bags filled per minute. With this scale, bags are filled to approximate weight, placed on the scale and then 'even weighed' with a hand scoop. These scales are useful in following conditions.

a) Weighing bags of non-free flowing seeds.
b) A bagging bin is not available
c) Labour costs are minimal.

Semi-automatic: This is the most widely used scale. The scale is attached to the bottom of a bagging bin, and the bag is clamped to the bottom of the scale. The feed gate is opened manually and may be closed either manually or automatically when the proper weight is attained. The scales have a capacity of weight four to eight bags of 50 kg per minute, depending upon the seed being packaged and the skill of the operators.

When selecting a scale of this type, the circumference and composition of bags or containers must be considered. The orifice, or the bag clamp, must be smaller than the open end of the bag. However, too small an orifice and clamp will result in seed spilling around the edge of the bag. The bag clamps hold bag materials of specific finish and thickness, therefore, the composition of the bagging material, this is, jute, cloth, plastic, paper, etc., should be stated when ordering the scale.

Automatic scales: Scales of this type are used primarily for small packages, e.g., vegetable and lawn seeds. In these machines the entire weighing and filling process is done automatically. Installation is similar to the semi-automatic bagger. Some completely automated systems pick up the empty bag; place it on a bagger, fill the bag and release the filled bag which then moves by conveyer to a bag closer.

Regardless of the types of scales used, they should be checked regularly to determine their accuracy, particularly if they are portable. Frequent and careful cleaning of the weighing mechanism will decrease the number of inaccurate weighings and extend the life of the scale.

Platform scales: Lorry weigh-bridges are used primarily for weighing heavy loads of incoming seed received on trucks, trailers or wagons. Seed normally received in bags, boxes or other containers can be handled by fork-lift trucks, or by hand, when a platform scale is available.

Most processing plants also use at least one small portable platform scale for weighing a small lot of seed, chemicals used in treaters, partially filled containers, and other materials weighing up to two hundred kilograms.

(ii) Bag sewing machine: After an open-mouth bag is filled, the bag top must be sewed with a bag sewing machine. Bag sewing machines are precision, high speed machines and must be operated and maintained properly to prevent frequent break-downs and a short operating life. For proper operation, the bag sewing machine must be.

1. Operated only by carefully trained personnel
2. Equipped with thread of proper size
3. Allowed to sew across the top of the bag at a speed equal to the speed at which the sewing foot feeds the bag through the machine. Forcing the sewing machine across the bag too rapidly, or dragging the sewing machine across the top of the bag too slowly, always, causes trouble.
4. Started into the bag on the side opposite the bag seam, to prevent jamming.
5. Operated with the proper thread tension to insure the correct stitch.
6. Operated with a smooth and properly adjusted looper. Knots of thread should never be removed from the looper with a sharp pointed or sharp edged instrument; this may scratch the looper and cause thread cutting.
7. Kept well-oiled and clean. At frequent intervals the entire neck of the bag sewing should be dipped into and run for a few seconds in a 50-50 mixture of kerosene and light motor oil. This oils the sewing machine removes dust and collected trash.
8. Prevented form striking a seed as the bag is sewn shut.

For most effective operation, the bag sewing machine should not be moved from bag to bag. The sewing machine should be suspended by a cord so that operator can work it with maximum ease. Bags should be moved past the sewing station on a slow moving conveyor which moves at the proper speed for the feeding foot of the bag sewing machine. Seed packed in plastic bags are closed with a heat sealer.

B) Handling

Several types of conveyors are available for moving unpacked or packed seed into, through or away from processing plant in vertical, horizontal or inclined directions. Different types of conveyors are used in processing plants, e.g., bucket elevators, belt conveyors, vibrating conveyors, pneumatic conveyors, screw conveyors, chain conveyors and lift trucks. Selection of the proper type of conveyors, for each operation receiving seed in the plant, moving seed from dryers, shellers and from one processing machine to another and finally moving packaged seed into storage, has an important bearing on the efficiency of processing operations. Conveyors should be selected on the basis of the kinds of seeds handled, direction and length of conveying, capacity of equipment from which or to which seeds are conveyed and should be properly cleaned.

Packaging Material:

The choice of packaging materials and amount of seeds to be packed depend on kind of seeds to be packed, duration of storage, storage environment, the seed moisture content, the cost of seed, the cost of packaging material, the geographical area where the seeds will be stored.

Types of packaging material:

1. Moisture vapour permeable container, e.g., jute (burlap) bag, cloth bag paper bag, multiwall paper bag :
2. Moisture vapour resistant container, e.g., jute bag laminated with thin polythene film : and
3. Moisture vapour proof container, e.g., tin can, polythene bags, aluminimum foil pouches, glass bottles.

The packaging materials should protect most physical qualities of seed and should have sufficient tensile strength, bursting strength and tearing resistance to withstand the handling stresses. Such materials may not always protect the seeds against either insect pests or moisture regain.

Lecture No: 26

Seed Storage

Seeds are uniquely equipped to survive, as viable regenerative organisms until the time and place are right for the beginning of a new generation. However like other form of life, they cannot retain their viability indefinitely and eventually deteriorate and die. Fortunately neither nature nor agricultural practice ordinarily requires seeds to survive longer than the next growing season, though the seeds of most species are able to survive much longer under the proper conditions.

Depending on the longevity of seeds during storage, seeds can be divided into two categories;

1. **Orthodox Seeds** : Orthodox seeds are long-lived seeds. They can be succe3ssfully dried to moisture contents as low as 5% without injury and are able to tolerate freezing temperatures. Most orthodox seeds come from annual temperate species adapted to open fields. At physiological maturity they contain moisture content of 30 – 50%.
2. **Recalcitrant Seeds** : They are short-lived seeds, which cannot be dried to moisture contents below 30% without injury and are unable to tolerate freezing. They are

difficult to store successfully because of their high moisture content encourages microbial contamination and results in more rapid seed deterioration. Storage of these seeds at subzero temperatures causes the formation of ice crystals, which disrupts cell membranes and causes freezing injury. These seeds are from perennial trees in the moist tropics such as coconut, coffee, cacao, citrus etc. These seeds mature and exists in their fruits and are covered with fleshy or juicy ariloid layers and impermeable testa. At physiological maturity they contain more moisture content (50-70%) than orthodox seeds, even though their embryos are only about 15 % of the size of an orthodox seed embryo. In general recalcitrant seeds never go into dormancy but instead continue their development and progress towards germination.

Most attempts at storing these seeds have focussed on using endogenous seed inhibitors such as absisic acid or replacing the high water content with other substances such as sugar or ethylene glycol to permit successful storage even under low temperature without inducing ice-crystal formation and subsequent seed damage.

Factors influencing the life span of seeds

1. Genetic factors : Seeds of some species are genetically and chemically equipped for longer storability than other under comparable conditions. Most long-lived seeds belong to species possessing hard, impermeable seed coat. Generally seed species possessing high oil content do not store well as those with low oil content. Quantity of oil present in embryo portion of seed is responsible for storability. For eg. Whole seeds contain only about 3 % oil, but their embryo portion has about 27% oil.

Seeds of different species may also be chemically similar but have greatly different storability due to differences in genetic potential. For eg. Chewing fescue and annual ryegrass seeds are similar in appearance and chemical composition, how ryegrass seeds have much better storability under comparable conditions. These genetic factors affect seed storability and have led to classify the seeds based on their relative storability.

Differences in seed storability may also occur among cultivars. Some cultivars store long than others. Some inbred lines of maize have shown to germinate 90% after 12 years of storage while others were completely dead at the same storage period. Inheritance clearly exerts a marked effect on seed longevity. Environment strongly alters the genetic potential for seed longevity.

2. Initial seed Quality: The physical condition and physiological state of seeds greatly influence their life span. Seeds that have been broken, cracked deteriorate more rapidly than undamaged seeds. Several kinds of environmental stresses during seed development and prior to physiological maturity can reduce the longevity of seeds. For example deficiency of minerals (N,K,Ca), water and temperature extremes. Immature small seeds within a seed lot do not store as well as mature and large seeds within a seed lot. Hard seediness also extends seed longevity.

3. Seed Moisture: Moisture content of the seed is one of the important factors influencing the viability of seed during storage. Over the moisture range, the rate of deterioration increases with increase in moisture. In general for every 1% decrease in moisture the store potential of the seed doubles (when the seed moisture is in the range of 4 – 14%). If the seed moisture content is in the range of 12-14 %, losses occur due to increases mould growth and if the moisture content is above 18-20% due to heating of the seed. Moreover within the normal range, biological activity of seeds, insects and moulds further increases as the temperature increases. The higher the moisture content of seeds the more they are adversely affected by both upper and lower ranges of temperature. At very low moisture content of 4 per cent seeds may be damaged due to extreme desiccation, or breakdown of membrane structure hastens deterioration. This probably a consequence of reorientation of hydrophilic cells membranes due to loss of water molecules necessary to retain their configuration.

Since the life span of seeds largely depends on the moisture content it is necessary to dry it to safe moisture limits before storage. However the safe moisture content again depends on length of storage, type of storage structure and kind of the seeds to be stored. For cereals in ordinary storage conditions for 12-18 months the seeds should be dried to 10 – 12 % moisture content. However for storage in sealed containers (Hermetic packing) the seeds should be dried to 5 to 8 per cent moisture content.

4. Relative humidity and Temperature: the most important factors that influence the life span of seeds are relative humidity and temperature. The effects of R.H. and temperature of the storage environment are highly interdependent. Most crop seeds loose their viability at R.H. approaching 80% and temperatures of 25-30^{o}C but can be kept for 10 years or longer at R.H. of 50 % or less and a temperature of 5^{o}C to lower (Toole 1950).

According to Harrington, 1973 because of interdependency the sum of the percentage of RH plus temperature in ^{o}F should not exceed 100 for safe storage. Harrington suggested the following thumb rules regarding optimum storage conditions.

1. For every 1% reduction in seed moisture the storage life of seed doubles
2. For every 10^{o}F reduction in temperature doubles the life span of the seed
3. The sum of relative humidity in percentage and temperature in ^{o}F should not exceed 100.

The thumb rule applies to only when the seed moisture is in-between 4 and 14 %.

5. Provenance: It has already been stated that a number of factors operating before and during harvest can affect seed viability. The samples obtained from different sources may show differences in viability behavior. The seeds harvested from regions of high relative humidity and temperature at the time of maturation or harvesting store less than the seed harvested from the regions of low relative humidity with moderate temperature.

6. Pre and post harvest conditions: Environmental variations during seed development usually has little effect on the viability of seeds, unless the ripening process is interrupted by premature harvesting, weathering of maturing seeds in the field, particularly in conditions of excess moisture or freezing temperature results in a product with inferior storage potential. Mechanical damage inflicted during harvesting can severely reduce the viability of some seeds eg. Certain large seeded legumes. Cereals are largely immune from mechanical injury presumably because of the protective lemma and palea. Small seeds tend to escape the injury during harvest and seeds that are spherical tend to suffer less damage than do elongated or irregularly shaped ones. During storage injured or deeply buried areas may serve as centers for infection and result in accelerated deterioration. Injuries close to vital parts of the embryonic axis or near the point of attachment of cotyledons to the axis usually bring about the most rapid losses of viability. High temperatures during drying or drying too quickly or excessively can dramatically reduce viability.

7. Oxygen Pressure during storage: Increase in oxygen pressure during storage tends to decrease the period of viability. Use of antioxidants has increased the storage period in some of the crops. If seeds are not maintained in hermetic storage at low moisture contents or even under conditions of constant temperatures and moisture the gaseous environment may change as a result of respiratory activity of the seeds and associated microflora.

8. Effect of storage conditions on the activity of organisms associated with seeds in storage: There are six main types of organisms associated with seeds in storage. They are bacteria, fungi, mites, insects, rodents and birds.

Bacteria : Bacteria probably do not play a significant role in seed deterioration. As germination is rarely reduced unless infection has progressed beyond the point of decay. Since bacterial populations require free water to grow, they cannot grow in stored seeds as the seeds are dry.

Fungi: Two types of fungi invade the seeds; field fungi and storage fungi. The field fungi invade seeds during their development on plants in the field or following harvesting while the plants are standing in the field.they cannot invade seeds during storage. Field fungi associated with wheat or barley in the field are *Alternaria, Fusarium, and Helminthosporium* spp.

Storage fungi, mostly belong to the genera Aspergillus and penicillium. They infect seeds only under storage conditions and are never present before, even in seeds of plants left standing in the field after harvesting. Major deleterious effects of storage fungi are to decrease viability, cause discoloration, produce mycotoxins, cause excessive heat and develop mustiness and caking

Insects and Mites: Deterioration of seeds by insects and mites is a serious problem, particularly in warm and humid climates. Weevils, flour beetles or borers are rarely active below 8% moisture content and 18-20 ^{o}C, but are increasingly destructive as the moisture content rises to 15% and the temperature to 30 – 35^{o}C. Mites do not thrive below 60% RH, although they have temperature tolerance that extents close to freezing. Hence for protecting the seeds from insects and mites the seeds should be stored at a moisture content of less than 10%, at a temperature of less than 20oCand the R.H. of less than 60%.

Rodents and Birds: Birds are constant source of seed loss in even small openings exists. All openings should be sealed or screened, if needed for ventilation. Rats and other rodents are more serious problems. Rodents may result into a complete loss of seed. Rodents can be prevented from entering the store by elevating the floor by 90 cm above the ground level, and it should have a lip like structure of 15 cm around the building at 90 cm level. A removable deck should be provided at the entrance for loading and unloading of seeds into the store.

9. Other factors: Besides the above factors storage life is affected by number of times and kind of fumigation, effect of seed treatment etc.

General principles of seed storage

1. Seed storage conditions should be dry and cool
2. Effective control of storage pests
3. Proper sanitation in seed stores
4. Before placing seeds into storage they should be dried to safe moisture limits, appropriate for storage system.
5. Store only high quality seed i.e. seeds which are well cleaned, treated, with high germination and vigour.
6. Determine seed storage needs in view of period or length of storage time and preveling climate of the area during storage period.

Long-term storage requires more exacting conditions of seed storage than short-term storage. Similarly, the regions with favourable storage climate, i.e., one where relative humidity is rather low, require less sophistication than areas of high relative humidity.

Lecture No: 27

Seed Marketing – Marketing Structure & Organization

Seed marketing is one of the most vital components of seed technology. On it depends the size and scope of the seed industry. Broadly, it includes such activities as production, processing, storage, quality control and marketing of seeds. In the narrow sense, however seed marketing refers to the actual acquisition and selling of packed seeds, intermediate storage, delivery and sales promotional activities. In the present context, our discussion is limited to seed marketing in the narrow sense,

Seed marketing comprises the following:

1. Demand forecasts (assessment of effective demand);
2. Marketing structure;
3. Arrangements for storage of seeds;
4. Sales promotional activities;
5. Post-sales service; and
6. Economics of seed production and seed pricing.

Demand Forecasts

The assessment of effective seed requirements is critical to any planned seed programme. The underlying principle in making demand forecasts should be that the seed supply keeps pace with seed demand (both present and future) in terms of quantity, quality, price, place and time. The outcome of such an approach would be planned seed production and marketing. It would also avoid shortages and gluts and as well ensure stable prices and profits.

In making demand forecasts, the following factors must be considered carefully.

(a) Total cultivated acreage, seed rate, quality replacement period and assessment of total potential seed requirement of each of the important crops.

(b) Impact of extension efforts on the introduction of improved production techniques, and future plans for promotion.

(c) Current acreage under high yielding varieties and amount of seed sold in the last year.

(d) Cultivator preferences for varieties, package size, kind of packing, quality and price.

(e) Number and size of competitors.

(f) Kinds of publicity and sales promotion that are most effective.

(g) Climate of the area where seed is being marketed.

Assessment of potential effective seed demand of the market, based on total seed requirements is of very little value, since the demand for high quality seed normally exists for the crop area which is under good fertility and irrigated conditions. The requirements for the remaining crop area are covered by uncontrolled production material obtained from the previous crop production. Furthermore, experience shows that the varietal purity and the yield potential of high quality seed of the self-pollinating varieties can be maintained by farmers during the reproduction process, without significant deterioration for three to four generations. Therefore, individual farmers only need to replace seed of self-pollinating varieties every third or fourth year. Thus, the demand for high quality seed of self-pollinated crops is normally not higher than 25 to 30 per cent of the total requirement for areas under irrigated, and high fertility conditions. However there could be some exceptions, *e.g.,* if the climate of the region is not suitable for retaining viability of seed from the previous crop production. The farmers of such areas, if properly trained, can buy high quality seed each year, even of self-pollinated crops.

A rather different approach must be taken in the marketing of hybrid seeds, in which case new seed is needed by the farmer each season. Although, the critical period may be rather difficult, the subsequent planning is easier, particularly after sale statistics are seen to point in a certain direction.

The dealers need to make periodic surveys of the market areas, to determine market potential, at least one season in advance. Dealer advance orders should be treated as informational material to aid the production section in organizing an effective production programme. The dealer should, however, not to be held to the exact amounts of such advance orders.

The uses of demand forecasts are many and varied. A reliable forecast is the sheet anchor of all planning in business. Long term demand indications, in terms of quality, quantity, prices and term demand indications, in term of quality, quantity, prices and locations, help to make an investment decision, that is how much to invest, where to locate the production facility, and how to organize marketing. Intermediate-range demand forecast help to make decisions on action necessary to optimize profits by balancing production and sales. Uses of short-term demand forecast include production planning and scheduling, distribution planning and scheduling, determination of targets and quotas for dealers and salesmen, planned buying of inputs, preparation of cash flow budgets, preparation of overall budgets and profits and loss statements, modifications of prices, policies, etc.

Marketing Structure (Establishment of effective channel of seed distribution)

The key to success in seed marketing is the establishment of effective channel of distribution. The various channels through which seed can be marketed vary greatly according to the needs of the seed company.

Present status of seed distribution.

The types of seed distribution systems in India are:

a) *Farmers of farmer distribution.* This is the traditional method, whereby farmers obtain their requirements from neighbours either on cash payment or on an exchange basis. No formal marketing organization is required for this type of distribution.

b) *Distribution by co*-operatives. This involves procurement of seeds by cooperatives and its subsequent distribution. The distribution of seeds through cooperatives has often been encouraged by the government through subsidies and guarantees.

c) *Distribution by Departments of Agriculture.* Seeds are purchased by the government, out of the government funds, and are distributed through District Agricultural Officers and Block Development Officers.

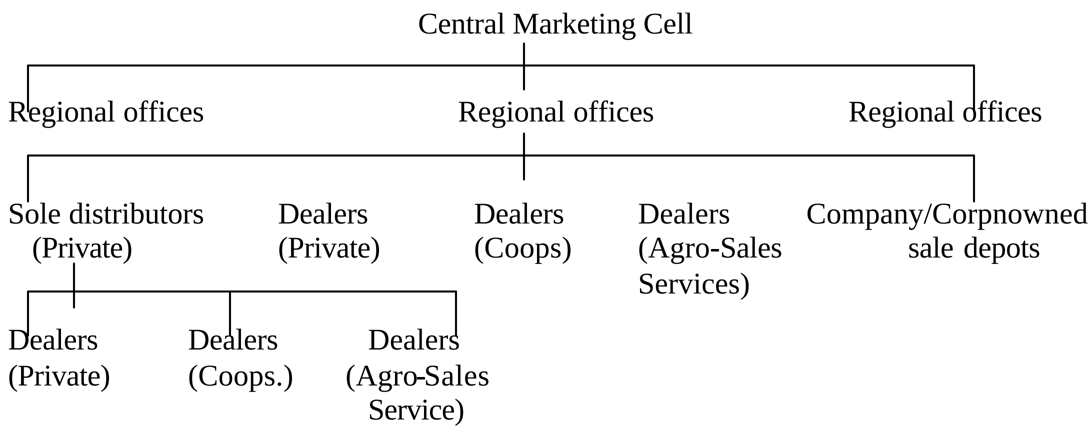
d) *Distribution of seeds by non*-government or quasi-government agencies. In this system, the seeds are distributed through a network of seed distributors and seed dealers.

Both the Seed Review Team (1968) and the National Commission on Agriculture (1976) have recommended that the State governments should withdraw from the seed procurement and distribution fields in a phased manner, so as to be able to concentrate on their principal function of providing extension education in the use of high quality seeds for improving productivity. Thus, emphasis is on the establishment of a seed marketing network to replace the role of State governments, and to establish a system that will be adequate for the anticipated increase in seed demand. In this connection, it is considered necessary that a network of seed dealers should be established.

Marketing Organization

There are a number of possible ways in which a marketing network could be organized.

The simplest and most efficient system is to establish a central marketing cell and regional offices in end-use areas. The retail sale could be organized either by appointing distributors/dealers such as private dealers, cooperatives, agro-sales service centres, etc., or by opening seed company/corporation-owned sales points, or both, as illustrated in Figure 21.1.



Under such a scheme, the central marketing cell is responsible for planning, appointment of dealers/distributors, seed movement, marketing intelligence research, pricing promotional activities, financing and record keeping.

The regional offices are responsible for seed supply and promotional materials to dealers/distributors, training of seed dealers, expansion into new market areas, publicity and execution of promotional programmes.

The dealers and distributors are the last, but most important link in the chain of seed marketing and they must assume great responsibilities.

Law *et al.* (1971) have listed the following responsibilities for dealers which are self-explanatory.

1. Ethical dealings.
2. Sell quality seed only.
3. Proper storage of seeds.
4. Maintenance of attractive shops.
5. Wise use of publicity.
6. Knowledge of product and competitors.

The utmost care should be taken in the mater of appointment / selection of distributors and seed dealers. In this connection, due emphasis should be placed on an integrated marketing approach. The dealers involved in selling fertilizers / pesticides, or other agricultural inputs, should be preferred. The dealer distributor network should be organized in such a manner that the seed retailers are located within easy reach of farmers e.g., establishment of at least four sales points in each Community Development Block.

Lecture No: 28

SEED TESTING

Seed testing is required to assess the seed quality attributes of the seed-lots which have to be offered for sale. These quality attributes are seed moisture content, germination and vigour, physical and genetic purity, freedom from seed-borne diseases and insect infestation.

In India, during seed testing, moisture, germination and physical purity of seeds are generally determined.

Standard seed-testing procedures for the evaluation of seeds have been developed by the International Seed Testing Association (ISTA) and the seed scientists from all over the world have played a key-role in these developments.

It is obligatory on the part of the seed analysts to follow rules prescribed by the International Seed Testing Association 9ISTA, 1985) for seed testing if the seed is moving into the international trade. However, if the sale of the seed is regulated in a country by an Act of Parliament, the testing of seeds for quality-control purposes may be done by the rules prescribed in the country.

The science of seed testing, that is, the science of evaluating the planting value of seed has been developed to achieve the following objectives for minimizing the risks of planting low quality seeds:

Objectives of Seed Testing

1. To determine their quality, that is, their suitability for planting
2. To identify seed quality problem and their probable cause
3. To determine the need for drying and processing and specific procedures that should be used.
4. To determine if seed meets established quality standards or labeling specifications.
5. To establish quality and provide a basis for price and consumer discrimination among lots in the market.

International Seed Testing Association (ISTA)

As seed testing developed, it became obvious that cooperation between seed testing stations was imperative for the establishment of common methods of testing that would secure uniformity in evaluation and test results. This need ultimately led to the foundation of the International Seed Testing Association in 1924.

The primary object of ISTA is to develop, adopt and publish standard procedures for sampling and testing seeds, and to promote uniform application of them for the evaluation of seeds moving in the International seed trade. In addition, it also promotes research in all aspects of seed science and technology, including sampling, testing, storing, processing, and distribution, it encourages cultivar certification, participates in conferences and training courses aimed at furthering these objectives and establishes and maintain liaison with other organizations having common or related interests in seeds.

The technical and scientific work of the associations is carried out by fifteen special committees (e.g., committee on seed sampling and bulking, purity, germination, vigour, etc). It publishes scientific and technical papers in the Association's journal, Seed Science and Technology.

One of the foremost achievement of ISTA is the adoption of the International Rules for Seed Testing. These rules prescribe testing techniques based upon scientific evidence, which are accurate within stated statistical limits and practicable within the everyday operations.

In developing the rules for seed testing (Justice, 1972), the following objectives have served as guidelines.

1. To provide methods by which the quality of seed samples can be determined accurately.
2. To prescribe methods by which seed analysts working in different laboratories in different countries throughout the world can obtain uniform results.
3. To relate the laboratory results, in so far as is possible, to planting value.
4. To complete the tests within the shortest period of time possible, commensurate with the above-mentioned objectives.
5. To perform the tests in the most economical manner.

The ISTA Rules for testing seeds are followed by its member countries, in carrying out seed testing work.

The introduction of the International Seed Analysis Certificate, widely used in the international seed trade, is another important achievement.

Establishment of Seed Testing Laboratory:

The seed testing laboratory is the hub of seed quality control. Seed testing services are required from time to time to gain information regarding planting value of seed lots. To carry out these responsibilities effectively, it is necessary that seed testing laboratories are established, manned and equipped in a manner such that whatever samples are received could be analysed in the least possible time, so that the seed quality control work and the need of seed industry are effectively met.

Kahre *et al.,* (1975) has listed the following conditions that are essential for ensuring good seed testing work.

1. A highly responsible staff which must continue to work conscientiously when the person in charge is away.
2. Uniformity of equipment, procedures and interpretations. In other words, consistently good facilities and skilled analysts.
3. Good service, that is, prompt analysis and a cooperative spirit among employees.
4. Leaders with a scientific background to give advice to all types of customers and to furnish explanatory remarks in reports, when necessary, to those who submit samples.
5. Promotion to research, leading to improvement of the whole seed programme, especially of testing procedures, with practical questions being submitted for scientific analysis.

Plan for Seed Testing Laboratory and General Principles

1. The physical-infrastructure and facilities should be planned on the basis of average expected workload during the peak season, so as to permit efficient handling of seed samples without undue delays. The working space should be adequate. This is important since the time taken in reporting results is of crucial importance. There should be sufficient space left for any special tests section etc. if the need arises.
2. The kinds of tests to be carried out or likely to be carried out, for examples, routine tests, seed health test, varietal purity tests etc. must be ascertained in advance for making provisions in the plan.
3. The selection and number of the equipment should be such so as to permit efficient handling of work. The equipment must meet requisite specifications.
4. The decent furnishing, light arrangement and other necessities should be provided so as to reduce the strain of otherwise strenuous work.

Building A seed testing laboratory can be housed as a separate building or it could form part of a larger building housing a Department. The entire work can be organized in a hall/or in separate rooms. The size of the building or space requirement depends upon the number of samples to be handled and the kind of tests to be done. The following space requirements for testing 10,000 samples per year may serve as a guideline.

The purity room, in particular, should have abundant natural non-glare light. It should be preferred to locate window in this section along the north side of the building. It would also be desirable that the bottom window panes open in a horizontal manner so that the air coming through the window will be deflected upward and not blow directly across the working table of the seed analyst. Windows should also be screened on the outside to keep out insects and birds.

Staff : The number of workers in the seed testing laboratory should be related to the number of samples, crop species to be handled and kind of tests to be performed. The following criterion may serve as a guideline for a laboratory handling 10,000 sampler per year.

The need for additional hands is invariably felt during the peak seasons. This need should be met my employing graduate -students on da ily wage basis.

Equipment : The Rules for testing seeds includes the type of equipment and its specifications. The equipment for a seed testing laboratory, therefore, should be selected accordingly. Only the best available should be purchased. The following list of equipment may serve as a guideline.

List of equipment for seed testing laboratory

S. No.	Equipment
1.	Seed Sampling and dividing equipment Seed triers, Boerner divider, Gamet divider and Soil type divider
2.	Sample storage boxes and racks
3.	Balances – Single pan (top loading), Analytical Balance
4.	Purity work boards
5.	Germinators – Cabinet germinators and Walk-in-room germinator
6.	Refrigerator
7. 8.	Hot Air Oven Grinding mill
9.	Incubators
10.	Autoclave
11.	U.V. Lamp
12.	Miscellaneous equipment – Seed blower – Seed Scarifier – Moisture meter (electric), Hand sieves, Petridishes

Seed Testing Procedures for Quality Assessment:

The following may be used as a guideline for managing the work in a seed testing laboratory for efficient handling of seed samples.

1. Receipt and registration of seed samples: The samples received in the laboratory should be entered in a pre-printed register or forms and assigned a test number to be used in all the analysis. The information, namely, name of the sender, type of sample, kind of tests required, crop, variety and class of seed etc. should be properly recorded. The samples especially received for moisture test in the moisture-proof containers should be passed on as such to the moisture test section after assigning the test no.

For speedy operation it would be desirable to simultaneously prepare separate seed analysis cards and envelops for working samples. The test no. would invariably be written on each card and the envelop. These are passed on to the person responsible for preparation of the working samples. The entire work should be so organized that this work is completed in same day.

2. Moisture test: The samples intended for a moisture test requires special attention, because it may otherwise either lose or may absorb moisture from outside. These samples after assigning the test no. should be passed on for moisture testing analysis without unnecessary delay.

3. Working sample: After entering the samples the next step is to prepare the working sample(s) or various tests. To save time taken in completing the seed tests the first objective should be to prepare a working sample for the germination/viability test so as to limit the seed testing time to the minimum time required to complete seed germination / viability test, as the case may be.

Subsequently, if the seed cleaning on laboratory model machines or test weight determination, is desired, the same may be done at this time. The working sample envelopes for the various tests alongwith the corresponding analysis card should be serially placed in sample trays for sending to the concerned section.

4. Routine Tests: In a seed testing laboratory, germination test, purity test, test for other seeds and moisture test are known as routing test. For all such crops where the analysis for diseased seeds or other variety seeds is also desired on the routine basis (as in the case of certified seed samples for the issuance of seed certification tags) these tests should also be included in the routine tests. Every effort should be made to analyse the samples speedily so that there are no undue delays in sending the results. These tests must be done as per rules, that is, rules mentioned in the 'Seed Testing Manual'.

5. Other tests: Every effort should be made to complete these tests as quickly as possible. These should be carried out as per available procedures. The name of the procedure adopted should, however, be mentioned while reporting the results.

6. Reporting of results: After the tests have been completed the results are reported on a printed form, known as, seed analysis certificate in the requisite manner. One of the common complaint against seed testing laboratories is "length of time", that is, the days taken in sending the report. It is therefore important to ensure that there are no undue delays. The result of seed samples received from seed inspectors under the provision of seeds Act should be communicated within 21 days from the date of receipt but not later than 30 days in any case.

7. Storage of guard samples: The submitted samples received by the seed testing laboratory, on which reports are issued, should be stored after analysis for one year from the date of issue of reports, in conditions calculated to minimize any change in quality.

8. Maintenance of records: To serve the needs of seed certification, farmers and other applicants, it is essential that records are immediately available for any sample tested during the current year, season or at any other specified time. The records should be maintained in such a manner that any information needed can be traced immediately.

Lecture No: 29

Varietal Identification through Grow-Out test and Electrophoresis

The main aim of grow-out test is to determine the genetic purity of the variety of the given sample. In grow-out test plant characters that are less influenced by the environment and which are highly heritable are observed by growing the plants in the field. The variety, which is to be tested for genetic purity, should be grown in the area for which it has been released so that the characters of that variety are fully expressed. Each sample should be sown with proper spacing by adopting the recommended cultural practices so that the differences between the varieties are fully expressed.

Sampling: The sample for grow out test are to be drawn simultaneously with the samples for other quality tests and the standard procedure shall be followed.

The size of the submitted sample shall be as follows:

1000 g	for maize, cotton, groundnut, soybean 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	species of other genera with seeds of similar size.
100 g	For bajra, jute, and species of all other genera.
250 tubers / cuttings/ roots etc.	Seed potato, sweet potato and other vegetatively propagated crops.

Procedure

Before sowing the seed in the field the seed should be examined on the diaphanoscope to identify the seeds of other variety. The seeds of other variety should be separated and the percentage should be noted. One may also separate the doubtful seed, which may be sown separately for through examination.

The various samples of the same cultivar are sown in adjacent plots with standard samples at regular intervals. In case of self pollinated crops the characters are fixed and it is easy to identify the plants of other cultivars. In cross pollinated crops where the variability for characters is more it is essential to sow the authentic samples at regular intervals for comparison between the samples to be tested and the standard sample. The sample plots should be regularly observed during the entire growing period of the crop as some of the characters are expressed at seedling stage while the others are expressed at flowering or at maturity stage. The size of plots, row length etc. will differ from crop to crop. How ever the specifications for different crops are indicated in the following table. The certification agency may change the specifications if considered necessary:

S. No	Crop	Row length (meters)	Plant to plant distance (cm)	Space between rows (cm)	Space between plots (cm)	No. of Replications
1.	Wheat, barley, oats	6	2	25	50	2
2.	Pea, cowpea	6	10	45	90	2
3.	Chickpea, greengram, blackgram	6	10	30	60	2
4.	Maize	10	25	60	90	2
5.	Hybrid Cotton	5	10	45	45	2
6.	Paddy: a. Very early to medium	6	15	20	45	2
	b.Late and very late	6	25	30	60	2
7.	Pearlmillet	6	10	60	90	2
8.	Sorghum	6	10	45	60	2

The seed rate may be adjusted depending on the germination percentage of individual samples and the sowing may be done by dibbling. Subsequent thinning is not recommended.

The test crop may be raised along with the control either in the areas recommended for the variety or in off-season nurseries. The authentic control sample from the originating plant breeder/breeding institute is to be maintained by the testing station/Agency following standard procedures. A minimum of two hundred plants from control sample will be raised along with the test crop.

Observations

a. All plants are to be studied keeping in view the distinguishing characters described for the cultivar both in the test crop as well as the control. Necessary corrections may be incorporated if the control is found to be heterogeneous.

b. Observations are made during full growing period, or for a period specified by originating breeding Institute and deviations from the standard sample of the same variety are recorded. At suitable development stage the plots are examined carefully and plants which are obviously of other cultivar are counted and recorded.

The specifications of the field plot, row length etc. may be determined from the information given in the table. On the basis of the number of plants required for taking observations is depended on maximum permissible offtypes, which are as follows:

Maximum permissible offtypes %	Minimum genetic purity %	Number of plants required per sample for observation.
0.10	99.9	4000
0.2	99.8	2000
0.3	99.7	1350
0.5	99.5	800
1.00 & above	99.0 & below	400

Calculation, interpretation and reporting of the results

Percentage of other cultivars, other species or aberrant found may be calculated upto first place of decimal. While interpreting the results, use of tolerance may be applied by using the reject table given below.

Rejection number for prescribed standards and sample size

Standard	**Reject number for sample sizes 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.

When nothing worthy of special comment is found the results may be reported as "The results of a filed plot examination of this sample revealed nothing to indicate that varietal purity is unsatisfactory"

Advantages

1. It is the cheapest way to examine reasonable number of plants.
2. It is possible to examine a large number of plots and for each plot it is possible to check large number of plants.
3. The plants are examined during the whole period of growth. Some characters are more prominent at one time of the year than another, and the samples may therefore, be examined several times during the season.

Disadvantages:

1. The results are not available until 4 to 12months after the seed was received for testing.

ELECTROPHORESIS

Objective: Verification of variety by electrophoretic mobility of protein on polyacrylamide gel.

Principle: Proteins and enzymes are the primary products of genes and hence are most suited for genetic purity determination. Changes in coding base sequence result in corresponding replacements in amino acids and thus in the primary structure of protein and enzymes. They possess ionizable groups and can therefore be made to exist in solution as electrically charged particles either as cations (+) or anions (-). Molecules with similar charge and size will have differential migration in solution with porous support medium in an electric field based upon differences in net electrical charges as molecules with higher charge migrate faster than those with a lower charge. Particle with smaller molecular weight migrates faster than those with higher weight. This separation of molecules based on their size and net electrical charge is known as electrophoresis.

Interpretation of protein banding pattern

After staining of the gel, it is placed over a trans illuminator to see the banding pattern. Relative mobility of each protein (band) is calculated by the following formula.

$$\text{Relative mobility (Rm)} = \frac{\text{Distance traveled by protein}}{\text{Distance traveled by tracking dye}}$$

On the basis of Rm value and thickness of the band a zymogram is drawn on a paper to show the banding pattern.

The varieties are verified on the basis of banding pattern.

1. By measuring Rm of bands
2. Total number of bands
3. Presence or absence of specific band
4. Intensity of band
5. Difference in banding pattern in comparison to authentic zymogram of the variety under test.

Lecture No: 30

SEED LEGISLATION IN INDIA

In India, until mid-sixties (except in Jammu and Kashmir, where an Act in respect of regulation of vegetable seeds was in force) there was no legislation governing the quality of seeds sold to farmers. the rapid development of agricultural production with the introduction of hybrid varieties of maize, *Jowar* and *bajra,* and dwarf varieties of wheat and paddy, however, necessitated the enactment to seed legislation. On 29th December 1966, the Seeds Act was passed. It came into force throughout the country on 2nd October 1969.

The main features of the Seeds Act, 1966 are discussed below:

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

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

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

Statutory Bodies And Agencies Established in India Under the seeds Act, 1966

1. Central Seed Committee: The Central Seed Committee set up under the Act is the main source of advice to the Central Government on the administration of the Act, and any other matter related to seeds. The committee consists of a chairman, two representatives of seed growers, eight representatives of other interests; nominated by the Central Govt., and one representative of the State Governments. Director (Seeds), in Ministry of Agriculture, Govt. of India, cats as the Secretary of the Committee.

The main functions of the Central Seed Committee as envisaged in the Act and Rules are:

a) To advise Central and State Governments on all matters related to seeds.
b) To advice Government regarding notification of such kinds/varieties for which it thinks it has become necessary or expedie nt to regulate the quality of seeds.
c) To advice Government of the minimum limits for germination and purity for those kinds/varieties brought under the purview of the Seeds Act.
d) To recommend the procedure and standards for certification, grow, out tests, and analysis of seeds.
e) To recommend to the Central Government the suitability of any seed certification agency established in any foreign country for the purposes of this Act.
f) To recommend the rate of fees to be charged for analysis of samples by the Central and State Seed Testing Laboratories, and for certification by certification agencies.
g) To advise the Central and State Governments regarding suitability of seed testing laboratories.
h) To send its recommendations and other pertinent proposals related to the Act to the Central Government.
i) To carry out such other functions as are supplemental, incidental or consequential to any of the functions conferred by the Act or Rules.

2. Central Seed Certification Board: The Government of India has also constituted the Central Seed Certification board to deal with all problems related to seed certification and to co-ordinate the work of State Seed Certification Agencies. The membership consists of a Chairman, 13 members representing interests as the govt. thinks fit, 3 Directors of Research of Agricultural Universities, 4 Directors of Agriculture in a State; nominated by the Central Government besides a nominated secretary.

3. State Seed Certification Agencies: The Act provides for the establishment of State Seed Certification Agencies by notification in the official Gazette of State Government / Central Government in consultation with the State Government. On recommendation of the Central Seed Committee these agencies have been established in the form of societies having a governing body and an executive wing. The governing body consist of persons representing all interests, namely, the State Government, seed producing agencies, farmers, subject specialists and seed law enforcement agencies. The Agriculture Production Com missioner or Secretaty of State, Department of Agriculture acts as the Chairman of the Statutory Certification Agency. The governing body lays down the broad policy, while the inspections, seed certification and seed analysis is the responsibility of the executive wing. The functions specified for the Seed Certification Agency under the Act are:

a) Certify seeds of any notified kinds or varieties:
b) Outline the procedure for submission of applications and for growing, harvesting, processing, storage and labeling of seeds intended for certification till the end so as to ensure that seeds lots finally approved for certification meet prescribed standards for certification under the Act, or these rules;
c) Maintain a list of recognized breeders of seeds;
d) Verify, upon receipt of an application for certification, that the variety is eligible for certification, that the seed source used for planting was authenticated and the record of purchase is in accordance with these rules and that the fees have been paid;
e) Take sample and inspect seed lots produced under the procedure laid down by the certification agency and have such samples tested to ensure that the seed conforms to the prescribed standards of certification;
f) Inspect seed-processing plants to see that the admixtures of other kinds and varieties are not introduced;
g) Ensure that action at all stages, *e.g.*, field inspection, seed processing plant inspection, analysis of samples taken and issue of certificates (including tags, marks, labels and seals) is taken expeditiously;
h) Undertake educational programmes designed to promote the use of certified seed, including a publication listing certified seed growers and sources of certified seed;
i) Grant certificates (including tags, labels, seals, etc.) in accordance with the provisions of the Act and these rules;

j) Maintain such records as may be necessary to verify that seed fields for the production of certified seed were eligible under the rules;

k) Inspect fields to ensure that the minimum standards for isolation, roguing (where applicable), use of male sterility (where applicable) and similar factors are maintained at all times, as well as to ensure that seed-borne diseases are not present in the field to a greater extent than those provided in the standards for certification.

4. Central Seed Testing Laboratory: The Seed Testing Laboratory at the Indian Agricultural Research Institute, New Delhi, has been notified as the Central Seed Testing Laboratory.

The functions assigned to this laboratory at present are:

a) Initiate testing programme in collaboration with the State Seed Laboratories designed to promote uniformity in test results between all seed laboratories in India.

b) Collect data continuously on the quality of seeds found in the market and make this data available to the Committee;

c) Carry out such other functions as may be assigned to it by the Central Government from time to time; and

d) Act as referee laboratory in testing seed samples for achieving uniformity in seed testing. The State Seed Testing Laboratories are required to send five percent samples to the Central Seed Testing Laboratory along with their analysis results.

5. State Seed Testing Laboratories: The Act envisages the establishment of State Seed Testing Laboratories in each State by notification in the official Gazette. The function of the State Seed Testing Laboratory is to carry out the seed analysis work of the State in a prescribed manner.

6. Appellate Authority: The Act envisages appointment of an appellate authority / authorities through an official notification in the Gazette by the State Governments to look into the grievances of certified seed producers against a seed certification agency; and that of seed traders against seed law enforcement officials.

7. Recognition of seed certification agencies of foreign countries: The Central Government, on the recommendation of the Central Seed Committee and by notification in the official Gazette, may recognize any seed certification agency established in any foreign country, for the purpose of the Indian Seeds Act, 1966.

REGULATORY LEGISLATIONS

Notification of kinds or varieties

The Central Government after consultation with the Central Seed Committee can issue notification for such kinds/varieties for which it is of the opinion that it has become necessary or expedient to regulate the quality of seed to be sold for the purposes of agriculture. The notification brings such kinds/varieties under the purview of the Seeds Act.

Regulation of Sale of Notified Kinds/Varieties

Under Section 7 of the Act, the seeds of notified kings/varieties can be sold in containers only, if they are either (a) labeled, or (b) certified and meet the minimum prescribed requirements.

Staturory Requirements for Sale of Seed

1. Labeled seed: The seed container shall be labeled in the following manner. The colour of the label shall be buff.

1. Kind
2. Variety
3. Lot number
4. Date of test
5. Inert matter percentage
6. Pure seed percentage
7. Other crop seed percentage
8. Weed seeds percentage
9. Germination percentage
10. Net content
11. Seller’s name and address
12. If treated, then either of the following two statements should appear on the lable.

    “Do not use for food, feed or oil purposes”

Or

POISON

If the contents of the container is 250 gms, or less, items 5 to 9 may be replaced by the following statements:

“The seed in this container conforms to the minimum limits of germination and purity prescribed under the Act”.

The labeled seed, offered for sale must be packed in containers; must be of notified varieties; and must meet the prescribed minimum limits of purity and germination.

Lecture No: 31

SEED LAW ENFORCEMENT

The responsibilities for enforcing various provisions regarding regulation of sale of seeds of notified kinds/varieties rests with the seed inspectors. The seed inspector is required to:

a) Inspect of frequently as may be required all places used for the growing, storage or sale of any seed of any notified kind r variety;
b) Satisfy himself that the conditions of the certificates/labels are being observed;
c) Procure and send for analysis, if necessary, samples of any seeds, which he has reason to suspect, are being produced, stocked or sold or exhibited for sale in contravention of the provisions of the Act of the Rules.
d) Investigate any complaint which may be made to him in writing in respect of any contravention of the provisions of the Act, or the Rules;
e) Maintain a record of all inspections made and action taken by him in the performance of his duties, including the taking of samples and the seizure of stocks and to submit copies of such records to the Director of Agriculture, or the certification agency.
f) When so authorized by the State Government, to detain imported containers which he has reason to suspect contain seeds, the import of which is prohibited, except and in accordance with the provisions of the Act and the Rules;
g) Institute prosecution in respect to breaches of the Act and the Rules; and
h) Perform such other duties as may be entrusted to him by the competent authority from time to time.

Prowers of Seed Inspectors

1. To take samples of seed of any notified kind/variety from any person selling such seed, or purchaser or consignee, and to send such samples for analysis to the seed analyst notified for the area;
2. To 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;

3. To examiner any record, register, document or any other material object found in any place mentioned in clause (2) 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 exercise such other powers as may be necessary for carrying out the purposes of this Act or any Rule made there under.
4. On demand to pay the cost of seed, calculated at the rate at which such seed is usually sold to the public, to the person from whom the same is taken.
5. To break-open any container in which any seed or 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 nay other person in occupation of the premises, if he is present therein, refuses to open the door on being called upon to do so.
6. 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 the memorandum to be prepared in the prescribed form and manner.
7. The provisions of the Code of Criminal Procedure, 1898, shall, so 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.

Lecture No: 32

World Trade Organization – Protection of Plant Varieteis and Farmers Rights Act – Intellectual Property Rights – Plant Breeder's Rights

The power of knowledge in the society is truly unimaginable. Gone are the days where wealth is associated with tangible properties *i.e.,* for more than a century, the worlds wealthiest man has been associated with oil, starting with John Rockefeller ending with the Sultan of Brunei in the late twentieth century.

But today, for the first time in history, the worlds wealthiest person is a knowledge worker Bill Gates. The paradigm shift in the understanding from **"Heritage of Mankind" to the "Sovereign Rights of state"** in respect of biological resources as a consequence of

Convention on Biological Diversity(CBD) triggered several changes in the International arena.

CBD is an International Treaty concluded under the auspices of the United Nations Conference (3-14 June 1992) on Environment and Development at Rio de Janeiro, Brazil, On 5th June 1992 and Convention was participated and signed by 168 countries .Currently 188 countries has joined Party to the CBD.CBD came into force on 29 December, 1993.CBD was developed on recognition of the intrinsic value of biological diversity and of the ecological, genetic, social, economic, scientific, educational, cultural, recreational and aesthetic values of biological diversity and its components. And the importance of Biological Diversity for evolution and for maintaining live supporting systems of the biosphere.

Mean while the global paradigm shift occurred due to several Asian countries which were major importers of food grains like India and China with 21% of arable land and 39% of world population became self-sufficient and Shift in agricultural research from public to private sector in Developed countries having agricultural surplus.

The setting up of International body-the **World Trade Organization (WTO)** in January 1995 – was to restructure international institutions in the areas of finance, trade and economic stability.

The liberalized trade regime under WTO became operational with the Marrakesh Agreement, ratified in 1994 at the conclusion of 8th Uruguay Round of Trade talks which began in 1986. India was one of the 136 member countries and signatories to the Agreement which altered the whole framework of international trade which has existed under the earlier General Agreement on Trade and Tariffs (GATT). Three-fourths of the member countries are developing countries, and together, they account for over 90% of world trade.

The issue of Plant variety Protection has been brought into focus under the provisions of **Trade Related Aspects of Intellectual Property (TRIPs)** Right which is a part of Agreement on Agriculture (AoA) under World Trade Organization (WTO) for which India is signatory and a founding member.

Different forms of Protection of New Plant Varieties have been existing in the developed countries through the system of **Plant Breeder's Rights (PBRs).**

In order to co-ordinate inter-country implementation of PBRs **"International Union for the Protection of New varieties of Plants" (UPOV)** was established by International Convention for Protection of New varieties of Plants, which was signed in

Paris in 1961. The purpose of the convention is to ensure that the member states of the union acknowledge the achievements of breeder of new plant varieties by making available to him exclusive marketing rights, on the basis of a set of uniform and clearly defined principles.

As the existing UPOV models of plant variety protection were not suitable for our requirements, the Government of India enacted our own legislation on the **Protection of Plant Varieties and Farmers Rights Act (PPV&FR)** In 2001 which is a unique model in the world as it provides equal rights to farmers along with breeders. For the purpose of implementation of this act, central Govt. of India established PPV&FR authority

Main objectives of the Protection of Plant Varieties and Farmers Rights Act

1. Registration of plant varieties,
2. Characterization and documentation of registered varieties,
3. Documentation, indexing and cataloguing of farmer's varieties,
4. Providing compulsory cataloguing facility for all plant varieties,
5. Ensuring that seeds of all registered varieties are made available to farmers,
6. Collection of comprehensive statistics on plant varieties,
7. Maintenance of National Register of Plant variety

Intellectual Property:

Intellectual property is an idea, a design, an invention etc which can ultimately give rise to a useful product / application.

For the development of such intellectual property, requires intellectual inputs, innovativeness, considerable monetary and other resources. Therefore, the inventor would like to ensure a fair reward for his invention. But the major problem with intellectual property is that they can be copied, imitated or reproduced, this minimizes the returns to the original inventor.

The right on an invention to derive economic benefits for his invention (*i.e.* intellectual property) is called as intellectual property rights (IPR). The IPR however is recognized by the govt. only so long as it is not detriment to the society.

Protection of Intellectual Property Rights – The protection of IPR may take several forms depending on the type of intellectual property and the type of protection sought. Each form of protection has its own advantages & disadvantages. The main forms of IPR protection are as follows.

1. Trade secrets
2. Patents

3. Plant Breeder Rights (PBR)
4. Copyright

1. Trade secret: When the individual / organization owning an intellectual property does not disclose the property to any one and keeps it as a closely guarded secret to promote his business interests, it is called trade secrets. Trade secret may relate to formulae, processes or parented lines in hybrids, in biotechnology trade secret include cell lines, micro organism strains etc.

Advantages:

1. They are for unlimited duration
2. It is not necessary to satisfy the stringent procedures for patents
3. The cost of facing, contesting & enforcing patents is saved
4. The risk of some one improving upon the product etc is reduced

Limitations:

1. Maintaining a trade secret itself is a costly affair
2. It is not protected from independent innovation / invention
3. Non-disclosure of the invention does not give others as chance to improve upon the original inventions. This prevents or delays the progress in that particular field.
4. It cannot be applied to many inventions eg. Equipments designs, plant varieties, books etc.

2. Patents: A Patent is the right granted by a government to an inventor to exclude others from imitating, manufacturing, using or selling the invention in question for commercial use during the specified period.

Patent Requirement: For granting a patent the main requirements are as follows

1) Novelty
2) Inventiveness
3) Industrial application & usefulness
4) Patentability
5) Disclosure

Novelty: The invention must be new and should not be already known to public.

Inventiveness: The invention should represent an innovation

Industrial Application & Usefulness: The patent must have an industrial application should be useful to the society/nation.

Patentability: It must be patentable under the existing law and its current interpretation. The criteria at present varies from country to country and with time within the same country.

The Indian Patent Act 1970 does not allow product patents in pharmaceuticals, food and agriculture. The key element is that substances used as food/medicine/drug and the entire class of materials formed by any chemical reaction do not qualify as patentable subject matter i.e. product patents are not allowed in India.

As a result, an antibiotic is not patentable in India, while the process of its production is in contrast; both the product & the processes are patentable in Europe & USA.

Disclosure : The inventor has to describe his invention in sufficient detail so that a person of normal skill is able to reproduce it. In case of biological entities already known, organisms may be simply named. But if they have been genetically modified, the nature and the method of modification has to be described fully.

A patent may be viewed as a contract between the society and the inventor where in the inventor discloses his intention in return for the protection granted to him by the society to control the commercial aspects of his invention to the extent that is not determined to the society.

The disclose of an invention gives an opportunity to other inventors to improve upon the various features of the invention, so that it became more efficient & /or more useful. This in-turn, results in scientific and economic progress of the society/nation.

Limits of a patent: A patent is limited both in time and space

a) **Limitation of Time** – A patent is valid for a specified period of time from the date of award in most countries this period is 15-20 years. The Indian patent act (1970) grants protects for 7 or 14 years. However, there is a strong argument for larger protection as it ay take upto 10 years from the time or patent is awarded to the time the product reaches market.

b. **Limitation of Space** – A patent is valid only in the country of its Award and not in other countries. A group of nations may agree to honour the patents awarded by any member country eg. European Economic community. WTO has a similar provision that a patent awarded by WTO will be valid in all member countries.

3. **Copyright**: Certain intellectual properties are not patentable. They are protected by copyr ight eg: Books, Audio, Video cassettes & Computer software. The copyright is limited both in time and extent.

Plant Breeder Rights: **are the rights granted by the Govt. to plant breeder, or owner of a variety to exclude others from producing commercially the propagating material or that variety for a period of 15-20 years.**

To qualify for PBR protection a variety has to be novel, distinct from existing varieties and uniform and stable in its essential characteristics. A person holding PBR title to a variety can authorize other organizations to produce and sell the propagating material of that variety.

PBR in India – India had evolve a *sui generis* system of PBR. Which means a system of their own. The essential features of UPOV - 1978 act are being considered for adoption. Some important features of the Indian *sui generis* system are

1. Farmers rights
2. Researchers right to use the material for research
3. Protection period of 15 years for annuals and 18 years for fruit trees
4. Compulsory deposit of the material in national gene bank
5. Establishment of National Authority for the protection of Breeders, farmers and researchers use rights.

Benefits of PBR–

1. Profits obtained by breeders through PBR will act as an incentive in promoting Plant Breeder research.
2. It encourages private companies to invest in Plant Breeding Research.
3. It will enable access to varieties developed in other countries & protected by IPR laws
4. Increased competitiveness among various organizations engaged in Plant Breeding is likely to benefit both farmers and the nation

Disadvantages of PBR –

1. PBR will encourage monopolicy in genetic material for specific use
2. It suppress free exchange of genetic material and encourage unhealthy practices
3. The PBR holder may produce less seed and increase the price for achieving more profit.
4. Farmers privilege to resow the seed produced by him may be gradually diluted
5. PBR may result in increased cost of seed and may be burden for poor farmers.