SEED PRODUCTION

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

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

Seed Production

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

The benefits of seed production are

- ❖ Higher income
- ❖ Higher quality seed for next sowing

Difference between seed and crop production

Seed production	Crop production
Basic seed should be from an authentic source	Any seed material can be used
Seed plot should be selected carefully for better performance, as per edaphic and environmental requirement	Can be grown in any area
Needs isolation from other varieties	Isolation is not necessary

Needs technical skill for maintenance of quality	Special technical skill is not required
Maintenance of genetic purity is important	Genetic purity is not required
Roguing is compulsorily practiced	Roguing is not practiced
Harvesting should be done at physiological/ harvestable maturity	Harvested at field maturity
Resultant seed should be vigorous and viable	Question of viability does not arise
Importance is given to seed quality rather than the yield	Importance is given more to yield

There are two types (major) of seed production ie. varietal and hybrid Seed production based on the type of seed used for multiplication .The difference between varietal and hybrid seed production are as follows

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

SCOPE AND IMPORTANCE OF SEED PRODUCTION

Indian Agriculture has made enormous progress in the last 50 years. Food grains production has risen from 50 million tons in 1947 to 212 million tons in 2003-04. The country has advanced from a situation of food scarcity and imports to that of food security and exportable surpluses. The Green Revolution of India has been universally acclaimed as a successful enterprise of the farmers, the Scientists and the Government. The land mark achievements in agriculture in the 60s and 70s were the result of a combination of inputs like introduction of high yielding varieties, increased fertilizer use, expansion of irrigation facilities, massive extension efforts, improved farm practices and, above all, ingenuity and industry of the Indian farmers. However, the growth of agriculture sector has not kept pace with the growth of the population and has stagnated. The unsatisfactory growth of agriculture, apart from serious implications for food security of the country, has been adversely impacting the growth rate of country's economy. The imperative of National food security, nutritional security and economic development demand a very focused and determined approach to raise productivity and production in agriculture. In view of the fact, that the area under cultivation is unlikely to increase significantly, thrust will have to be on raising productivity per unit of cultivated land.

Substantial increase in yield and quality of crops depends upon a number of factors viz., inputs like fertilizers, irrigation and plant protection measures and suitable agronomic practices. However, the use of high quality seed thus plays a pivotal role in the crop production. The use of poor quality seeds nullifies the utility of all agronomic practices and every other input applied to the crop no matter how lavishly they are applied. Economically, the cost of seed is a very small component of the total cost of production. Sindhur Sen (1974) summarizes the importance of seed quality thus "What are known as the seeds of hope may turn into seeds of frustration" if they are not of high quality. It is therefore, important to use the seed confirming to the prescribed standards in terms of high genetic purity, physical

purity, physiological quality and health quality. Since ages, Indian farmers were mostly dependent on traditional varieties, therefore seed requirements were met through farm saved seeds. The use of traditional varieties coupled with farm saved seeds whose quality is not guaranteed, resulted in drastic reduction in production.

Seed is the critical determinant of agricultural production on which depends the performance and efficacy of other inputs. Quality seeds appropriate to different agro-climatic conditions and in sufficient quantity at affordable prices are required to raise productivity. Availability and use of quality seeds is not a onetime affair. Sustained increase in agriculture production and productivity necessarily requires continuous development of new and improved varieties of crops and efficient system of production and supply of seeds to farmers.

The National Seeds Policy 2002 clearly emphasizes that "It has become evident that in order to achieve the food production targets of the future, a major effort will be required to enhance the seed replacement rates of various crops. This would require a major increase in the production of quality seeds……." According to the National seeds Policy 2002, the thrust areas have to be -

i) Varietal Development.
ii) Seed Production.
iii) Seed Replacement Rate Enhancement.
iv) Primary responsibility for production of breeder seed to be that of the ICAR/State Agriculture Universities.
v) An effective seed production programme.
vi) Popularization of new varieties.
vii) Availability of newly developed varieties to farmers with minimum time gap.
viii) Provision of incentives to domestic seed industry to enable it to produce seeds of high yielding varieties and hybrid seeds at a faster pace to meet the challenges of domestic requirements.

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

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

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

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

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

Strengths

- A well developed and knitted seed multiplication and distribution systems linked with several ICAR institutes / SAUs / NSC / SFCI etc.
- A network of 20 seed certification agencies and more than 96 notified seed testing laboratories to legally assure the quality seeds moving in the seed market.

- A large number of varieties in different vegetable crops are available suited to varied agro climatic conditions. This makes the selection easier for taking up production in a particular area.
- Our county is bestowed with varied agro climatic conditions, which can be exploited for taking up seed production of vegetables at any time of the year in one or other past of the country.
- A very fast development of private seed companies which are helpful in bridging. The gap between demand and supply of vegetable seeds in the country.

Weaknesses

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

Factors which affect demand

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

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

- Cropping pattern and intensity
- Type of seed used

- Climate
- Demand for crop products
- Market scenario
- Disposable farm income
- Rate or level of adoption of new technology
- Government policy
- Crop cycles
- Habits and tradition
- Product performance
- Competitiveness
- Price
- Promotion

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

Demand Forecasting of seed

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

- Longer period of time for the development new products from breeding programmes
- Seasonality of production
- Production subject to variables like agro climatic conditions outside the control of management
- Statutory controls and quality standards
- Existence of a generation system – where by the production in one year is the progenitor the next

- Limited shelf like and loss of germination
- Seed replacement rate: Seed Replacement Rate is the rate at which the farmers replace the seeds instead of using their own seeds

Seed Replacement Rate of Select Crops : 2005-06

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

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

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

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

SCOPE FOR SEEDS EXPORT

There is lot of scope for marketing of seed by Indian seed companies in countries lying between 30^0 North and South latitudes, which are having similar agro-climatic situations and the varieties bred in India are suitable as well as comparable to varieties produced in European Union (EU), USA and Japan etc. In addition, wage rates and consumption pattern of those areas are comparable to Indian conditions. The seed can be exported from India to Indonesia, Bangladesh, China, Sri Lanka, African countries. Central and South America and markets in developed countries. The Indian cotton hybrids are suitable for African countries, where the wage rates are low for hand picking in indeterminate types. The hybrid seeds of paddy, cotton, maize, sorghum, pearl millet, sunflower, varietal seeds of paddy, vegetables (tomato, brinjal, gourds and bhendi) can be produced more economically in AP for export purposes.

Export opportunities

The export opportunities can be classified into two major categories.

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

ii. Export of branded seeds

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

Hybrid vegetable seed production is highly labour intensive. As the competition is going up, most of the major global companies are outsourcing the seed production to the countries having labour cost advantage *viz.,* China, Thailand, Vietnam, Chile, India etc. several Indian companies have established good reputation over the past 10 years by supplying good quality seed under contract production. We also have experienced and skilled manpower to take up this activity on large scale. If we look at the production capacity 70% of India's seeds' sales come from farmer bred seeds, 26% from those bred in publicly financed institutions, and only 4% from researched hybrids. The domestic hybrid seeds

market is placed at INR 4.9 Billion and is annually growing at 10% a year, against the 5% global growth rate.

ii. Export of branded seeds

Over the last 15-20 years, Indian seed industry has emerged as a vibrant research based industry (in vegetable as well as field crops). Several innovative superior products have been developed for widely varying agro-climatic conditions in the Indian agriculture. It is reported that Indian germplasm / seeds can adopt very well in the countries failing in the region 30^0 North and South on the equator. This would cover markets of several developing countries from Central / South America, Africa and Asia. Incidentally, both Africa and Asia are presently the fastest growing markets. Indian seed sector with its vast germplasm base and trained man power would become a strong technology source for such countries.

Agri –export zones

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

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

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

Demand Forecasting of seed

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Demand forecasting techniques

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

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

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

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

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

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

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

SEED PRODUCTION

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Recommended System of Breeder Seed Indent and Supply

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

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

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

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

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

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

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

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

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

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

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

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

Deterioration of Crop Varieties – Causes and Maintenance

Deterioration of Genetic Purity

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

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

1. Developmental Variations

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

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

2. Mechanical Mixtures

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

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

3. Mutations

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

4. Natural Crossing

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

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

5. Minor Genetic Variations

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

6. Selected Influence of Pest and Diseases

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

7. The Techniques of the Plant Breeder:

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

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

Maintenance of Genetic Purity during seed Production

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

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

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

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

Genetic Purity Maintenance in Hybrid Seeds

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

Nucleus Seed of Inbred Lines

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

- It is rather important to ensure that the crop is well isolated, with the requirement varying from crop to crop and depending upon the nature of the material to be protected by isolation, the nature of the contaminant, and the direction of the prevailing wind.
- The isolation can be achieved either by distance or by time (maize). The inbred line may be composited for bulk planting in the next season.
- Maintenance of genetic purity in inbred lines through hand pollination and adequate isolation alone is not enough to achieve perfection.
- The isolated fields must be critically rogued for off types and other impure types prior to the shedding of pollen.
- The nucleus seed crop is harvested after physiological maturity if artificial drying facilities exist.
- Ear to harvest lines are harvested separately and piled; These are again critically examined for ear characteristics, sorting out of all off-coloured, diseased, or otherwise undesirable ears.
- If the overall percentage of off types exceeds 0.1%, hand pollination should be repeated to produce the second year's breeders seed.
- The uniform ears are bulked, dried in a clean dry bin at temperatures not exceeding 43^0C, shelled, cleaned, treated with pesticides, and stored under ideal storage conditions as breeder stock seed. This seed may be increased during the following season by paying adequate attention to isolation, roguing, etc., to maintain high genetic purity of the seed.

Nucleus Seed of Non-Inbred Lines

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

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

Seed Quality

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

Seed is defined as

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

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

As per Seed Act (1966) seed includes

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

Differences between seed and grain

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

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

Importance of seed

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

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

A carrier of new technologies

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

A basic tool for secured food supply

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

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

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

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

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

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

SEED QUALITY

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

The major seed quality characters are summarized as below.

1. Physical Quality:

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

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

2. Genetic purity:

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

3. Physiological Quality:

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

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

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

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

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

4. Seed Health

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

Hence the quality seed should have

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

Characteristics of good quality seed

- **Higher genetically purity:**

  Breeder /Nucleus - 100%

  Foundation seed - 99.5%

  Certified seed - 99.0%

- **Higher physical purity for certification**

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

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

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

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

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

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

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

Objectionable Weeds of Seed Crop Plants

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

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

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

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

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

  Long term storage - 6 - 8 %

  Short term storage - 10-13%

- **It should have high market value**

Role of good quality seed

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

Significance of quality seed

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

SEED AND ITS MULTIPLICATION

Seed multiplication ratio

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

Seed renewal period

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

Seed replacement rate

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

SRR = x / y x 100

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

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

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

Generation system

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

Multiplication ratios and seed multiplication stages

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

CLASSES OF SEED

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

Breeder seed

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

Foundation seed

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

Registered seed

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

Certified seed

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

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

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

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

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

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

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

Differences between certified seed and truthful labelled seed

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

GENERATION SYSTEM OF SEED MULTIPLICATION

Generation system of seed multiplication

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

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

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

a. Three - Generation model

Breeder seed - Foundation seed - Certified seed

b. Four - Generation model

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

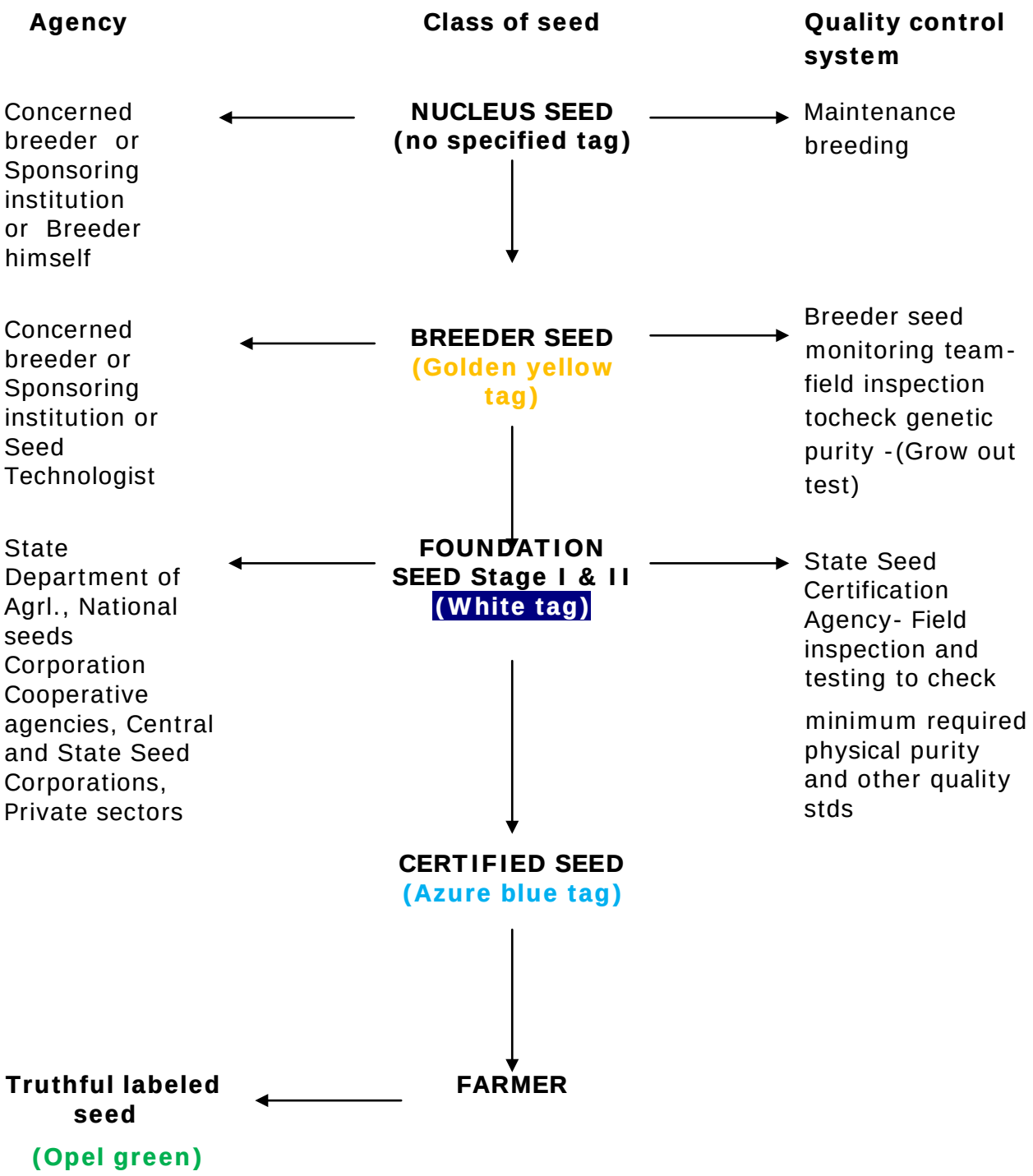
c. Five - Generation model

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

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

GENERATION SYSTEM OF SEED MULTIPLICATION AND QUALITY CONTROL

(NOTIFIED VARIETIES AND HYBRIDS)



Nucleus and Breeders seed production

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

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

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

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

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

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

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

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

b. Table examination of samples: The two hundred plants of each sample should be threshed separately and the seed should be examined in piles on the table. Discard any pile appearing obviously off type, diseased or otherwise unacceptable. The seeds of each two hundred plant samples or less is now ready to be sown in a variety purification nursery called as nucleus.

c. Locating and seeding of nucleus: Each nucleus seed should be grown on clean fertile land at an experiment station in the region or in area in which this new variety could be grown, in the event of its release. The land must not have had a crop of the same kind in the previous year.

d. Inspection of nucleus two-row plots and removal of off types: Throughout the season of growth, from the seedling stage until maturity, the nucleus plot should be examined critically. Differences in the habit of early plant growth, leaf colour, rate of growth, time of heading, height head characteristics and diseases reactions should be looked for. If a plot differs distinctly from the average in the preheading stages of growth, it should be removed before heading.

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

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

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

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

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

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

Maintenance of breeder's seed of established varieties

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

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

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

Carry-over Seed

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

SEED PRODUCTION IN MAIZE

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

Floral biology

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

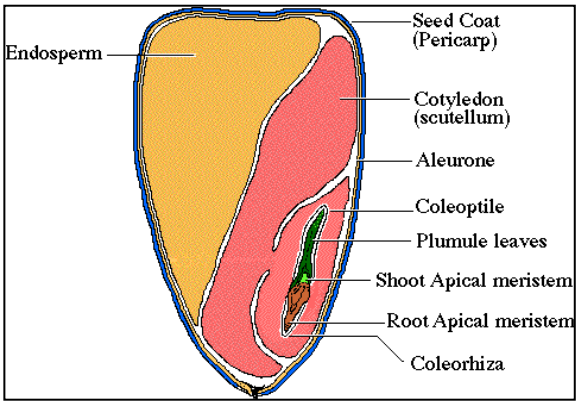
Tassel

Cob

Husk

Silk

Seed



Types and Methods of seed production in maize

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

a. Open pollinated varieties

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

b. Synthetics

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

c. Composite varieties

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

d. Inbreds

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

Varietal seed production technique

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

Stages of seed multiplication

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

Popular varieties

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

Season

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

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

Land requirement

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

Isolation distance and Modification of isolation distance

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

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

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

Selection of Seed

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

Pre sowing seed treatment

The seeds are given with any one of the seed treatment or in combination. Seeds are soaked in 2% KH_2PO_4 for 16h with a seed to solution ratio of 1:0.06

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

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

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

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

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

Sowing

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

Plant spacing

Row spacing

Seed rate

Varieties : 20 kg /ha

Nutrient application

At last ploughing apply 12.5 tonnes of compost per hectare

Fertilizers(varieties) 150:75:75

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

Micronutrients

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

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

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

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

Weeding

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

Irrigation

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

Pest and disease management

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

Roguing

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

Seed Certification

Number of Inspections

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

Field Standards

General: Maize field should be isolated from contaminants as follows

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

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

Specific standard: These are verified at the final inspection

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

Preharvest sanitation spray

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

Seed maturation

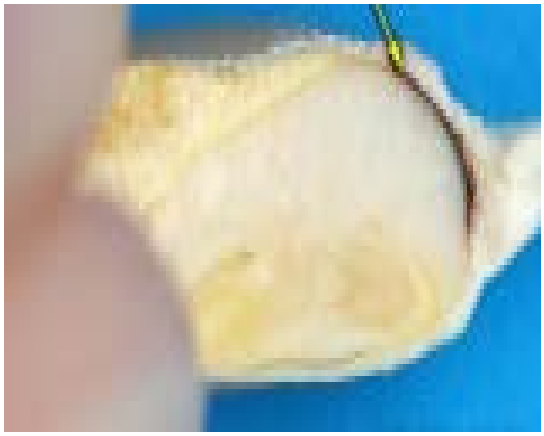
- 14-20 DAA milky stages (starch in fluid stage)
- 35 DAA : Soft dough stage
- 45 DAA : Glazad dough stage
- 55 DAA : Ripe dough stage

Symptom of Physiological maturation

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

Matured cob

Dunken layer



Harvesting

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

Dehusking

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

Cob sorting

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

Zenia and metazenia

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

Shelling

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

Drying

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

Processing

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

Seed treatment

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

Seed packing

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

Storage

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

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

Seed yield: 3 to 4.0 tones

Seed standard

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

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

B. Shelling

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

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

Mid storage correction

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

HYBRID SEED PRODUCTION IN MAIZE

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

Detasseling

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

Method

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

Precautions to be adopted during detasseling

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

System of Hybrid seed production

- Detasseling (Manual creation of male sterility)

Types of hybrids

Single cross hybrid

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

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

Double cross

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

Example

Ganga 2 : (CM 109 x CM 110) x (CM 202 x CM 111)

Ganga 101 : (CM 103 x CM 104) x (CM 201 x CM 206)

COH3 : (UMI 101 x UMI 130) x (UMI 90 x UMI 285)

Three way cross

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

Example Ganga -5 (CM 202 x CM 111) x CM 500.

COH (M) 4 : (UMI 90 x UMI 285) x UMI 112

Double top crosses : The first generation resulting from the controlled crossing of a certified single cross and a certified open pollinated variety.

: (A x B) x variety

: (Ax B) will be detasseled and crossed with a variety

Seed production technology

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

Isolation distance

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

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

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

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

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

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

Seed production stages and production of parental lines / hybrids

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

Spacing

Seeds are sown in ridges and furrows

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

Planting ratio

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

Fertilizer

NPK kg / ha	:	200 : 100 : 100
Basal	:	100 : 100 : 50
1st Top	:	50 : 0 : 0 (20th days -vegetative phase)
2nd Top	:	50 : 0 : 50 (Boot leaf stage at 45 days)
Foliar	:	DAP 2% at 50% flowering
In Zn deficient soil	:	$ZnSO_4$ @ 25 kg ha^{-1}

Roguing

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

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

Field standard (%)

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

Inseparable other crop : Nil (both stage)

Objectionable weed : Nil (both stage)

Designated diseases : Nil (both stage)

Field standards –specific

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

Number of inspection : Four

(Seed certification officers) : One : Before flowering

: Three : During flowering

Harvest

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

Threshing

a. Dehusking - The husks are removed manually.

b. Cob sorting - Remove ill filled, diseased cobs and cobs having kernel colour variation.

Zenia

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

Matazenia

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

Shelling

Cob sorting should be the first operation it is a post harvest, evaluation for genetic purity. The sheath is removed and check for kernel colour, shank colour, diseased cobs, kernel arrangement. The cobs are shelled either mechanically or manually at 15-18% moisture content. Improper shelling leads to48% damage to kenel Growth of storage fungal Pericarp damage. Crack on pericarp can be identified by $FeCl_3$ or Tz test. Shelling is done mechanically using cob sheller and manually by rubbing with stones.

Drying

Seeds are dried to 12% moisture content.

Grading

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

Seed treatment

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

Others: As in varietal seed production

Seed yield : 2.5 - 3.6 t/ha

Seed standard inbred, varieties and hybrids

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

Production of Synthetic cultivars

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

In pure-line theory of classic plant breeding, a pure line is defined as all the descendants of single homozygous individual by continued self-fertilization, resulting in a homogeneous cultivar. Hybridization, however, results in significant heterogenity. The multiplication of such heterogenous progeny in bulk to select homozygous individuals would be gigantic task. Most modern hybrid cultivars are, therefore, selected at an early stage (F_2) as subsequent lines and probably released at the F_8 and F_{12} generations. These are obviously not as homogeneous as a pure line.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

SEED PRODUCTION TECHNIQUES IN PADDY VARIETIES

Phenology

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

Varietal seed production

Stages of seed production

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

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

Land requirement

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

Isolation

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

Selection of seed

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

Seasons practiced at Tamil Nadu

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

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

Selection of season

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

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

Rainfed rice	June-July and Septemb – October	Specific to location	ADT 38 ADT39 (Medium Duration Varieties)

Seed Rate

It varies with varieties and type of cultivation.

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

Seed Management Technique

Dormancy

Paddy exhibits dormancy which varies for duration of 0-30/45days depending on the variety. This could be broken by either soaking in KNO_3 0.5 % for 16 hr or soaking in 0.1N HNO_3 for 16 hrs. However the duration and concentration vary with varieties (e.g.) ADT36 exhibit 20-30 days of dormancy period from days to physiological maturity period which could be broken by soaking the seeds in 0.5%KNO3 for 16 hrs. Practically the intervening duration between the harvesting, and threshing, and further drying will remove the dormancy.

Seed Upgradation Technique (Egg Floatation Technique)

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

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

Methodology

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

Caution

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

Sprouting of seeds (pre germination)

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

Hardening and other seed management techniques

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

Nursery Management

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

Nutrient Management

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

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

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

Sowing

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

Nursery sowing

Water Management

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

Weed Management

Apply any one of the pre emergence herbicides viz. butachlor 2l per ha,thiobencarb@2l/ ha, pendimithalin @ 2.5l/ha on 8^{th} day after sowing to

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

Pest Management (NURSERY)

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

Age of transplanting

The age of transplanting vary with varieties as follows

DURATION OF VARIETIES	AGE OF TRANSPLANTING
Short duration varieties	18-22days

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

Pulling out of seedling

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

Main field preparation

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

Fertilizer Requirement

CROP DURATION	**FERTILIZER REQUIRMENT (Kg / ha)**

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

Transplanting

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

Details on transplanting

Specifications	Duration of cultivars		
	Short	Medium	Long
No. of seedling per hill	2-3	2	2
Depth of planting (cm)	3	3	3
Spacing (cm)	20 x10	20 x15	20 x20
No. of hills/m2	50	33	25

Breeder seed multiplication	Adopt double row planting with a spacing of 15 x 10 cm for easy roughing

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

Weed Management

Pre emergence herbicide

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

Gap Filling

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

Pest and disease management

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

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

Water Maintenance of Paddy

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

Top Dressing

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

Foliar Spray

- Spray $FeSO_4$ 0.5% to prevent yellowing of plants in calcarious soils.
- Spray DAP 2% to enhance seed set in paddy cultivars (BEST).
- Spray GA_3 three times at panicle initiation stage for complete exertion of panicle (hybrids).
- Spray panchakavya 1% for organic seed production to enhance seed set.
- Spray 0.5 % zinc sulphate thrice during crop growth on 20^{th} 30^{th} and 40^{th} day of planting for short duration varieties or 30^{th} 40^{th} and 50^{th} day for medium and long duration varieties in case of zinc deficient soils.

Rouging

- Is important to maintain for maintenance of genetic purity.

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

Physiological maturity

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

Pre-harvest Sanitation Spray

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

Harvesting

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

Threshing

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

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

Winnowing and Drying

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

Grading

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

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

Seed Treatment

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

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

Seed Yield

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

Storage

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

Mid storage Correction

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

Seed Certification

Land Requirement

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

Number of Inspections

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

Field Standards

General: Paddy field should be isolated from contaminants as follows

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

Specific standard: These are verified at the final inspection

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

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

Seed Standard

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

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

Paddy Bunt

HYBRID SEED PRODUCTION IN PADDY

Breeding technique for commercial hybrid seed production	:	Cytoplasmic geneic male sterility system
Stages of seed production for seed certification	:	Breeder seed – foundation seed certified

Seed Multiplication work at different Stages

Breeder Seed stage	:	A (AxB), B, R lines are raised separately under isolation.
Foundation Seed stage	:	A (AxB) and R lines raised separately under isolation.
Certified seed stage	:	A and R line are crossed under isolation to get hybrid.

Systems of hybrid seed production

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

Popular hybrids

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

Genes involved in EGMS

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

Advantages of EGMS system

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

Genes for fertility restoration in CGMS system : Rf1 and Rf2

COMMERCIAL SEED PRODUCTION TECHNIQUE

Land requirement : similar to variety

Isolation

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

Season

Kharif (May- June sowing)

Rabi (December- January sowing)

Rabi is more suitable than kharif.

Favourable climatic conditions during flowering for higher seed set.

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

- ✓ Free from continuous rain for above 10 days during peak flowering season.

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

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

Seeds

Seed selection: Purchase from authenticated source with tag and Bill

For Foundation stage - (A & B lines)

For Certified stage - (A & R lines)

Seed rate : Female : 20 kg /ha

: Male : 10 kg /ha

Nursery Management

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

Main field Transplanting

Spacing

Between A line - (15 x 15cm)

Between A and R line - (20 x15cm)

Between R line - (30 x 15cm)

Age of transplanting

A line : 25 days

R line : 14,18,20 days

Fertilizer

Hybrids : 150:60:60

N & K applied in 3 splits

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

Staggered sowing of parents for synchronization

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

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

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

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

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

Staggered seeding of R line for synchronization.

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

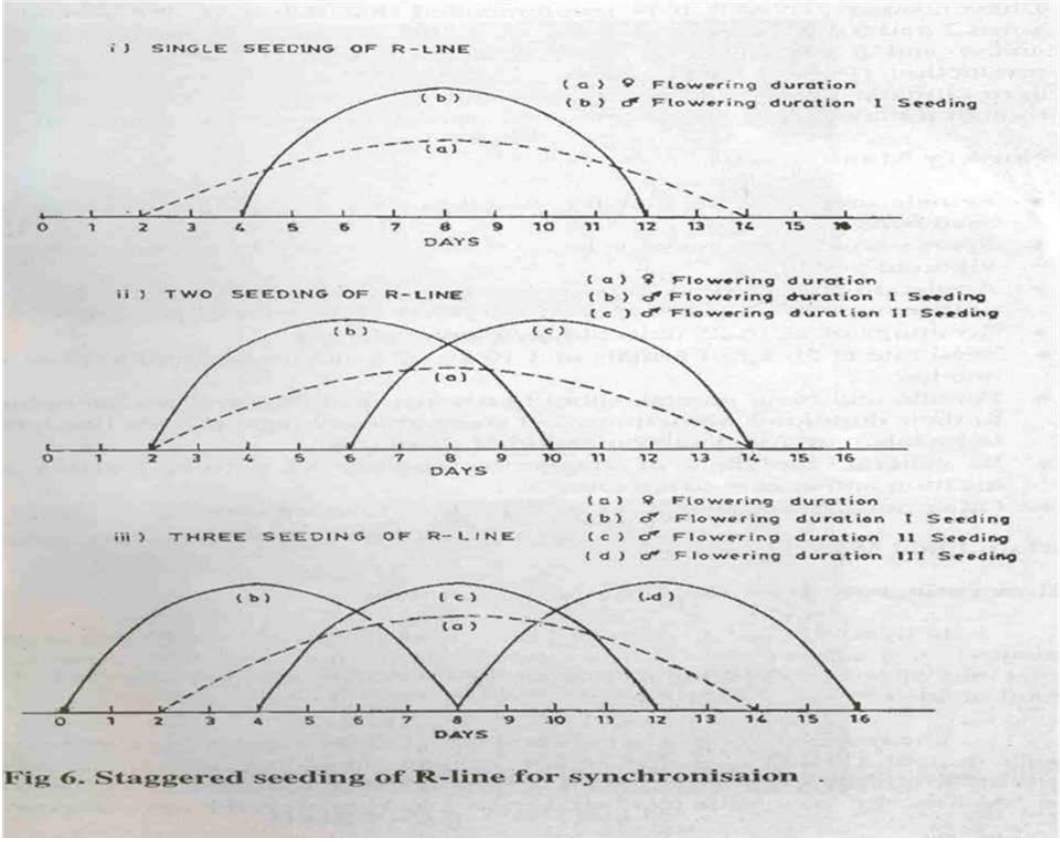


Fig 6. Staggered seeding of R-line for synchronisaion .

Row ratio: 8:2 or 10:2

Factors influencing row ratio

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

Layout for transplanting

To facilitate out crossing, the rows of male and female in the seed production plot should be perpendicular to the prevailing wind direction expected at flowering time of the parents.

Practically a row ratio of 8:2 (A x R) is currently adopted for hybrid seed production and the transplanting sequence for 8:2 row ratio is as follows:

Transplanting of the 'R' line

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

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

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

R	R	A	A	A	A	A	A	A	A	R	R
•	•	x	x	x	x	x	x	x	x	•	•
•	•	x	x	x	x	x	x	x	x	•	•
•	•	x	x	x	x	x	x	x	x	•	•
•	•	x	x	x	x	x	x	x	x	•	•
•	•	x	x	x	x	x	x	x	x	•	•
•	•	x	x	x	x	x	x	x	x	•	•
•	•	x	x	x	x	x	x	x	x	•	•

•	•	x	x	x	x	x	x	x	x	•	•
R	R	A	A	A	A	A	A	A	A	R	R

Female: Male ratio = 8:2 wind direction :

Transplanting of the 'A' line

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

Prediction of heading date

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

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

Method of observing panicle initiation

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

Adjustment of flowering date

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

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

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

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

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

Application of Gibberellin (GA_3)

GA_3 plays an important role in rice hybrid seed production. It can adjust physiological and biochemical metabolism of rice plant especially stimulating the elongation of young cells. About 25-30%. spikelets of a panicle are inside the flag leaf sheath in most of the indica CMS lines than that of the Japonica CMS lines. GA_3 has a definite role in exertion of panicle. In general, it is recommended that 50 g /ha with knapsack sprayer in two split doses, i.e. spray on 15-20% earhead emergence and 2^{nd} spray in the next day for enhanced seed set.

GA_3 will not dissolve in water and hence it should be dissolved in 75-90% alcohol (1g in 20-25 ml of alcohol) and make the required solution. Spraying should be done at 8 to 10 a.m. and 4-6 p.m.

Advantages of GA_3 application

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

Supplementary pollination

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

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

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

Foliar spray

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

- ✓ Short duration: Ist Spray on 60 DAS
  IInd " 80 "
- ✓ Medium duration: Ist Spray on 80 DAS
  IInd " 100 "

Roguing

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

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

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

Roguing in hybrids

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

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

Rogues / off types : Based on variation in phenotypic Characters

Harvesting, threshing & drying

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

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

Seed treatment

Seeds are treated with thiram / captan @ 4 g/kg. or with 5 gm halogen mixture. The halogen mixture is prepared by mixing $CaOCl_2$ + $CaCO_3$ for 1 week in air tight container.

Storage

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

Others - As in variety

Seed Yield

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

General Tips

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

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

SEED PRODUCTION IN SORGHUM

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

Floral biology

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

VARIETAL SEED PRODUCTION

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

Stages of seed multiplication

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

Popular varieties

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

Season

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

Land requirement

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

Field Standards for isolation

Sorghum field should be isolated from contaminants as follows

Contaminants	Minimum distance(m)	
	FS	CS
Fields of other varieties of grain and dual purpose sorghum	200	100

Fields of same variety not confirming to varietal purity requirements for certification	200	100
Johnson grass (Sorghum halapense)	400	400
Forage sorghum with high tillering and grassy panicle	400	400

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

Seed and sowing

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

Presowing seed treatment

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

- Seeds are soaked in 2% KH_2PO_4 for 16h with a seed to solution ratio of 1:0.06 and are dried back to their original moisture content of 8-9% .This management could be used both for dry land agriculture as well as garden land.

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

Nutrient application

- At last ploughing apply 12.5 tonnes of compost per hectare.
- The fertilizer requirement of seed crop is 150:50:50 kg of NPK, in which 100:50:50 kg / ha of NPK is applied as basal, while 25kg of N is applied after first weeding and the remaining 25 kg of N is applied after boot leaf stage.
- The seed crop is also sprayed with 2% DAP at primordial initiation stage and twice thereafter at 10 days interval.
- In calcarious soil and in problem soils FeSo4 0.5 % is sprayed thrice at 10days interval from primordial initiation stage.

Weeding

- Application of atrazine @ 10ml per litre as pre-emergence herbicide control the growth of weeds upto 20-25 days.

- One hand weeding at the time of primordial initiation keep the field free of weeds. Weeding after boot leaf stage is not economical.
- On organic production, 2 hand weeding at seedling stage and other at boot leaf formation will keep the field weed free
- At 15-20 days after sowing furadon granules are placed at leaf whorls to avoid shootfly infection.

Irrigation

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

Pest and disease management

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

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

Roguing

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

Specific standard: These are verified at the final inspection

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

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

Smut

Ergot

Seed Certification

Number of Inspections

A minimum of three inspections shall be made as follows:

1. The first inspection shall be made before flowering on order to verify isolation, volunteer plants, and other relevant factors,

2. The second inspection shall be made during flowering to check isolation, offtypes and other relevant factors

3. The third inspection shall be made at maturity and prior to harvesting to verify true nature of plant and other relevant factors

Preharvest sanitation spray

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

Harvesting

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

Threshing

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

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

Drying

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

Processing

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

Seed treatment

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

Seed packing

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

Storage

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

Seed yield : 3000-4000kg/ha

Seed standard

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

Seed Standard

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

Mid storage correction

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

HYBRID SEED PRODUCTION IN SORGHUM

Breeding technique for Commercial production

Cytoplasmic genetic male sterility (CGMS)

Seeds produced in different stages

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

Stages of Seed Production

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

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

Certified seed ---> A x R

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

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

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

Foundation seed production : A and B line are raised in 4:2 ratio with 4 rows of B line as border row and allowed for cross pollination. The seeds from A line will be collected as A line seeds (multiplied).

Certified seed production : Hybrid seed production

Commercial in Hybrid seed production techniques

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

Johnson grass

Forage sorghum

Seeds and sowing

Seed rate	:	A line : 8 kg ha^{-1} R line : 4 kg ha^{-1}
Spacing	:	A line : 45 x 30cm R line : 45 x solid row spacing.
Planting ratio	:	Foundation seed stage: 4:2 (A: B) Certified seed stage : 5.2 (A:R)
Border rows	:	4 rows of male (either B or R line) to, supply adequate pollen.
Live markers	:	• Live plants used for identification of male line live markers are used. • It should have distinguishable

morphological characters.

- Live markers can be sunflower, daincha etc.

Manures and Fertilizers

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

Synchronization technique

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

✓ CSH-5, MS 2077 A must be sown 10-15 days earlier to the male CS 3541,

✓ CSH 6, the female parent MS 2219 A can be sown simultaneously with CS 3541

✓ CSH 9, the female parent MS 296 A must be sown 7-10 days earlier than male CS 3541 in November- December season.

2. Spraying growth retardent MH 500 ppm at 45 DAS, delays flowering in advancing parent. MH wont dissolve in water and hence dissolve it in NaOH and then mix with water.
3. Urea spraying 1% to the lagging parent.
4. Withhold one irrigation to the advancing parent.
5. Spraying CCC 300 ppm will delay flowering.

Roguing: Do it in both parents.

Off types

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

Types of contamination

Presence of B line in A line called as pollen shedders

Presence of A line in Bline called as off type

Presence of R line in B line called as rogue

Presence of B line in B line called as rogue

Presence of B line in Rline called as rogue

Presence of B line in R line called as rogue

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

Pollen shedders

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

Partials

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

Field Standards

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

Designated disease

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

Method of harvesting

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

Threshing

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

Drying

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

Processing

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

Seed treatment and storage

- ✓ The seeds are treated with captan or thiram @ 2 g/kg of seed and pack it in cloth bag at 12% moisture content for short term storage and 8% moisture content in 700 gauge poly ethylene bag for long term storage (or)
- ✓ The seeds can also be treated with halogen mixture @ 3 g/kg of seeds. The halogen mixture is prepared by mixing $CaOCl_2$ and $CaCO_3$ +*Albizzia amara* at the rate of 5:4:1 and this mixture is kept in an air tight plastic container for 1 week. After one week the mixture is used for seed treatment.
- ✓ The treated seeds can be stored upto 12 months under open storage and upto 18 months in moisture vapour proof containers, provided it is not infested by the storage insects.

Seed yield : 3000 kg ha^{-1}

Seed standards

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

Other crop seed	5 kg^{-1}	10 kg^{-1}
Weed seed	10 kg^{-1}	20 kg^{-1}
Other distinguishable variety	10 kg^{-1}	20 kg^{-1}
Ergot disease by number	0.020%	0.040%
Moisture content		
Moisture pervious container	12	12
Moisture vapour proof container	8	8

Others – as in varieties

PRICING POLICY

Seed pricing involves setting prices when a new product is launched or a new distribution channel is used. Also, decisions may need to be taken to change the price in response to competition and to the general market situation.

In the public sector prices are often based on an economic pricing policy. Economic pricing considers the effect of seed price on the economy, taking into account the amount officials think farmers can afford to pay and the role of the seed industry in the development of agricultural production. Ideally, however, the public sector should follow a more commercial pricing policy which accounts for all costs and allows for an element of profit.

Some objectives in government seed pricing could be:

- to induce farmers to use certified seed of improved varieties in order to increase national production
- to provide adequate incentives to seed producers to supply seed in sufficient quantity to meet demand
- to encourage the development of private distribution channels
- to implement government agro-economic policies.

Some objectives in private sector seed pricing are likely to be:

- props maximization which will be the long-term target although there may be many other shorter term considerations which will influence pricing policy, such as increasing market share and gaining acceptance of new products
- price competition, may be achieved by setting a price that gives a competitive edge in the market place but may not be lower than that of a rival because other factors, such as service, will be contributing to a company's competitive advantage
- a yield 01? investment which must be at least as good as other uses for investors' funds.

Pricing strategies

Once a company's seed pricing objectives have been established, different pricing strategies must be considered. These include:

Low price strategy

Low price strategies are used where consumers respond very positively to small downward changes in price, but a company may not always gain from setting low prices as more efficient competitors may respond with similar price cuts. If the product is not particularly price sensitive then the net effect of a price reduction can simply mean a reduction in revenue. A company may be tempted to reduce its price where similar or substitute products are also sold or when there is an oversupply. However, seeds can become devalued by selling them cheaply especially where there are real benefits associated with the product. Imported vegetable seeds are often chosen by farmers in preference to locally produced varieties in the belief that they are better because they are more expensive. It is therefore critically important to understand the likely response of the farmer when adopting a low price strategy.

Market price strategy

Where a few large companies dominate supply, products tend to be similar (known in the seed industry as "me-too" varieties) and the role of price tends to be neutral, i.e. a market price is established.

High price strategy

This strategy can be used as a long- or short-term policy. In the case of the long-term policy the company will have identified a market segment for a high quality, value-added product such as graded and treated seed for precision drilling. A high price will reflect the exclusive image or added value of the product. A short-term, high-price policy takes advantage of a new product introduced onto the market, as may be the case with a new high-yielding variety where supply is limited.

Pricing techniques

The important influences on pricing are cost, demand, prices of the product's main competitors and short-term sales targets.

Cost-plus pricing

This method involves calculating the unit cost of a product and adding the appropriate profit margin to give a base price which might then be altered in relation to prevailing market conditions. While this seems a simple approach the fact that such pricing is production oriented and may therefore not reflect what is happening in the market place, makes it risky. A rigid application of cost-plus pricing may lead to price increases when demand is lower and reductions when demand is strong. This is the opposite of what should normally be done.

Contribution pricing

This is a form of cost-plus pricing which involves separating the different products that make up the product portfolio and allocating to them the direct costs associated with their production. The price is determined at a level which will generate revenues in excess of these costs, thereby contributing towards meeting business overheads. Individual products can be analysed in terms of their ability to cover their direct costs and contribute to overheads.

Competitive pricing

Where there is market competition, costs cannot always be the determining factor in pricing. Here the nature and extent of competition will have a major influence on the price. If a product is faced with direct competition from similar products the price will be restrained. In contrast, when a product is faced by indirect competition from products in different sectors of the market there will be more scope to vary the price. This provides the possibility of using different strategies.

Short-term pricing techniques

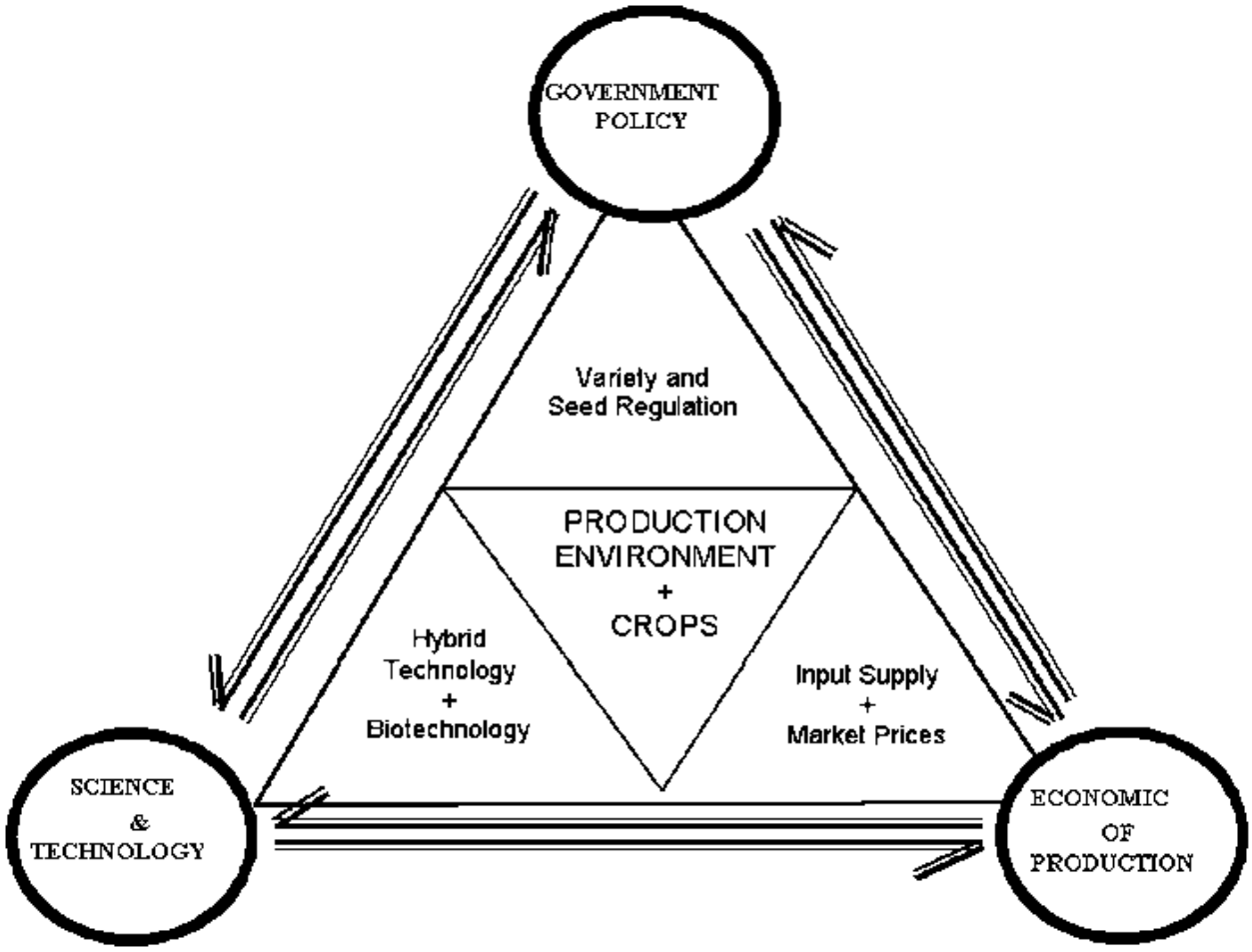
Pricing can be a useful tool for pursuing short-term marketing and sales targets. When a new variety is launched higher prices can be set, providing the opportunity of earning higher returns from those farmers willing to pay the higher prices before seed becomes more widely available. Lower prices may be linked to promotional activities such as boosting sales of established varieties, creating interest in new ones, reducing high stocks and encouraging farmers to buy early.

An overview of factors affecting the seed industry

Three broad influences determine the development and status of the seed industry, namely:

- Technology - especially the flow of new varieties from research;
- Economics - both of seed production itself and of the agricultural sector generally; and
- Policy - creates the commercial and financial environment.

All of these factors can be modified and there are many interactions between them that ultimately determine the size, viability and other characteristics of the seed industry. Figure 1 provides a diagrammatic representation of this analysis, in which various influences on the seed sector are represented within the triangle formed by these three primary elements. Policy has been placed at the top because of the major impact it can have on technology and economics. At the centre lies the production environment, which forms the basis for agriculture, and which cannot be substantially modified, except by irrigation or protected cultivation.



We should recognize seed policy as a major tool for change, but also accept that it cannot alter certain physical and environmental factors and, in a free market, it will always interact with technology and economics. In addition to the policy designed specifically for seeds, wider social and environmental policies may also have an impact on the seed sector and these may be driven by public awareness. For example, the current debate in Europe about the use of genetically-modified crops is not primarily conducted on technical issues about seeds but on wider environmental and food safety concerns. It has nonetheless had a major effect on the seed industry.