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FACULTY OF AGRICULTURAL SCIENCES

AND ALLIED INDUSTRIES

SEED PRODUCTION IN PADDY

Paddy is a self-pollinated crop with cross pollination to an extent of 0-4%. Inflorescence is a panicle, borne on the peduncle of the last internode. The main axis is glabrous to ciliate. The main axis gives rise to primary branches. From the primary branches the secondary branches arise. Rarely tertiary branches are seed. Spikelets are borne on primary and secondary branches. The number of spikelets borne on primary branches shows no variation. It is the number of secondary branches that contribute significantly to the total number of spikelets on a panicle may vary from 80 to 300 in a panicle.

The individual spikelet consists of small rachis in which two rudimentary glumes are borne. Above the glumes lemma and palea are present, which represent bract and bracteole respectively. The lemma is five nerved, leathery and boat shaped. The palea is three nerved. The lemma and palea enclose the gynoecium and androecium. A pair of lodicules represents perianth. The androecium consists of six stamens, bilobed anthers, basifixed, linear and pendulous. The gynoecium consist of superior ovary, monocarpellary, unilocular, two styles with plumose stigma.

Panicle emerges 4 to 5 days after the boot leaf is completely out. The flower opening starts from the tip of the primary and secondary branches and proceeds downwards. Normally 6 to 8 days are required to complete flowering in a panicle. Under normal conditions flower opening is between 7 and 10 am. The flower remains open for 10 minutes and afterwards it closes. The dehiscence of anthers is independent of spikelet opening. The dehiscence may takes place before opening up of flowers or after flower opening. The stigma is receptive for three days. The pollen grains are viable for 10 minutes under field conditions.The seed multiplication ratio is 1:80(Varieties) and 1:100 (Hybrids).

Methods of seed production

a) **Varieties:** The seeds are sown in isolation and by open pollination seeds are allowed to set and later multiplied in different stages. Nucleus seeds are preserved by ear to row method.

b) **Hybrids:** The tool involved in hybrid seed production is known as cytoplasmic genic male sterility system. It is a three line breeding system, where three lines (A, B and R lines) are involved. A line is a male sterile line and serve as female parent of F1 hybrid. B line is the maintainer line of A line and is male fertile. It is isogenic to A line in all aspects except male fertility. R line is the male line in actual hybrid seed production. It restores the fertility of A line and hence it is known as restorer line.

In hybrid seed production programme particularly in breeder and

foundation seed stages, A line is multiplied with the use of B line and is produced in isolation from R line which is multiplied as that of variety. In certified seed production A line and R line are crossed to produce actual hybrid seed.

Season

The hybrid seed yield is higher in Rabi (January-April) season compared to Kharif

(May-August) season. Seeding of parental lines should be done in such a way that flowering coincides with the following favourable climatic conditions. Daily mean temperature should be 25-30^{o}C. The RH should range from 70-80%. The difference in temperature between day and night should be 8-10^{o}C.

Land requirement

Land should be fertile with good irrigation and drainage facilities. It should be free from volunteer plants. It should have good sunlight and aeration. The seed crop should be isolated from other varieties of the same crop. The field should not have been grown with the same crop in the previous season. If grown, it should be the same class of seed for the same variety and approved by seed certification agency.

Isolation

Isolation distance is 3 m for varieties in both foundation and certified class of seed. For hybrid the isolation requirement is 200 and 100 m at foundation and certified seed stages respectively. When space isolation is not possible the time isolation of over 21 days or barrier isolation with polythene sheets of 2m height or barrier crops like sesbania, sugarcane and maize covering a distance of 3m would serve as isolation.

Seeds and sowing

The basic seeds should be obtained from authenticated seed source with respective certification seed tag and purchase bill. The seed requirement will be 20 Kg, 10 Kg and 10 Kg ha^{-1} of A, B and R lines, respectively. The seeds are sown in nursery beds and are transplanted in the mainfield. The seed rate for varieties is 60 Kg ha^{-1}.

Upgrading of seeds

Upgrade the seeds on weight basis before sowing by density grading using common salt solution having a specific gravity of 1.13 (1.5 kg of salt in 10 litres of waters) and collect only the heavy seeds that sink at the bottom and rinse with water.

Presowing seed hardening treatment

The paddy seeds are soaked in 1% KCl solution for 10 hours in 1:1 ratio. Then they are dried back to original moisture content (11-12%). Then the seeds are treated with Captan/Thiram @ 4g Kg^{-1} and also with Azospirillum/ Azatobacter @ 3 pockets/acre seeds. To raise wet nursery the rice seeds should be pregerminated as the seeds will not germinate in the waterlogged anaerobic condition since oxygen is very essential for germination, which is not available in

the submerged condition. For pregerminating, the seeds are soaked overnight in loosely tied moist gunny bags. Then the gunny bags are tied tightly with thread. The bags are incubated in dark for 24 hours. The emerged plumule can be seen as white dots on the gunny bags after 24 hours.

Dormancy breaking treatment

Seeds may be soaked in 0.18% conc. HNO_3 (240 ml in 45 liters of water) at 1:1 equal volume for 12 - 16 hours. The seeds may then be air dried to original moisture.

Seed treatment

Treat the seeds with panostine quazatine at 0.2 % dissolved in dichlormethane or with cuman at 1.0 % dissolved in 20% PEG for 12 hours to kill ***H oryzae*** internally seed borne pathogen then air dry the seeds.

Nursery management

For hybrid seed production female and male nurseries should be raised separately. Sparse sowing in nursery beds @ 1 $Kg/cent^{-1}$should be practiced to get robust seedlings. Application of DAP @ 2 Kgs/cent if not possible apply straight fertilizers 16 kg of urea and 120 kg of super phosphate. Basal application of DAP is recommended when the seedlings are to be pulled out in 20 - 25 days after sowing.

Advantages of phosphorous application to nursery

i. Seedlings absorb and store phosphorous and utilize even at later stages of crop growth.
ii. If 30 % recommended phosphorous as per soil test is applied to main field besides nursery application, higher yield can be realised.
iii. Application of phosphorous to nursery is very economical.

For proper synchronisation of flowering of male and female parents in hybrid seed production, staggered sowing should be done for male parent.

For A line seed production B line should be sown 6 and 10 days after the sowing of A line in both the season. The days of staggering varies according to the location, season and duration of parents. Seedlings are to be transplanted at the age of 25 days.

Main field preparation

The male either B or R line and female (A line) can be planted in the row ratios of 2:8 or 2:10. Planting the seedlings perpendicular to wind direction will facilitate higher outcrossing. The male rows are to be planted first (2 rows) and should be followed with female rows (8/10 rows). Care should be taken not to mix the seedlings of A and R lines. Female should be planted as single seedling and male as 2-3 seedling/hill. A good population structure to get more seed yield will be 300-420 effective tillers of A line and R line, respectively/m^2.

Manure's and fertilizers

Farmyard manure can be applied on last puddling @ 12.5 tonnes/ha. The recommended dose of NPK for the hybrid seed production is 150:60:60 Kg ha^{-1}. The P is added at last puddling stage. The N and K are applied in three splits viz., (1) Basal (2) Active tillering and (3) Panicle initiation stage. Additional nitrogen application delays panicle development whereas P and K promote the same. For varieties the recommendation is 150:50:50 Kg ha^{-1} of NPK and N is applied in three split doses.

Bio-fertilizer application

When bio-fertilizers are used through seed, seedlings and main field apply only 75% of N recommended for the area by the soil testing laboratory. For low land rice Azospirillum strain IPI responds well.

HYBRID RICE SEED PRODUCTION

Male Sterility system in Rice

Rice strictly a self pollinated crop. In hybrid rice seed production, cytoplasmic male sterility system is mainly utilized to produce bulk quantity of seed. There are three types of breeding systems they are as follows.

i. **Single line breeding :** It is based on apomixis and tissue culture
ii. **Two line breeding**
a) **Emasculation and dusting method**
b) **Use of Environmentally Induced Genic Male Sterility (EGMS) system**

In rice EGMS system is commonly used. In EGMS system two kinds of rice lines are made use of viz., PGMS (Photo sensitive Genic Male Sterility) and TGMS (Thermosensitive Genic Male Sterility) which have been developed successfully in China. In this system male sterility is mainly controlled by one or two pairs of recessive nuclear genes and has no relation to cytoplasm. Developing hybrid rice varieties with this system has the following advantages over the classical CMS system as given below.

- Maintainer lines are not needed
- The choice of parents for developing heterotic hybrids is greatly broadened.
- No negative effect due to sterile cytoplasm
- Unitary cytoplasm situation of Wild Abortive will be avoided.

In this system, exploitation of heterosis can be achieved by developing inter- varietal and inter-subspecific F1 hybrids. In 1991 China had released hybrid combinations using this approach and some of these combination out yielded the best existing hybrids by 10-20 (Yuan, et al, 1994).

Other possible approaches to develop two line hybrid breeding system includes identification of genic male sterility system which would revert to male fertility in response to application of growth regulators and also the chemical induction of male sterility.

Temperature sensitive genic male sterile lines like SA2, F61, TS 29, TS 18, TS 6 are governed by a single parent recessive gene and they turn into sterile under high temperature regimes i.e. 22.0^{o}C (day) /24.0^{o}C (night) while the same plants under low temperature regimes turn male fertile and introduce selfed seeds.Keeping this principle, hybrid seed can be produced.

c). Using chemical hybridizing agents / Gametocides

Characteristics of an ideal gametocide

1. It should make the stamen sterile without affecting the normal functioning of the rest of the plant to ensure the quality and quantity of the hybrid seed on the female parent.
2. It should be safer to human and animals.
3. It should be stable and persistent one, should not be altered by unfavourable weather conditions.
4. Should have high rate of emasculation and produce long exerted stigma
5. Should have high rate of hybridization through male sterility and low rate of selfing. (e.g.) Chemical emasculants / gametocides

1. Malic Hydrazide : 1-2 dichloropyridoxin 3,6 dione

Crystals of MH will not dissolve in water. To get required strength of MH, first we have to dissolve in NaOH 10 N (least quantity of NaOH should be used) and later make it up with water.

2. Ethrel : 2 chloroethyl phosphoric acid

6000-8000 ppm 1st spray - one week before boot leaf stage 4000-6000 ppm 2nd spray - boot leaf stage.

By spraying this we can get 90% male sterility.

3. RH 531
4. Zinc methyl arsenate - 4000 ppm
5. Sodium methyl arsenate - 2000 ppm
6. Calcium sulphomate - 2000 ppm
7. Fussol (Flavo acetamide)

Mechanism of chemical emasculation

The male gametocide (Methl arsenates etc.,) are absorbed by leaves and translocated to panicle within 30 minutes of spraying. Male gametocides in panicle amounts 0.001 % of the total spraying. Within 6 hours the amount reaches to 0.01% of the total spray used. They are present in pistil, stamen and lodicules within the spikelet in the ratio 2:1:1 which makes the pollen to sterile.

Success of chemical emasculation technique depends upon:

1. Use of appropriate dosage of emasculants : Gametocide must emasculate stamen and not compromising pistal sterility.
2. Even coverage of gametocides : Each plant in the natural community must receive equal dose of gametocide during EEP (Effective Emasculation Period).
3. Timeliness :Timely application of gametocide is necessary to achieve effective male sterility.

iii. Three line breeding:

For the first time in the country, four rice hybrids were released for commercial cultivation during 1994, by the State Variety Release Committees. These are **CORH 1 (MGR -1)** for Tamil Nadu , APHR-1 and APHR 2 for Telungana and Rayalaseema regions of Andhra Pradesh, KRH 1 for Karnataka states. Subsequently six more hybrids viz., **CNRH 3, DRRH 1, CORH -2 . ADTRH 1, CRH 1, PHB 71** were released
recently.All were developed using CMS (Cytoplasmic Male Sterile Systems).

Characteristics of cytoplasmic male sterile line.

1. Should have complete pollen sterility to avoid self fertilization
2. Should have stable pollen sterility at different environments
3. It should have good adaptability to cultural practices.
4. Should have good agronomic potential
5. Should have fair to good general combining
ability (**e.g.)** cytoplasmic genetic male sterile
lines.

Flowering and synchronisation

The flowering period of male (6-8 days) and female (8-10 days) vary between the parents. For perfect synchronisation of flowering between male and female parent is essential for seed set. The synchronisation can be achieved by adopting any one of the following techniques.

1. **Staggered sowing:** By sowing/planting the male line (early parent) in different dates so that its flowering coincide with female. In nursery sowing of early parent (male) can be 2-3 days later than late parent (female). Even in main field, for continuous supply of pollen to the female, the male parent can be planted in 3 different dates. Hence the supply of pollen will be continuous and seed set will be proper.

2. **Urea application:** Apply Urea @ 35 Kg ha^{-1} to the advancing parent (Flowering delayed due to enhancing of vegetative growth by application of urea) or spray (2-3 sprays) 20 Kg urea in Knapsack sprayer in 500 lit. of water ha^{-1} instead of power sprayer. This should be done from 4^{th} stage of panicle initiation which is around 70 days after sowing.

3. **Withholding of irrigation:** Draining of water in R line can delay its flowering by 2-3 days.

4. **GA_3 Application:** The panicle exertion in female parent is not full. Good panicle exertion will help in improving the seed set. Spraying of GA_3 @ 50g ha^{-1} at 15-20% flowering stage in three split doses in consecutive days with knapsack sprayer at 500 litres of spray solution per hectare will increase the seed set and final yield. Morning 8 am to 10 am and evening 5 to 6 pm are ideal for taking up spraying of GA_3. Note: GA_3 is not soluble in water. Hence it should be dissolved with little amount of (1 gm in 10 to 20 ml) 75% alcohol and then volume is made up to the requirement.

5. **Rope pulling/Rod driving :**Passing of rope or rod across the population 3 to 4 times daily for 7-10 days during anthesis will supplement the pollination mechanism and aid in outcrossing in hybrid seed production. The normal anthesis time is between 10 a.m
- 1.00 p.m and 3-4 pm

Rouging

From vegetative phase upto harvest the seed production plot should be checked for rouging out volunteer, diseased and off type plants. Rouging should be done daily from earhead emergence to dough stage. The pollen shedders (presence of B line in A line) and other off types are to be checked at all times and the same should be removed to maintain genetic and physical purity of seeds.

Weed management

Pre-emergence

Post emergence

Field standards

The accuracy of roguing is checked for 2 times i.e., before and after flowering by Seed Certification Officer.

Characters	**Maximum Permitted (%)**	
	Foundation Seed	**Certified seed**
Varieties		
Off types	0.050	0.20
Objectionable weed plants (wild rice)	0.010	0.020
Hybrids		
Off types in seed parent	0.050	0.20
Off types in Pollinator	0.050	0.20
Pollen shedders in female	0.050	0.10
Objectionable weed plants	0.010	0.020

Pest management : In nursery and main field should be done.

Disease management for ex. Blast, brown spot and BLB.

Grain Discolouration

Mancozeb 1000 gm or IBP 500 ml or carbendazim 350 gm per hectare at boot leaf stage. Spray ***Pseudomonos fluorecencs*** (Pf 1 TNAU formulation) @ 1 kg ha^{-1} twice once at booting and again 15 days after first spraying or neem formulation (neem oil) 60 EC (A) 3 % and neem oil 60 EC (C) 3 % twice at booting and again 15 days after first spray.

Physiological maturity

Turning of green seeds (Caryopsis) to straw yellow colour is the stage of physiological maturation in paddy. The earheads should be harvested when the seeds have attained maximum physiological maturity (in 28 and 31 days

respectively for short and medium duration varieties) after the 50 per cent of the spikelets in the panicle have flowered. At this stage 90% of the seeds will be straw coloured and associate with moisture content of 20% for short and medium duration varieties and 17% for long duration varieties.

Harvest

When the panicle turns to straw yellow colour the yellowing of plants is activated. At that stage the irrigation to the seed production plot is with-held and this hastens the drying of the plants/seed. The plants are harvested with intact panicles. The male parent (B/R line) should be harvested first and removed from field and then the seed parent (female) is harvested. Care should be taken to avoid the admixture of female and male lines during harvest.

Threshing

The harvested plants are stacked in a cleaned (free from other variety and volunteer plant seeds) threshing floor. Then either by hand beating or with the use of LCT threshers under large scale production for separation from the plants. The preferable moisture for threshing is 15-18%. This will avoid the occurrence of mechanical injury to the seeds.

Drying

The seed should be dried to a safe moisture content of 10-13% under normal drying conditions.

Grading of seeds

The chaff, illfilled, under sized and oversized seeds are to be removed to maintain the physical purity of the seed to 99-100 %. It is done through processing. The seeds are graded in OSAW cleaner cum grader using proper sieves.

Seed treatment: The seeds are to be treated with Thiram/Bavistin @ 4g and 2g respectively Kg^{-1} as slurry treatment or for bulk storage, the seeds will be fumigated with celphos @ 3 g/m^2 in airtight condition for 7 days (or) Decis + Thiram @ 0.04 + 2.5 g Kg^{-1} as slurry treatment.

Seed Standards (Varieties & Hybrids)

Standards for each class Factor	Foundation	Certified
1. Pure Seed (min.)	98.0%	98.0%
2. Inert matter (Max.)	2.0%	2.0%
3. Huskless Seeds (Max.)	2.0%	2.0%
4. Other crop seeds (Max.)	10/kg	20/kg
5. Other distinguishable Varieties (Max.)	10/kg	20/kg
6. Total weed seeds (Max.)	10/kg	20/kg
7. Objectionable weed Seeds (Max.)	2/kg	5/kg
8. Germination (Min)	80%	80%
9. Moisture (Max.)		
a. Previous container	13%	13%
b. Vapour proof container	8%	8%

Storage

The seeds can be stored upto 1-2 year under ambient storage condition without much reduction in germination (80%) provided they are free from rice moth. In moisture vapour proof containers they can be stored for more than 3 years provided the initial moisture is below 8%.

SEED PRODUCTION IN BAJRA

Floral biology

It is a highly cross pollinated crop. The flowers are protogynous and aid in cross pollination. Inflorescence is panicle. The length and thickness of panicle varies with variety. The main rachis bears numerous rachilla arranged spirally. The number of spikelet per rachila maybe 25. Each spikelet contains two florets, with a short membranous outer glume (G1) and a longer inner glume (G2). Lower floret usually male, consisting of an oblong pointed lemma (L1) enclosing 3 stamens palea (P1) and lodicules absent; occasionally sterile, upper floret with a broad pointed leathery lemma, which may be hairy or hairless at tip, a thin oval palea, 3 stamens with long filaments and bilobed, dorsifixed, versatile anthers, and ovary with 2 styles jointed at base of the fruit (Caryopsis).

The spike emerges about 10 week after sowing, The styles begin to produce 2-3 days later (Protogynous), first at the inflorescence and proceeds downwards over a period of 24 hours and it takes two days to complete the entire spike. Exerted stigma remains receptive for 12-24 hours. Anthers usually emerge after the styles are dry. Emergence of anthers takes place in 2 distinct waves. The first wave involves bisexual florets (upper floret); the second wave usually 2-3 days after the first wave from the staminate florets (lower floret). The anther emergence starts from middle of the spike and proceeds upwards and downwards. Anthesis occurs throughout the day and night with the peak between 8.00 p.m. to 2.00 a.m. The plant is thus markedly protogynous and cross-pollination normally occurs.

Method of Seed Production

Varieties : By open pollination

Hybrids : (a) Tool employed - CGMS system

(b) Lines involved - A,B and R line

Stages of Seed Production

(1) Varieties : Breeder seed ---> Foundation seed ---> Certified seed

(2) Hybrids : Nucleus Seed Production - By ear to row

method BS - A multiplied with B
B and R multiplied under

isolation FS - A multiplied with B
R multiplied under

isolation CS - A and R are crossed to produce hybrid seed

Isolation

	Foundation seed	**Certified seed**
Varieties	400	200
Hybrids	1000	200

Seeds and sowing

Seed should be from authenticated source.Seed used should be of proper stage of seed in seed multiplication programme (Eg.) FS for CS production. Seeds are sown in ridges and furrows method.

Seed rate

1. Varieties : 8 kg/ha
2. Hybrids :1. A line : 6 kg/ha
   2. R line : 2 kg/ha

Spacing

1. Varieties: 45 x 20cm
2. Hybrids
   A line : 45 x 20cm
   R line : 45 cm solid row

Removal of Ergot affected seeds and Sclerotia to prevent primary infection

Dissolve 1 kg of common salt in 10 liters of water. Drop the seeds into the salt solution.Remove the ergot and sclerotia affected seeds which will float.Wash seeds in fresh water 2 to 3 times to remove the salt on the seeds.Dry the seeds in shade

Presowing Seed Management

Use graded seeds for sowing.Treat the seeds with three packets (600 g) of Azospirillum inoculant.Treat the seed with Azospirillum or pellet the seed with arappu leaf powder.

Nursery Preparation

Apply phorate 10 G 180 g or carbofuran 3 G 600g mixed with 2 kg of moist sand, spread on the beds and work into the top 2 cm of the soil to protect the seedlings from shootfly infestation.

The seeds are sown in nursery and then are transplanted to mainfield at the age of 20-25 days. Seeds are sown in lines, in raised bed nursery and are transplanted at seedling stage to mainfield. Seeds can be treated with Metalaxyl @ 6g/kg to avoid the incidence of downy mildew.

Nursery area

7.5 cents Apply 750 kgs of FYM or compost and incorporate by ploughing. Cover the seeds with 500 kg of FYM.

Planting ratio

At FS stage : 4:2

At CS stage : 6:2 (Even upto 16:2 the seed set will be proper)

(Winter season) October - December, the parental lines of Pusa 23 cumbu can be raised in the ratio of 8:2 for maximising hybrid seed production.

Border rows

At FS stage : 4 (B line)

At CS stage : 8 (R line)

Main field preparation

The field is made to fine tilth and is formed into ridges and furrows. The seedlings can be transplanted from nursery or on direct sowing, the extra seedling per hill can be pulled out and transplanted at gaps at 20-25 days after sowing.To avoid shootfly infestation a propylactic spray with rogar can be practiced one week after transplanting.

Manure's and Fertilizers

Compost	:	12.5ton/ha
NPK	:	100 : 50 : 50 kg/ha
Basal	:	50 : 50 : 50 N P K kg/ha
Top	:	50 kg N/ha (30-35 days-tillering phase)
Foliar spray	:	DAP 1% solution is sprayed at peak flowering stage to enhance uniform flowering and increased seed set.

Synchronisation of flowering

The extent of synchronization problem between parents is comparatively less in cumbu than sorghum and paddy due to the tillering habit of the crop. The pollen weight is less and flying capacity is more in this crop. The pollen viability and stigma receptivity is also for longer duration owing to these factors the nicking problem is less in this crop. But, for hybrids with widely varying parents either staggered sowing, or urea application or DAP spray or withholding of irrigation to late parent can be practiced.

Roguing

Roguing is done severely at 3 stages viz., seedling stage, tillering stage and grain formation stage based on leaf colour, leaf waviness, grain colour, earhead shape, size etc. to maintain genetic purity of the crop.

Field standard	**Maximum permitted (%)**	
	FS	**CS**
Off types	0.050	0.10
Pollen shedders	0.050	0.10
Downy mildew diseased plants Ergotted ear heads	0.020	0.040

Jerking

This is done on 20-25 days after transplanting or 30-40 days after direct sowing. The early formed earheads of the first tiller are pulled/removed so that physiological changes will occur in plant and flowering of all the tillers will occur evenly.

Irrigation

Field is irrigated immediately after sowing and on 3rd day life irrigation is given. Then once in 10 days irrigation has to be given. The critical stages for irrigation are tillering, milk stage and maturation stage. Proper and adequate irrigation increase the seed set and yield of quality seed.

Pests

Aphids, Jassids

Diseases

To control ergot disease carbendazim @ 500g/ac or Ziram 1000 ml or Manozeb 1 kg / ac is sprayed at 2 stages. First at 5-10% of population is in flowering phase and 2nd at 50% flowering stage.

Downy mildew

Growing downy mildew resistant varieties CO 7, WCC 75 is recommended. Transplanting reduces disease incidence. At the time of planting infected seedling should be removed. In the direct sown crop, infested plants should be removed upto 45 days after sowing as and when the symptoms are noticed. Treat seeds with Metalaxyl at 6 g kg^{-1} followed by one spraying with Metalaxyl 500 g or Ridomil MZ WP 2 kg ha^{-1} or Mancozeb 1 kg ha^{-1}.

Harvesting

Seeds attain physiological maturation 30-35 days after 50% flowering. This stage coincides with change of seed color from green to straw yellow and formation of dunken layer at the point of attachment to the panicle. The moisture content of seed at this stage will be 30-35%. Due to the tillering habit, the maturation of earhead may not be uniform, hence the harvest can be done in 2 pickings to avoid the ill effects of delayed harvest, where seeds are exposed to adverse environmental condition, which may invite fungal and insect activity. Selection of 5 to 7 tillers for seed purpose is preferable.

Threshing

The earheads are dried for 2-3 days on the threshing floor. Threshing is done at a moisture content of 15-18% either manually (stick beating) or mechanically (LCT thresher).

Processing

The seeds should be processed in OSAW cleaner cum grader using 4/64" round perforated metal sieve as middle sieve one for obtaining uniformity in the sample. For WCC 75 alone 5/64" round perforated metal sieve should be used as middle sieve.

Seed standard

Parameters	Foundation seed	Certified seed
1. Physical purity (%) (min)	98	98
2. Inert matter (%) (max)	2	2
3. Other crop seed (max)	20 kg^{-1}	40 kg^{-1}
4. Weed seeds (max)	10 kg^{-1}	20 kg^{-1}
5. Ergot affected seeds (max)	0.020%	0.040 %

6 Germination % (min)		80		80
7. Moisture content (%) (max)				
a. Moisture pervious	12		12	
b. Moisture vapour proof	5		5	

Seed Storage

The seeds can be stored upto 12 months on pre-storage seed treatment with Thiram @ 4 g kg^{-1}. The seed can be stored upto 24 months if the seeds are stored in polyethylene bags (700 gauge) and treated with Thiram.

SEED PRODUCTION IN MAIZE

Floral biology

The inflorescence is unisexual and monoecious. Staminate (male) inflorescence is terminal are known as tassel and pistilate (female) is axillary are called as cob.

Tassel

It is a terminal lax panicle with spikelets arranged in rows in central axis and lateral branches. Spikelets occur in pairs. One is pedicelled and the other sessile but identical; the glumes G1, and G 2 are long and membranous; with in the glumes there are two florets, both staminate. The florets posses lemma and palea and two fleshy lodicules, stamens are three in number, versatile, and pistil is rudimentary.

Cob

The ear - bearing branch is much like main shoot. It is produced in lateral branch

in the axil of one of the longest foliage leaves. The leaf covers the cob like structures called husk (bracts). These husks are enlarged leaf sheaths from each node, forming a protective covering around the terminal inflorescence. The ear is a spike with thickened axis one which paired spikelets are borne longitudinal rows. Each paired spikelets is two flowered, having 'cupola'. Both the spikelets are sessile and identical. Each spiklet is two flowered, having a pair of small membranous glumes. The lower flower is non- functional, represented by a lemma and palea. The upper one is fertile and consists of a membranous lemma and palea and a knob shaped ovary long thread like style called silk. The style is receptive throughout the length and at the tip is usually cleft into two branches. Lodicules are generally absent.

Maize is an example for protoandry. Pollen shedding begins three days before the silk emerge from the cob. It is estimated that normal plant produces 2,50,00,000 pollen grains. Under normal conditions pollen is viable for 12-18 hours. Fertilization occurs within 12-18 hours after the silk have been pollinated. The entire silk is receptive.

Method of Seed Production

(a) **Varieties :** Raise the varieties under isolation and allow the seeds to set by open pollination.

(b) **Synthetics :**The lines that combine well among themselves are mixed and allowed to set seed by open pollination.

(c) Composites: These are produced by open pollination among a number of outstanding strains usually not selected for combining ability with each other.

(d) Hybrids: Inbreds : The basic genotype used for hybrid seed production is known as Inbreds. It is relatively a true breeding strain resulting from repeated selfing.

Tool employed for seed production

In maize, hybrid seed production is achieved through detasseling, which is the physical removal of male part from the female plants and there by allowing the plant to act as female which is in turn crossed with selected male plant and effect seed setting. This is possible in maize alone due to the monoecious and protandry nature of the flowers.

Types of hybrids

In maize, single, double and three way cross hybrids are available.

(1) Single cross hybrid : It is the cross between 2 inbreds, where one serve as female and other as male.

(ii) Three way cross hybrid : It is the cross between a single cross hybrid (AXB) which serve as female with another inbred (C) which serve as male parent.

(iii) Double cross hybrid : It is a cross between 2 single crosses (AXB) and (CXD) involving 4 inbreds (A,B,C,D)

Steps in hybrid seed production

Seed Production Stages	**Class of Seed**		
	Breeder	**Foundation Seed**	**Certified Seed**
1. Varieties/Inbreds	A	A+	A++
(Multiplied at different stages)			
2. Single cross hybrid		A,B	A,B
	AXB (A and B multiplied separately under isolation)		
3. Three ways cross hybrid	A,B,C	AxB, C	(AxB)xC
4. Double cross hybrid (AXB)X(CXD)	A,B,C,D	(AXB), (CXD)	

Land requirement

The land selected should be fertile and should be free from volunteer plants. The same crop should not have been grown in the previous season.

Isolation distance (m)

Seed Production system	FS	CS
Inbreds, varieties synthetics, composite Single cross (hybrids)	400	200
Singe cross (parents)	400	-
Other hybrids	-	300

Seeds and sowing

Seed should be purchased from authenticated source with tag and bill.Proper stage of seed should be used.

			Seed rate	Spacing
Varieties:			10 kg/ha	45 x 10 cm
Hybrids	:	Female:	12 kg/ha	60 x 25 cm
	Male	:	4 kg/ha	60 x 25 cm

Pre-sowing seed treatment

Seeds are treated with Thiram or Captan @ 4g/kg. After fungicide treatment seeds are treated with 3 packets (600 g / ha) of azospirillum. Halogenise the seeds with either chlorine or iodine as dry or slurry treatment at 3 g/kg of seeds and store in polythene cloth to maintain seed viability more than 10 months.

		Planting Ratio	Border rows
Single cross Hybrid	:	4:2	4
Double cross hybrid	:	6:2	3
Three way cross hybrid	:	6:2	4

Note : For multiplication of A lines (Ax B) 12 kg/ha, 4 kg/ha of seed and planting should be taken in the ratio of 4:2 female to male line.

Manure's and Fertilizers as per recommendations

Detasselling

The tool employed in hybrid seed production of maize is known as detasselling. Tassel is the male inflorescence of maize. Detasselling is removal of tassel/male flowers from the plant. Detasselling should be done in the female parent of hybrid alone. It should be removed before anthesis and immediately after emergence. Detasselling should be completed when the tassel is well out of the boot leaf but before the anthers shed the pollen. It is done everyday from anthesis, upto 14 days.

Procedure for Detasselling

The stem is to be held with left hand and the tassel is to be removed with right hand in one upward pull. The pulled tassel should be taken away from the field and burried beyond the isolation distance. In any case no spikelet should be left which may cause genetic contamination. The leaves also should not be removed as it favour reduction of seed yield.

Roguing

Roguing, is the removal of unwanted, offtype and diseased plant from the seed production plot. The roguing is done based on leaf waveriness, tassel colour, cob shape, stem colour, silk colour, number of leaf, and presence or absence of auricle.

Weed management

Application of micronutrient

12.5 kg of micronutrient mixture should be mixed with sand to make a total quantity of 50 kg / ha is to be applied.Apply the mixture over the furrows and two thirds in the top ridges, if ridge planting is followed.If bed system sowing is followed, apply the micronutrient mixture over the furrows.Do not incorporate the micronutrient in the soil.

Field standards

	Character	Foundation seed	Certified seed
1.	Off type (max.)	0.01%	0.05 %
2.	Shedding tassel (max.)	0.5%	0.5%
3.	Diseased plants (max.)	0.05%	0.1%

Shedding tassel

Some of the tassel, which may remain inside the boot leaf during detasselling due to improper removal of tassel. This may shed pollen and cause genetic contamination. Hence detasselling should be perfect without shedding tassel.

Pest and disease management

Irrigation

Regulate irrigation according to the following growth phase of the crop Germination phase 1 to 14 days
Vegetative phase 15 to 39 days

Flowering phase	40 to 65 days
Maturity phase	66 to 95 days

Irrigation should be given once in a week after life irrigation (3rd day after sowing). The critical stages for irrigation which affect the seed quality are silk formation stage and milky stage of cob.

Harvesting

The cobs of male should be harvested first and are to be removed from the field. The female cobs are harvested as once over harvest. The crop reaches physiological maturation 45 days after flowering. Darkening of silk and drying up of husk to yellow colour are the visual symptoms of physiological maturation.

Dehusking

At threshing floor, the husk of the cob is to be removed either mechanically using maize dehusker or manually.

Cob sorting

This is an important operation to maintain genetic purity in this crop. The dehusked cobs are sorted out for true to typeness based on row number, kernel colour, Kernal size, pith colour, and arrangement of seeds in the cob. The odd ones are removed for the purpose of maintaining genetic purity.

The kernal colour variation in maize is termed as metazenia effect which is the influence of foreign pollen on the female parent.

Shelling

At the moisture content of 15-18% the kernals are separated from the cob, either manually by beating with sticks or mechanically using maize sheller. In both the cases mechanical injury caused to the seed should be avoided.

Drying.

The shelled seeds are dried to 12% moisture content for further safe handling.

Processing

The kernals can be size graded using 18/64" round perforated metal sieve as the middle sieve in OSAW cleaner cum grader.

Seed standards

Standards	**Inbreds**	**Hybrids**	
		Inbreds/Hybrids FS	
		FS	**CS**
Pure seed (%) (min)	98	98	98

Inert melter (%) (max)	2	2	2
Other crop seed (%) (max)	10/kg	5/kg	10/kg
Other distinguishable varieties based on kernal colour & texture (max)	10/kg	10/kg	20/kg
Weed seeds (max)	None	None	None

Germination % (min)	80	80	80
Moisture content (%) (max)			
a. Previous container	12	12	12
b. Vapour proof container	8	8	8

Storage

The seed can be stored well upto one year in gunny/cloth bags after seed treatment with thiram @ 4 kg^{-1}. The important storage insect is ***Sitophilus oryzae*** and storage fungus is ***Aspergillus spp.***