Hybrid seed production technology in maize

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Hybrid seed production technology in maize

Types of Maize

1. Dent Corn: It is characterized by a depression (dent) in the crown caused by the rapid drying and shrinkage of the soft starch at the crown. Of the multiple colors available, the yellow and white colors dominate the commercial production.

2. Flint Corn: Flint corn is predominantly composed of corneous or hard starch that encloses the soft starch at the center. The kernels are smooth, hard, and usually rounded.

3. Floury Corn: consists almost entirely of soft starch and accordingly the kernels are soft. It has the shape of dent corn but shrinks uniformly upon drying.

4. Pop Corn: is an extreme form of flint corn. It has very hard corneous endosperm with only a small portion of soft starch. The most common colors of the kernels are yellow or white. The kernels pop upon heating as a result of the unique quality of endosperm that makes it resist the steam pressure generated until it reaches explosive proportion.

5. Sweet Corn: This corn kernel is characterized by a translucent and wrinkled appearance upon drying. The immature kernels are sweet in taste.

6. Waxy Corn: has a uniformly dull appearance. Instead of amylose, the starch of waxy corn is amylopectin as a result of waxy (*wx*) mutation. Ordinary corn consists of about 78% amylopectin (a high molecular weight branched chain starch) and 22% amylose (a low molecular weight straight chain starch).

7. Pod Corn: Pod corn has primitive features, each kernel being enclosed in a pod or husk, before the entire ear is enclosed in husks like other corns.

Hybrid Maize

Hybrid is the progeny produced by a cross of two different parents.

Why Hybrids? More vigorous and high yielding.

Hybrid type	Female parent	Male parent	Seed yield	Seed price	Hybrid characteristic	Hybrid grain yield
Single-cross	Inbred line	Inbred line	Lowest	High	Uniform	Highest
Three-way	Single-cross hybrid	Inbred line	High	Moderate	Slightly variable	High
Double-cross	Single-cross hybrid	Single-cross hybrid	Highest	Low	Highly variable	Moderate to high
Top-cross	OPV	Inbred line	Moderate	Low	Highly variable	Moderate
Varietal cross	OPV	OPV	Moderate to high	Low	Highly variable	Moderate to low

Hybrid Maize Types

Conventional Hybrids:

i) **Single crosses**: a cross between two unrelated inbreds = (A x B).

ii) **Three-way crosses**: a cross between a single cross and an inbred = (A x B) x C.

iii) **Double crosses**: a cross between two single crosses = (A x B) x (C x D).

iv) **Modified single crosses**: A progeny from two related inbreds as the seed parent and an unrelated inbred as the pollen parent = (A x A') x B.

v) **Double modified single crosses**: A progeny from two single crosses, each developed by crossing two related inbreds = (A x A') x(B x B').

vi) **Modified three-way hybrids**: It is the progeny of a single cross as female parent and another single cross between two related inbreds = (A x B) x (C x C').

Non-conventional Hybrids

i) **Inter-varietal hybrids**:

- Formed by inter-crossing of two varieties.
- Approximately equivalent to synthetics/composites.

ii) **Top cross hybrids**: are inbred x variety hybrids.

It may also,

a. Inbred line x variety

b. Inbred line x synthetic variety

c. Inbred line x family

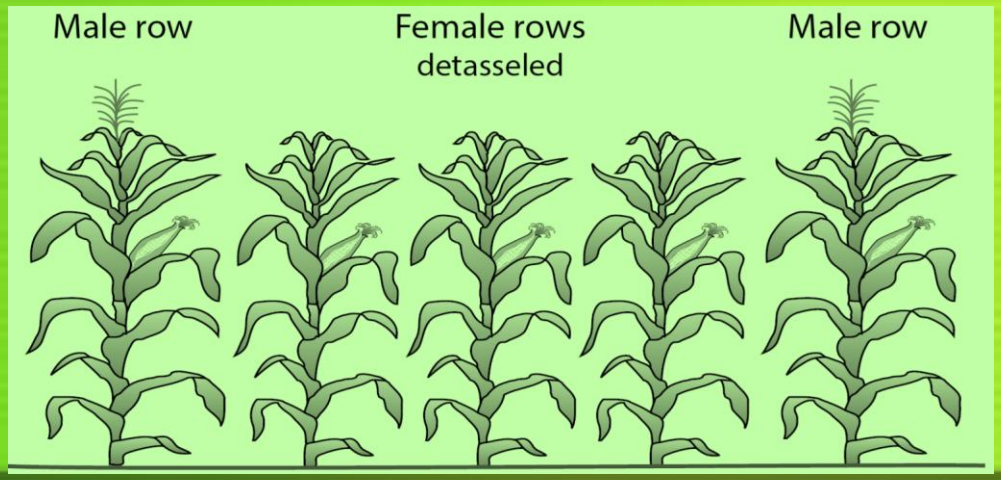
iii) **Inter-family hybrids**: The progeny resulting from the crosses of two families originating from the same population or two different populations.

iv) **Double top cross hybrids**: progeny of a single cross and a variety.

- Single, double and three-way cross hybrids have mostly been commercialized world over.

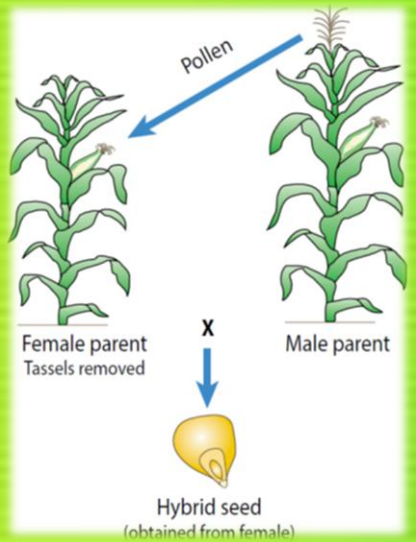
Advantages of Single Cross Hybrids

- High acceptability among the farmers and require only two parents.
- Highest yield potential among cereals as per day productivity is more
- Being C_4 plant has better adaptation under climate change
- Tolerant to biotic and abiotic stresses
- Tolerant to Water stress due to better root system
- Decreases need for irrigation water



Continue….

- Less yield reduction under nutrient stress condition
- Quick and higher percentage of germination
- Require less number of isolation i.e. only three
- Faster growth and most uniform
- Crop diversification and low cost of production



- Food, income and nutritional security for resource-poor farm families.
- Easy to market because of its uniformity and high productivity.
- Single cross hybrids are homogeneous whereas all other kinds of hybrids are heterogeneous.

Prerequisites for hybrid seed production

- Good compatible, uniform, productive and diverse parents.
- Proper site selection, avoid the sites where preceding crop was maize.
- Fertile and quality land with good quality and assured irrigation.
- Proper isolation distance.
- Knowledge of recommended package of practices.
- Technically experienced manpower.
- Stress free season.

Characteristic of good seed parent

Female parent

- Productive
- Strong
- Long cobs with complete exertion
- Low cob placement
- Shorter anthesis silking interval
- Nutrient responsive
- Stay green traits
- Erect leaves
- Resistant/tolerant to biotic and abiotic stress
- Strong root system

Male parent

- Lax tassel, long main branch with few secondary branches
- Long duration of pollen shedding
- Taller than female parent
- Attractive grain color
- Strong resistant to lodging with better root system
- High yield potential
- Resistant/tolerant to biotic and abiotic stresses.

Important considerations for hybrid seed production

PROPER ISOLATION DISTANCE

- Managing pollen drift
- Isolation distance is accomplished in three ways including: a) distance b) time and c) good synchronization.
- Practice of nicking, that is, when the pollen parent starts shedding just before silk emergence in the female parent.
- It includes planting a barrier of foundation or certified seed of the same variety on all sides about 50 m from the production block.
- It depends upon wind velocity/ seasonal, solation for hybrids 500 m.

Male female ratio:

Depends on

- The pollen shedding potential of male parent
- Male female synchrony in flowering.

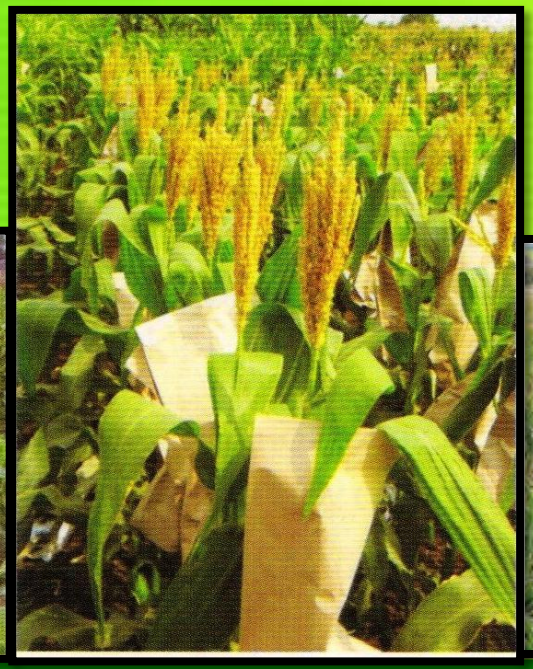
Different ratios are 1:2:1:2:1 or 1:3:1:3:1 or 1:4:1:4:1

6:2 female:male ratio.

3:1 female:male ratio.

To bring male: female synchrony

- Staggered planting of male and female lines.
- Manipulation in the plant distance by spaced and narrow planting.
- Irrigation along with fertilizer application.
- Application of FYM in either male or female to induce earliness and vigor.



Technology for hybrid seed production

- Well drained seed production site
- Disease, weed, pest free
- Preferably the field where preceding crop was not maize to maintain the genetic purity

Time of sowing

- For most part of India First week of July (kharif) to avoid flowering during heavy rains (washing off the pollens)
- First week of November for Rabi to avoid low temperature during flowering (killing anthers)

Method of sowing and layout

- Sowing should be done on the southern side of the east-west ridges for good germination.
- Spacing: 60 X 20 cm
- This spacing helps in easy movement in the field. Viz., roguing, removal of tassels, improving test weight etc.

Seed rate

Depends on

- Seed size/test weight of male and female seed.
- Plant type: In case of erect plant-higher seed rate.
- Male: female ratio- Optimum rate is 15 kg/ha for female and 10 kg/ha for male.
- Minimum germination per cent recommended-80 %.

Seed treatment:

- Necessary to protect the seeds from soil borne diseases and some insect pests.
- Bavistin +Captan in 1:1 ratio @ 2g/kg seed for TLB,BLSB (Banded leaf and sheath blight, Maydis leaf blight etc.
- Apran 35SD @4g/kg for brown strip downey mildew
- Captan 205g/kg for Pythium stalk rot
- Imidachlorpit@4g/kg or Fipronil @4ml/kg seed for termite and shoot fly.

Nutrient management

- Inbreds requires high fertility as compared to hybrids
- FYM@15t/ha 15 days prior to seeding.

Fertilizer:

180-200 kg-N

80 kg P_2O_5

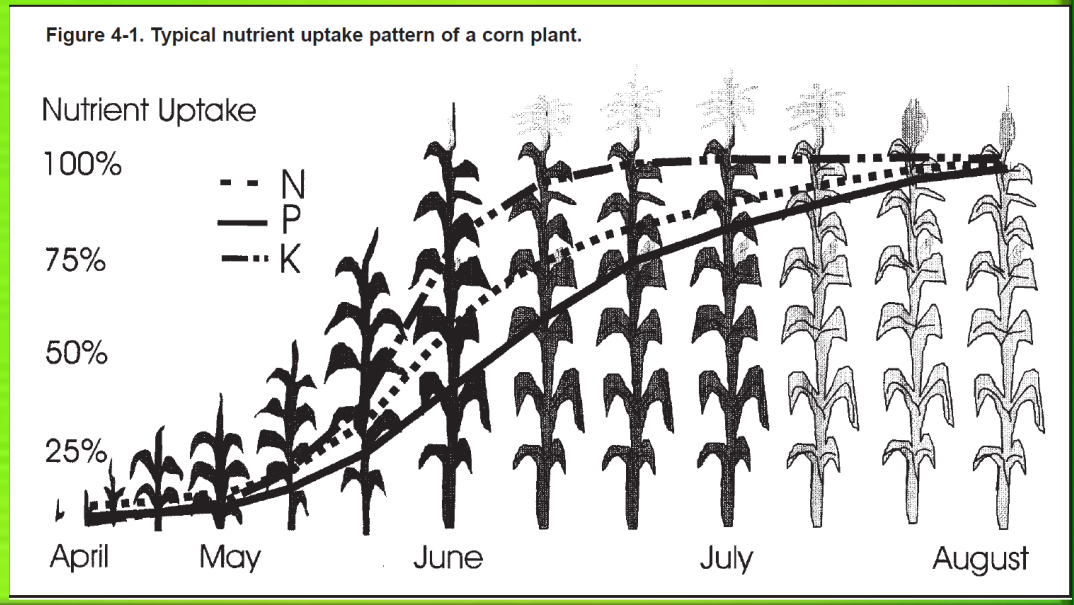
80 kg K_2O

25 kg/ha $ZnSo_4$

Full dose of phosphorus, potash, Zinc and 10 % N applied as a basal dose.

Remaining fertilizers given in the split doses:

1. 20 % N at 4 leaf stage
2. 30 % N at 8 leaf stage
3. 30 % N at flowering stage
4. 10 % N at grain filling stage.



Water management

- Avoid overflow during first irrigation.
- Irrigation should be applied in furrows up to 2/3rd height of the ridges.
- Light and frequent irrigations for inbreds.
- Sensitive stages are:

  Young seedlings

  Knee high stage

  Flowering

  Grain filling

  10 days after grain filling.

- Factors considered for the irrigation:

  Rainfall

  Soil type

  Soil water holding capacity.

Weed management

Major weeds:

Cynodon

Dactyloctenium

Echinocloa

Control:

- Atrazin: Broad spectrum pre-emergent herbicide. @1-1.5kg a.i/ha
- Manual weeding

Cyperus

Amaranthus

Chenopodium

Parthenium

Trianthema

Insect pest management

Major pest: **Stem borer**

Control measures:

1-2 spray of Carboryl or Endosulphan after 10 days and 20 days of germination

First spray: 500 gm Carbotyl or 625 ml of Endosulfan (35 EC)

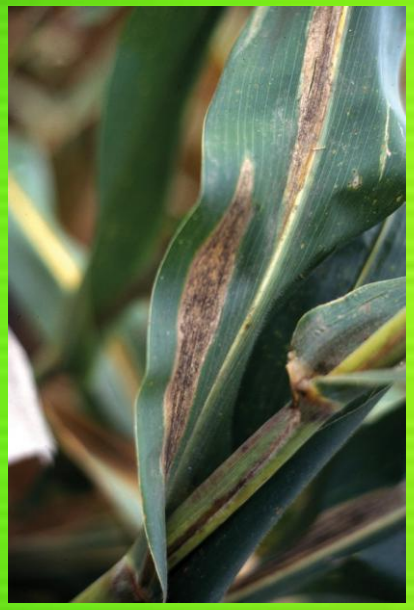
Second spray: 750 gm Carboryl or 900 ml Endosulfan (35 EC)

Disease management

- Estimated loss due to major diseases of maize in India : 13.2 % out of which foliar Diseases (5 %), stalk rots, root rots, ear rots (5 %).

Major diseases:

- Turcicum leaf blight : Zineb/Maneb @ 2.5-4 gm/l at 8-10 days interval.
- Maydis leaf blight: Dithane M-45/Zineb @2gm/l of water (2-4 application)
- Polysora rust: 3 sprays of Dithane M-45 @2-2.5 gm/l
- Banded leaf and sheath blight: Seed treatment of peat based formulation of *Pseudomonas fliorescence* @16g/kg.
  - Soil application @ 7 g/litre water (drenching).
  - Foliar spray of Sheethmar (Validamycin) @2.7 ml/l of water.
- Sorghum Downey mildews: Seed treatment with Apron 35 W.P @2.5 g/kg seed.
- Roguing and destroying infected plants as they appear in the field.



Turcicum leaf blight

Maydis blight

Polysora rust

Banded leaf and sheth blight

Sorghum Downey mildew

Roguing

- Removing unwanted and off plants.
- Should be conducted before genetic or physical contamination.
- Rogue volunteer plants.
- Roguing on male plants must be complete before pollen shedding begins.
- Roguing on female plants should be complete soon after silk-emergence.

Remove Late germinated plants

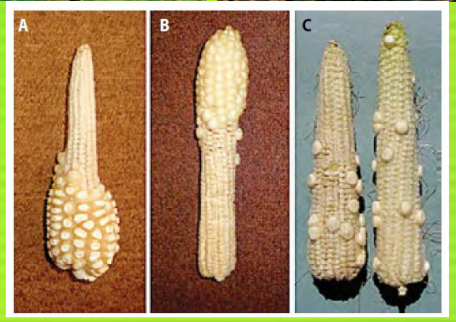
Remove Vigorous plants

Earthing up

- During earthing up 3rd split of N should be applied followed by hoing.
- It should be done before tasseling stage to save crop from lodging.

Detasseling

- Detasseling should be done in female before anthesis.
- Should be practiced row wise.
- No leaf should be removed
- The removed tassel should not be thrown in the field but fed to the cattle.



Controlled pollination

Harvesting

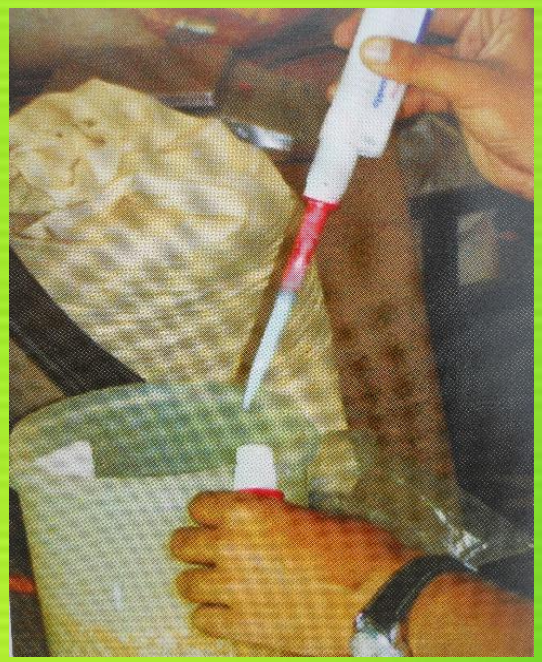
- Male lines harvested first then female.
- Optimum moisture for grain harvesting should be 20 %.
- Harvested crops should be spread evenly instead of pooling.

Stages of crop inspection

1. At the time of sowing
2. During pre flowering/ vegetative stage.
3. During flowering
4. During post flowering and pre-harvest stage
5. Harvesting time.

Post harvest management

- Drying and sorting of seed parent cobs: Sun drying is the best.
- Spread on Tarpoline sheets to avoid seed injury.
- 13-14 % moisture should be retained.
- Shelling: Shelling should be avoided during high moisture to avoid embryonic damage.
- It can be done manually or power operated maize sheller.

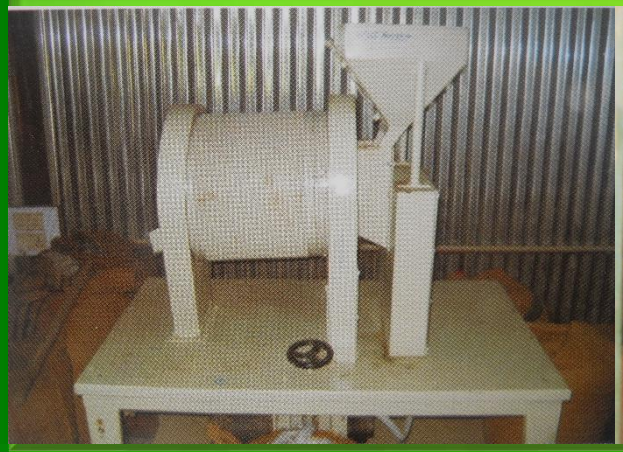
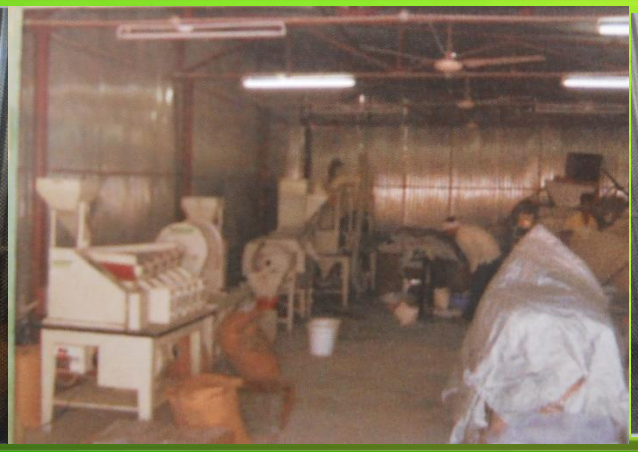


Seed processing

- Should be undertaken when seeds dry completely.
- To maintain quality remove all under sized, broken, damaged and malformed seeds.
- Should be done in seed processing plant.

Seed storage and marketing

- Seed drying should be done to bring moisture up to 8 % and should be kept in aerated jute bag.
- Store in dry and cool place to avoid germination and vigor loss during storage.


List of few released hybrid varieties for Uttar Pradesh

Extra early maturity	Early maturity	Medium maturity	Late maturity
Vivek 5, Vivek 15, Vivek 17, Vivek 21, Vivek 27, PMH 2	JH 3459, Prakash, PEH 2	HM 8, HM 10, Malaviya Hybrid Makka 2, Bio 9637, DK 701	NECH-132, NECH-131, Buland, Pro Agro 4212, Pro 311, Bio 9681

QPM hybrids

HQPM 4, HQPM 5, and other hybrids of HQPM series.

Seed Production standards

Isolation distance for maize hybrids

Contaminants	Minimum distance (meters)
1	2
*Fields of any maize with same kernel colour and texture	200
Fields of any maize with different kernel colour and texture, and teosinte	300
*Fields of the same hybrid (code designation) not conforming to varietal purity requirements for certification	200
*Fields of the other hybrids having common male parent and conforming to varietal purity requirements for certification	5
*Fields of the other hybrids having common male parent and not conforming to varietal purity requirements for certification	200

Weed seeds (maximum)	None
Germination (minimum)	80%
Moisture (maximum)	12.0%
For vapour-proof containers (maximum)	8.0%

Seed standards in hybrid seed production

Factor	Standards
Pure seed (minimum)	98.0%
Inert matter (maximum)	2.0%
Other crop seeds (maximum)	10/kg
Other distinguishable varieties based on kernel colour and texture (maximum)	10/kg
Weed seeds (maximum)	None
Germination (minimum)	80%
Moisture (maximum)	12.0%
For vapour-proof containers (maximum)	8.0%

Synthetics and Composites

Mainly produced in population improvement programs.
These are maintained by open pollination

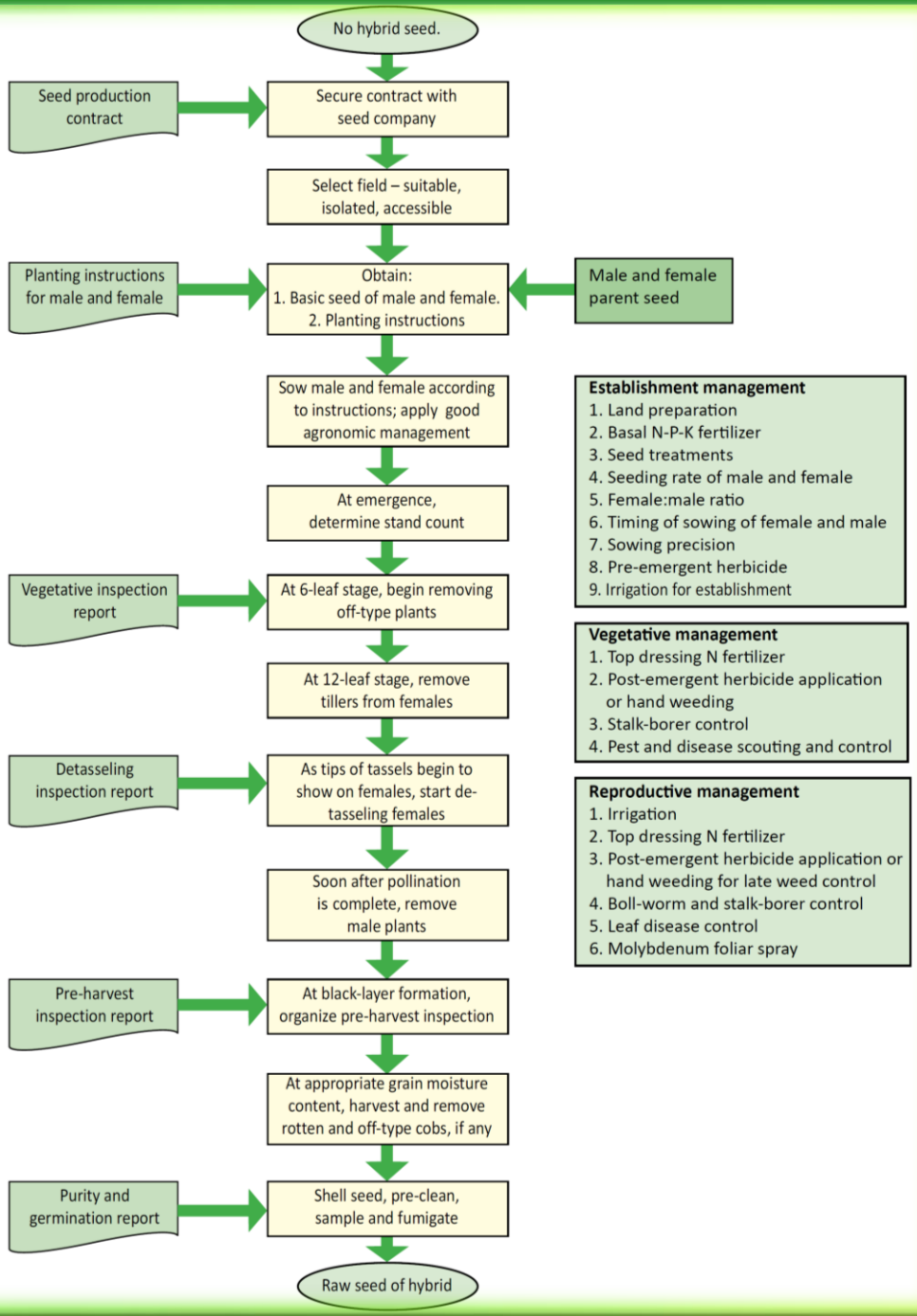
Synthetics	Composites
• Testing for GCA	• GCA is not considered
• Yield can be predicted in advance	• In advance yield cannot be predicted because yields of all the F1s among the component lines are not available
• Reconstitution is possible	• Reconstitution is difficult

Synthetics: Crossing in all combination of number of lines that combine well with each other

Composites: It is mixing the seeds of several phenotypically outstanding lines it and encouraging open pollination to produce crosses in all combination among the lines.

Synthetic and composite optimum characters standardized

Factor	Standards for each class	
	Foundation	Certified
Pure seed (minimum)	98.0%	98.0%
Inert matter (maximum)	2.0%	2.0%
Other crop seeds (maximum)	5/kg	10/kg
Other distinguishable varieties based on kernel colour and texture (maximum)	10/kg	20/kg
Weed seeds (maximum)	None	None
Germination (minimum)	80%	80%
Moisture (maximum)	12.0%	12.0%
For vapour-proof containers (maximum)	8.0%	8.0%


No hybrid seed.
Seed production contract
Secure contract with seed company
Select field – suitable, isolated, accessible
Planting instructions for male and female
Obtain:
1. Basic seed of male and female.
2. Planting instructions
Male and female parent seed
Sow male and female according to instructions; apply good agronomic management
At emergence, determine stand count
Vegetative inspection report
At 6-leaf stage, begin removing off-type plants
At 12-leaf stage, remove tillers from females
Detasseling inspection report
As tips of tassels begin to show on females, start de-tasseling females
Soon after pollination is complete, remove male plants
Pre-harvest inspection report
At black-layer formation, organize pre-harvest inspection
At appropriate grain moisture content, harvest and remove rotten and off-type cobs, if any
Purity and germination report
Shell seed, pre-clean, sample and fumigate
Raw seed of hybrid
Establishment management
1. Land preparation
2. Basal N-P-K fertilizer
3. Seed treatments
4. Seeding rate of male and female
5. Female:male ratio
6. Timing of sowing of female and male
7. Sowing precision
8. Pre-emergent herbicide
9. Irrigation for establishment
Vegetative management
1. Top dressing N fertilizer
2. Post-emergent herbicide application or hand weeding
3. Stalk-borer control
4. Pest and disease scouting and control
Reproductive management
1. Irrigation
2. Top dressing N fertilizer
3. Post-emergent herbicide application or hand weeding for late weed control
4. Boll-worm and stalk-borer control
5. Leaf disease control
6. Molybdenum foliar spray


HYBRID
SEED MAIZE
DH04
HYBRID
SEED MAIZE
H513

Seed production record sheet. Hybrid code:

Field name ……	Season ……
Farmer ……	Crop ……..……..
Contact: ……..	Seed variety …….
Area …… ha ……	Class of seed ……
Location ……..	Female name ……..… Seed lot no ……..……
GPS ……	Male name …… Seed lot no ……..

Land preparation
Date ……
Method ……

Basal fertilizer	Date:	Female	Male 1st	Male 2nd
(Including manure	Type:			
and lime)	Rate/ha:			

Planting dates	Seeding rate (kg/ha)		Plant population (plants/ha)
Female ……		Row width ……cm	Female ……...
Male 1st ……	Female ……..	Female in-row ……cm	Male 1st ……..……..
Male 2nd ……..	Male ……..	Male in-row ……cm	Male 2nd …….....

Top dressings	Date	Female	Male 1st	Male 2nd
	Type			
	Rate/ha			

Weed control
Dates ……
Methods ……

Pest and disease control
Dates ……
Chemical ……
Methods ……

Inspections	Date	Date	Date	Date
	Name	Name	Name	Name
	Ref	Ref	Ref	Ref

Roguing	Date	Date

Detasseling	Start date	End date	No. of laborers
Female flowering	5% silks	50% silks	95% silks
Male 1 flowering	5% pollen	50% pollen	95% pollen
Male 2 flowering	5% pollen	50% pollen	95% pollen

Male destruction date				
Harvest date		Total yield from field		Yield (kg/ha)
Delivery dates				

Observations