



UNIVERSITY OF NAIROBI
Seed Enterprise Management Institute

SEED PRODUCTION

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Outline

- *Introduction*
- *Cultivars*
- *Origin*
- *Growing environments*
- *Mating systems*
- *Isolation*
- *Field layouts*
- *Hybrid seed production*
- *Maintenance*

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INTRODUCTION

- Agricultural crop production is based on **seed or plant material** production
- **Seed** is a plant part containing **seed coat, embryo** and in some plants endosperm
- Farmers grow seeds of different **varieties/Cultivars**

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Varieties/Cultivars

➤ Variety

- ❖ A is a group of similar plants which by structural features /appearance and performance may be identified from other varieties within the same species
- ❖ Have distinct morphological (phenotypic homogeneity- sometimes genotypic) characters

➤ Cultivar –Is a cultivated variety

- ❖ Produced through bulking (multiplication) of introductions.
- Selection and bulking from introductions
- Hybrid from introduced materials or introduced materials are crossed to adapted varieties

Origin of Varieties/Cultivars

- Developed by public or private breeders/companies
- Developed hybrids are increased and distributed by seed companies
- Maintenance-Breeder/ Seed Company
 - ❖ Introduction/ Adaptability
 - ❖ Diseases and pests

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...Varieties

- *If found suitable, then:*
 - *Propagation (increase)*
 - *Testing*
 - *Bulking/multiplication*
 - *Distribution for commercial seed production*
 - *Commercial production*

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Production Environments

- Edaphic – soil
 - ❖ Nutrients requirements
 - ❖ Soil type
 - ❖ Pest prevalence
 - Climatic Conditions
 - ❖ Temperature
 - ❖ Rainfall/Risk of drought during the season
- Climate change mitigation—e.g. Drought tolerance*

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Mating/Reproductive Systems

- Mode of *transmission of genes* from one generation to the next through *sexual reproduction*
- *Agricultural species belong to two predominant mating systems according to pollination (transfer of pollen from anther to the stigma of the flower)*
 - ❖ *Self pollinating*
 - ❖ *Cross pollinating*

...Mating system

- **Self pollination (Inbreeding/ autogamy)**
 - Transfer of pollen from anther to the stigma of the same flower or within a clone
- **Cross pollination (Out breeding/allogamy)**
 - Transfer of pollen from an anther of one plant to the stigma of another plant or different clone
 - This influences the genetic structure of the population
 - This also influences approaches regarding seed production

Self pollinated crops

✓ *LEGUMES*

❖ *Field beans*

❖ *Chick pea*

❖ *Soyabean*

❖ *Cow pea*

✓ *CEREALS*

❖ *Wheat*

❖ *Barley*

❖ *Rice. etc*

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soyabean

- Demo Plot



Soya Plants





Seed production in self pollinated crops

- Self pollinated crops are genetically similar- are homogenous and homozygous and their seed production is not complicated
- The basic method by which seed of varieties is developed is through
 - ❖ Introduction
 - ❖ Selection
 - ❖ hybridization

Genetic basis of self pollination

1. Highest degree of inbreeding
2. Promotes homozygosity of all the gene loci and traits of the sporophyte (Zygote)
3. Genotypes of gametes are all the same
4. Progeny of a single plant are homogeneous
5. Restricts creation of new gene combination (no introgression of new genes through hybridization)
6. Mutations are readily exposed through homozygosity aiding selection by breeders
7. No inbreeding depression or loss of vigor following selfing

Seed production in self pollinated crops

- Seed of variety is introduced followed by screening for abiotic and biotic stresses*
- Multiplication of seed (Isolation may not necessary)*
- Avoid mixing*
- A number of varieties can be produced in same field as long as contamination is avoided at planting, harvest and post harvest handling*
- Seed is packaged and distributed for commercial production*

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Seed production in self pollinated crops

- SELECTION

- ❖ Process by which plants or groups of plants are sorted out from mixed population
- ❖ Done to discriminate among the variability to identify and select individuals with the desirable genotypes to advance and increase them to develop potential new cultivars.

- TYPES

- ❖ *Mass selection*– Removal of unwanted/wanted plants
- ❖ *Line selection*– picking of wanted plants and growing head to row

- Followed by multiplication of selected rows/plants; testing / distribution

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Hybridization

- Creating variability through crossing of selected parents
- Population must contain gene of interest / Combine genes for the desired traits into an improved cultivar
- Crossed lines are tested for combination of required traits
- Line/variety testing/with others in national performance trials (NPT) and subjected to DUS
- Seed multiplication; Seed distribution for commercial production
- Maintenance of seeds through good field management practices

Seed production

- Seed is planted on clean ground not planted previously with same crop variety

❖ Purity maintenance through:

1. Plant in isolation to reduce out-crossing.
 2. Rogue out off-types . All atypical material should be rogued out of the field before harvesting.
 3. Plant only in areas of crop adaptation avoid change in developmental changes due to genotype by environment interaction
- Harvest and post harvest handling

Seed production/Distribution

- *The seed is cleaned,*
- *Dried*
- *Treated*
- *packaged*
- *Distributed to the farmers (cooperatives and individual farm shops)*

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Cross pollinated crops

- *Maize*
- *Sunflower*
- *Sorghum*
- *Avocado*
- *Cassava*
- *Mustard*
- *Pearl millet*
- *Sugarcane etc*

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MAIZE

*KARI Mid-Altitude
Variety*



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ate

Cross pollinated crops

- Cross pollinated crops are heterozygous due to limitless gene combination
- Cross pollination is promoted by
 - Dioecy - Plants with separate pistillate and staminate flowers e.g spinach, date palm, papaya etc
 - Monoecy - Separation of flower - Maize
 - Self incompatibility - Can't fertilize same flower
 - Male sterility - Can't produce pollen - lines produced

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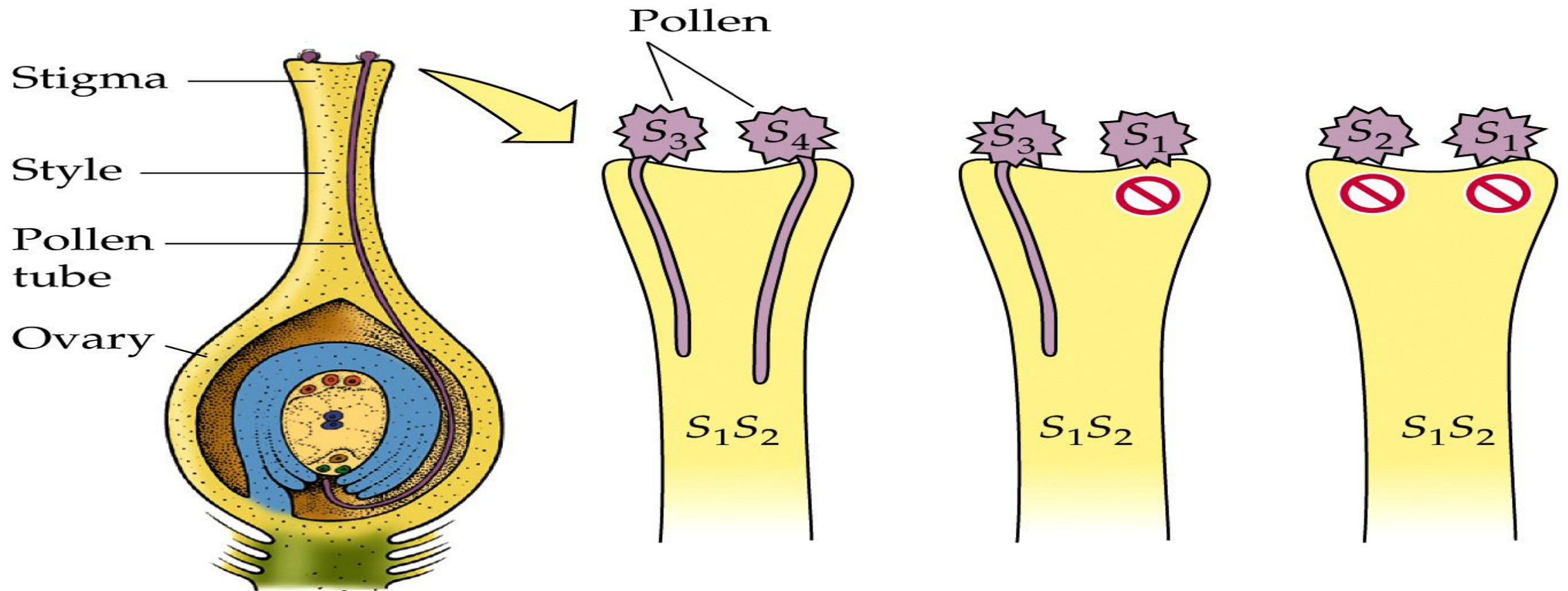
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Genetic basis of cross pollination

1. Genotype of the sporophytic generation (zygote) is heterozygous and genotypes of gametes of a single plant are different
2. Self incompatibility occurs in some species
3. Species have a wide gene pool and form new combinations in subsequent generations
4. Selfing causes inbreeding depression; deleterious recessive alleles which were suppressed due to heterozygous advantage become homozygous and become expressed
5. Cross pollination of the selfed restores hybrid vigour (increase in vigour of the hybrid over its parents resulting from crossing unlike parents)

SELF INCOMPATIBILITY:

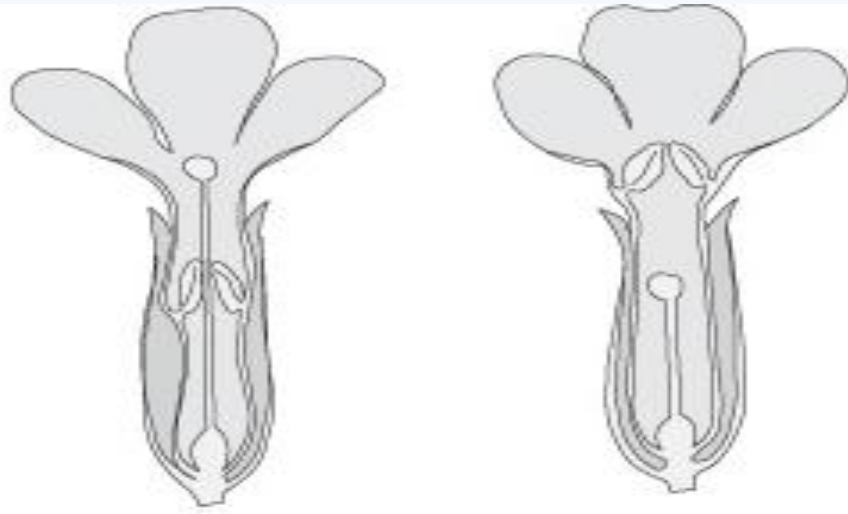
Genetically determined, inability for fertilization to occur between gametes derived from one individual.



Difference in *timing* of floral parts =
dichogamy

protandry - male first
protogyny - female first

Heterostyly: different
style/stigma and correlated
anther heights



long
(pin)

short
(thrum)

Distyly



early:
styles
mature

late:
anthers
mature

SORGHUM



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Methods of seed production

- *Introduction*
- *Selection*
- *Hybridization*

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Introduction

- ❖ *Introduction of parental materials*
- ❖ *Screening and selection*
- ❖ *Bulking of parental material/isolation*
- ❖ *Commercial seed production*
- ❖ *Distribution*
- ❖ *Commercial production*

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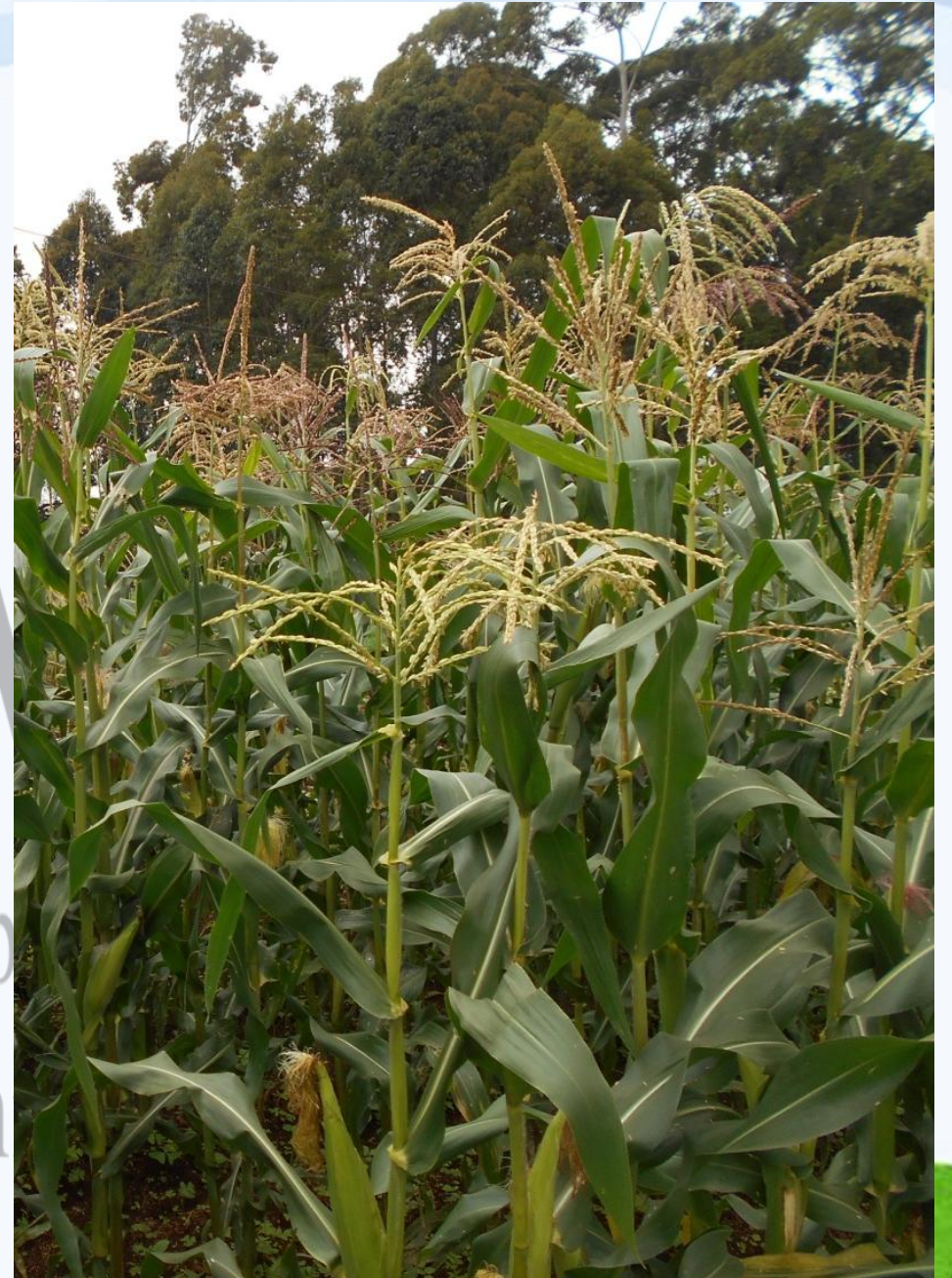
Selection

- Process by which plants or groups of plants are sorted out from mixed population to
 - To clean them and
 - Improve them
 - Mass selection- Removal of unwanted or wanted plants
 - Line selection- picking of wanted plants and growing head to row
 - Single plant selection
 - Recurrent selection
 - Followed by multiplication and distribution or for Crossing (hybridization)

Hybridization

- Hybrid – F1 cross between parents – inbred lines, varieties, clones or other populations that are genetically dissimilar
- *Why Hybrid?*

Exhibit hybrid vigour (heterosis) – enhanced performance with respect to a certain character – size, yield etc





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Hybridization

- Inbred lines development /characterization
- Evaluation and selection

Hybrid production

- Hybrid evaluation and selection
- Bulking of parental lines
- Commercial hybrid production; Distribution
- Commercial production



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Seed production in cross pollinated crops

- Parental lines are multiplied in isolation – time or space
- Seed producing parents are planted in isolation
- Appropriate row ratios used between seed producing parent and the pollinating parent
 - Sunflower, Maize, 3:1
- Hybrid from female parent
- Male parent removed or used for seed increase

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Hybrid Production

- Through emasculation
in maize

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Sunflower hybridization

- *Cytoplasmic male sterility system used: NO MANUAL EMASCULATION*
- *Male sterility is the failure of plants to produce functional anthers, pollen, or male gametes*
- *Establishment of populations*
- *Develop inbred lines*
 - *Male sterile (A- Line)*
 - *Male sterility Maintainer (B- Line)*
 - *Male sterility Restorer (R- line)*

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Cytoplasmic male sterility (CMS)

- *Why CMS?*
 - ❖ *The male sporophyte and gametophyte are less protected from the environment than the ovule and embryo sac*
 - ❖ *Result from natural selection on mitochondrial genes which are maternally inherited and are thus not concerned with pollen production*

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CMS lines

- They are maintained by repeated crossing to a sister line (known as the maintainer line –B line) that is genetically identical except that it possesses normal cytoplasm and is therefore male-fertile.
- In cytoplasmic–genetic male sterility restoration of fertility is done using restorer lines (R-line) carrying nuclear genes.
- The male-sterile line (A-line) is maintained by crossing with a maintainer line carrying the same nuclear genome as the MS line but with normal fertile cytoplasm.

CMS lines

- For hybrid seed progeny to be fertile and produce high yields of fruits or seeds, the pollen parent must carry a nuclear gene that can suppress the action of the abnormal mitochondrial gene (nuclear fertility restorer genes)
- Fertility restorer genes are extremely valuable so that hybrid seed will result in enhanced yield.

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...Sunflower hybridization

Hybrid production

- *CROSS Line A X Line R*

Hybrid seed production

- *Bulk A line*
 - *Cross AxB*
- *Bulk R By Selfing (Self pollination)*

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Isolation

- For both self and cross pollinated crops
- Isolation-Space/ Time is important
- **CROSS POLLINATED CROPS**
 - Avoid cross pollination where not desired
 - Inbred lines
 - Production of different hybrids

SELF POLLINATED CROPS

- Avoid contamination

Classes of Seed

- *Breeders seed* is seed that is provided by the breeder following the release of a variety
- The seed is planted in fields not subject to **volunteer plants** of the same crop and kept free of weeds.
- The field is **rogued** several times during the season for **off types**
- The harvest from this crop is bulked and used to produce other classes of seed i.e.
- **Foundation (pre-basic), Registered (basic) and Certified.**

Breeder Seed

- Breeder seed or pre-basic seed (or vegetative propagating material) is in the direct control of the plant breeder (or organization) responsible for developing the cultivar.
- Breeder preserves the genetic constitution of the cultivar; highest level of genetic purity
- Breeder seed plot (especially for self-pollinating species) comprises progeny rows of seed from individual plants (called nucleus seed) from the previous planting; Seed from rows that are true to type are bulked to form the breeder seed.
- Producers and consumers do not have access to the breeder seed,
- The breeder's seed is to satisfy the official certification process for purity, quality, health, and uniformity so that the producer has access to high quality seed.

Certified Seed

- *may be produced from foundation, registered, or certified seed*
- *Grown in isolation under prescribed conditions for the crop such that it meets the genetic identity and purity of the cultivar required for approval by the certifying agency upon both field and seed inspection.*
- *Available for planting by producers.*

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Maintenance of Seed Stocks

- During production, varieties become contaminated with off types
 - Need to maintain varietal purity (by plant breeder/seed company)
 - Plant small plots each year and remove off types
 - Self pollinated crops are easy

Maintenance

Hybrid

- *Complicated–Depends on the number of inbred lines or if CMS system is used*
- *Fields must be isolated from contaminating pollen but adequate amount of appropriate pollen vector must be provided for insect –pollinated species*
- *Fields are inspected and off types removed*

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...Seed Maintenance

- *Where artificial emasculation is used, the female parent must be emasculated before pollen shed occurs*
- *CMS SYSTEM*
- *A, B and R lines must be multiplied and maintained*
- *A and R line to be used to reproduce the hybrid*

SUMMARY

- *Mating system will determine how seed production is managed*

- ❖ *Isolation*

- ❖ *Field layout*

- ❖ *Maintenance*

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*THANK YOU
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