Centurion University

Male Sterility

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Contents

Introduction

- First reported by **Koelreuter**
- Male sterility is defined as an absence or non-function of pollen grain in plant or incapability of plants to produce or release functional pollen grains.
- Important outbreeding device.
- Promote to heterozygosity.
- Resulted from the action of nuclear gene or cytoplasmic gene or both.
- It is natural or can be induced.

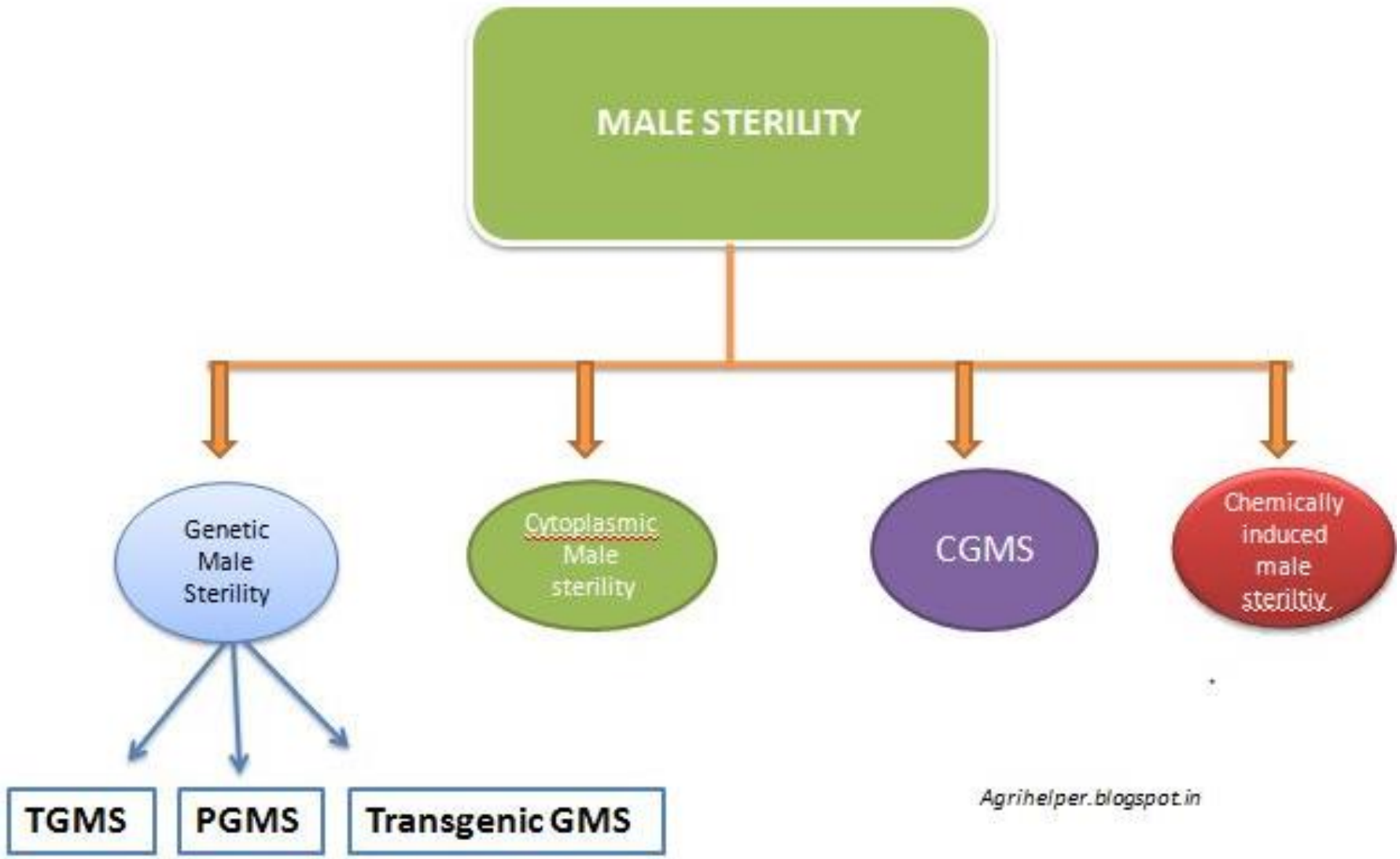
Ms gene has been grouped into following four classes by kaul (1998; in Benga & Benga):

1. Malformation of male sex organs androecium
2. A lack of normal anther sac or anther tissue.
3. Inability pollen to mature or to be released from anther sac.
4. Inability to develop normal microspores or pollen.

Comparison of self-incompatibility and male sterility

S.No.	Particulars	Self incompatibility	Male sterility
1.	Promotes	Outbreeding (allogamy)	Outbreeding (allogamy)
2.	Prevents	Autogamy (self pollination)	Autogamy (self pollination)
3.	Found in	Nature	Nature
4.	Induction	Difficult	Easy
5.	Pollen	Functional	Non-functional
6.	Types	Gametophytic and sporophytic	Genetic, cytoplasmic & genic cytoplasmic
7.	Causes	Morphological, genetic, physiological and biochemical	Genetic, cytoplasmic and both
8	Use	Hybrid seed production	Hybrid seed production
9.	Observed in	Few crops	Many crops

Classification of Male Sterility



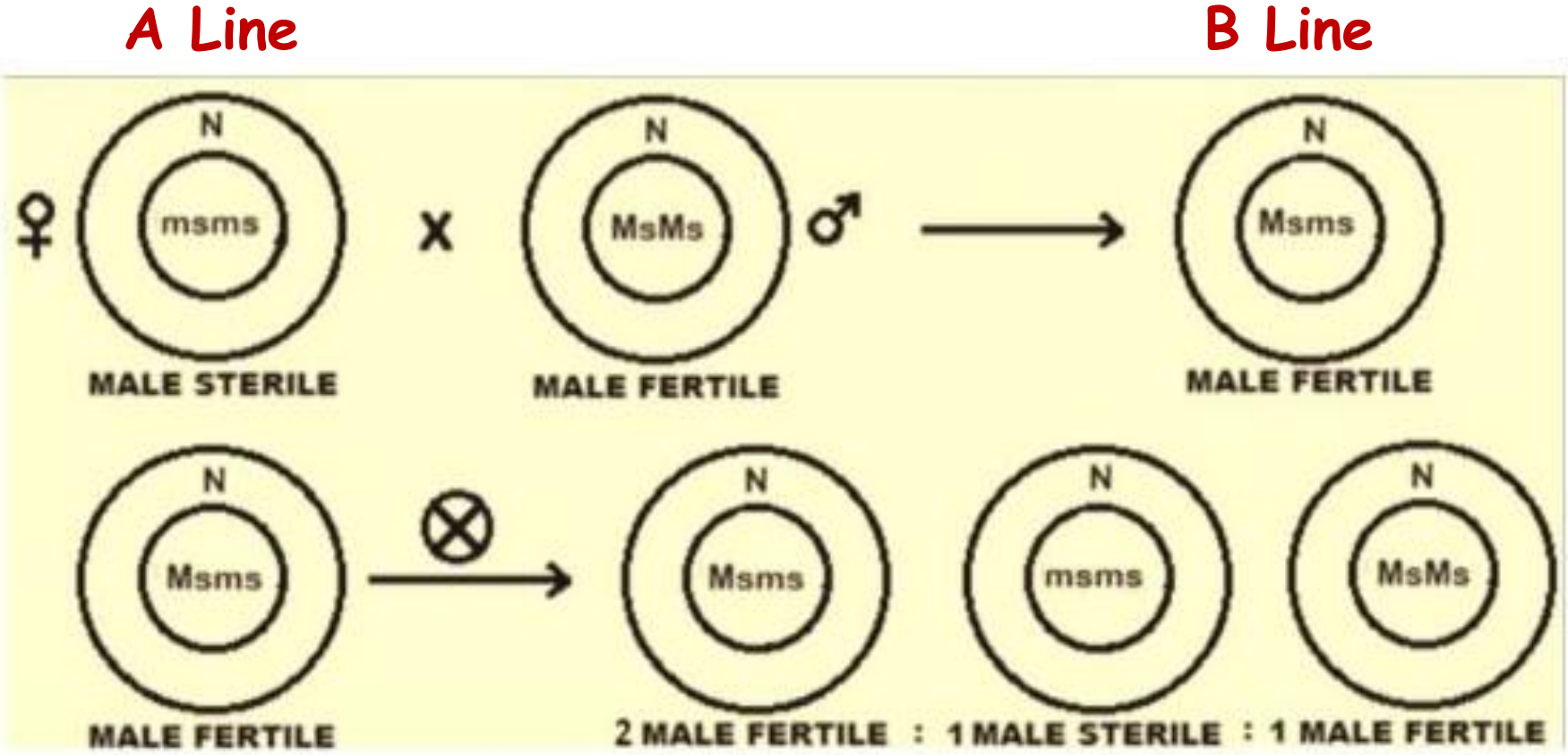
1. Genetic Male Sterility

- The pollen sterility, which is caused by nuclear genes, is termed as **genic or genetic or nuclear male sterility.**
- It is **usually governed by a single recessive gene ms or 's'** with **monogenic** inheritance, but dominant gene governing male sterility are also known E.g Safflower.

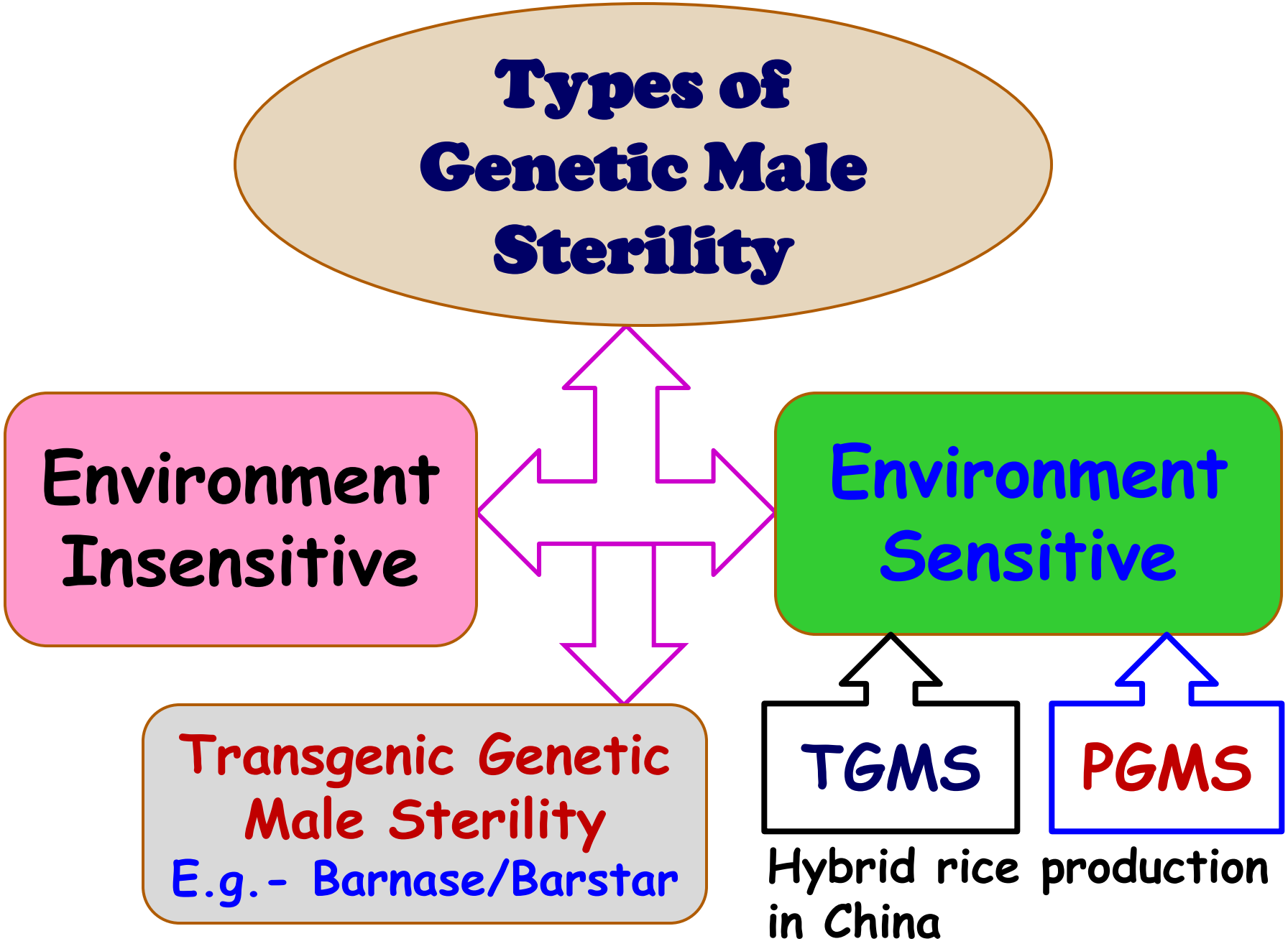
Origin of ms Allele:

- The male sterility alleles may rise spontaneously or it can be induced artificially viz. Pigeon pea, castor, tomato, limabean, barley, cotton, etc.
- **The most commonly used mutagens were gamma rays and EMS,** but even **colchicine** (in jowar or sorghum), **ethidium bromide** (in groundnut, wheat and maize) and **acetone** (in barley) are reported to have induced mutation for male sterility.

- This is two line system i.e. A line (genetic male sterile line) and B line (heterozygous fertile line)



- A male sterile line may be maintained by crossing it with heterozygous male fertile plant.
- Such a mating produces 1:1 male sterile and male fertile plants

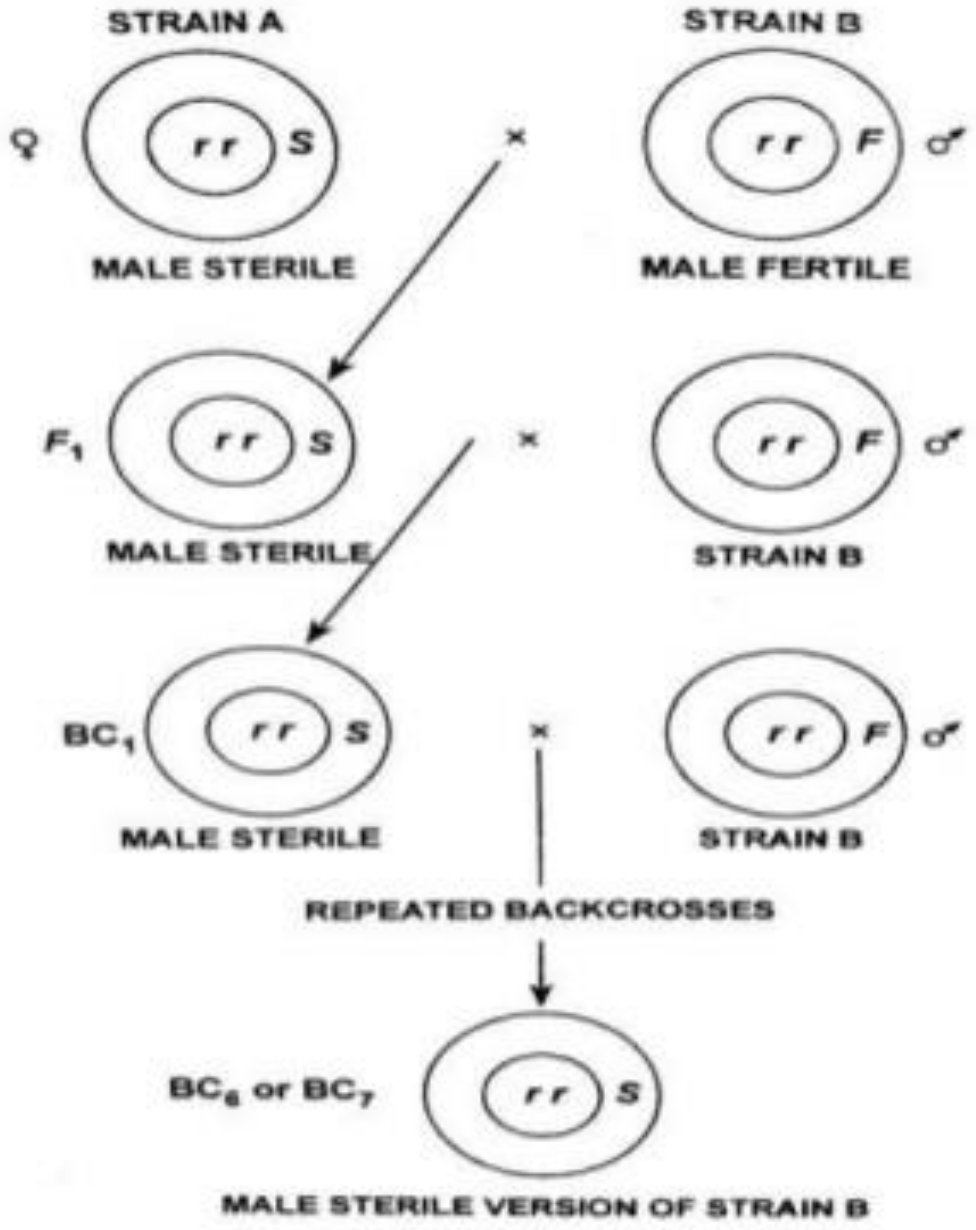

Types of Genetic Male Sterility
Environment Insensitive
Environment Sensitive
Transgenic Genetic Male Sterility
E.g.- Barnase/Barstar
TGMS
PGMS
Hybrid rice production in China

Utilization in Plant Breeding:

- Genetic male sterility is usually recessive and monogenic hence can be used in hybrid seed production.
- It is used in both seed propagated crops and vegetatively propagated species.
- GMS has been exploited commercially only in few crops by few countries. E.g. In USA used in castor while in India used for hybrid seed production of Arhar (cajanus cajan).

Cytoplasmic Male Sterility:

- The pollen sterility which is controlled by cytoplasmic genes is known as cytoplasmic male sterility (CMS).
- Due to mutation in mtDNA (cms-T of maoze, *Ogura* CMS of brassica) or cpDNA (tobacco, barley, sorghum & rapeseed).
- Usually the cytoplasm of zygote comes primarily from the eggs cell and due to this progeny of such male sterile plants would always be male sterile.
- The male sterile line is maintained by crossing it with pollinator strain (recurrent parent) in backcross, since the nuclear genotype of the pollinator is identicle with that of the new male sterile line. Such a **male fertile line is known as maintainer line or 'B' line and 'male sterile line is also known as 'A ' line.**
- CMS is not influenced by environmental factor.



Cross the male fertile strain B (male parent) to a cytoplasmic male sterile strain A (used as female parent)

(*i*) The F_1 would be male sterile
(*ii*) 50% of the nuclear genes of F_1 would be from strain B
(*iii*) Backcross the F_1 to strain B

(*i*) 75% of the nuclear genes would be from strain B
(*ii*) Backcross to strain B

(*i*) This is the male sterile version of strain B (>99% of the nuclear genes from strain B)
(*ii*) Maintained by crossing with male fertile strain B

Utilization in Plant Breeding:

- CMS has limited application. It cannot be used for development of hybrid, where seed is the economic product.
- But it can be used for producing hybrid seed in certain ornamental species or asexually propagated species like sugarcane, potato, and forage crops.

Cytoplasmic Genetic Male Sterility

- When pollen sterility is controlled by both cytoplasmic and nuclear genes is known as cytoplasmic genetic male sterility **(nucleoplasmic male sterility).**
- **Jones and Davis** first discovered this type of male sterility **in 1944 in onion**.
- This is the case of cytoplasmic male sterility, where a nuclear genes restoring fertility in the male sterile line is known.
- This system includes **A, B, and R lines.** A line is a male sterile line, B is similar to 'A' in all features but it is a male fertile and R is restore line it restore the fertility in the F1 hybrid.
- Since B line is used to maintain the fertility and is also referred as maintainer line.
- The **fertility restore gene 'R' is dominant** and found in certain strains of the species (e.g. maize, jowar, bajara, sunflower, rice, wheat etc.).

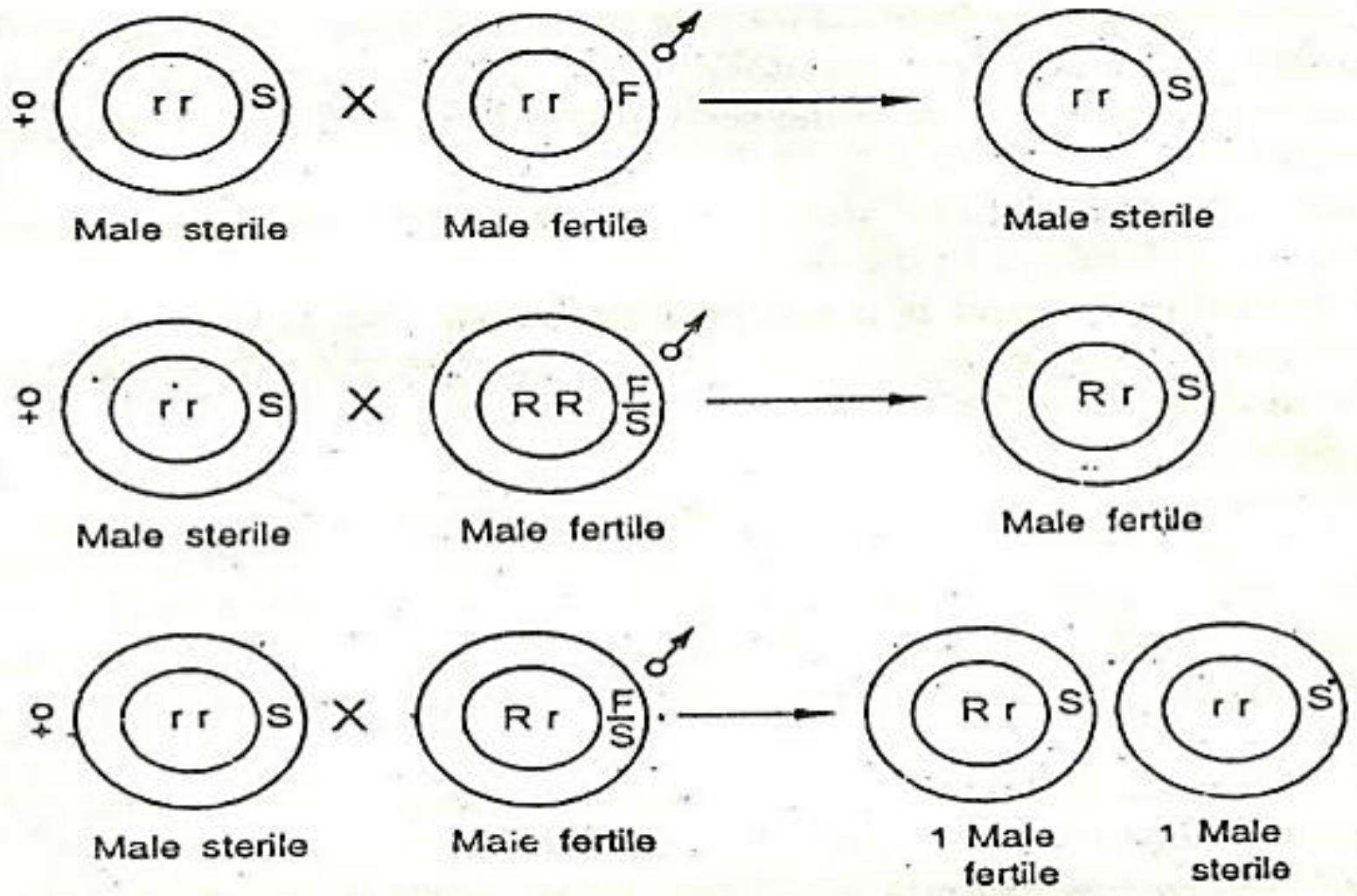


Fig. 4.3. Inheritance of cytoplasmic genetic male-sterility.

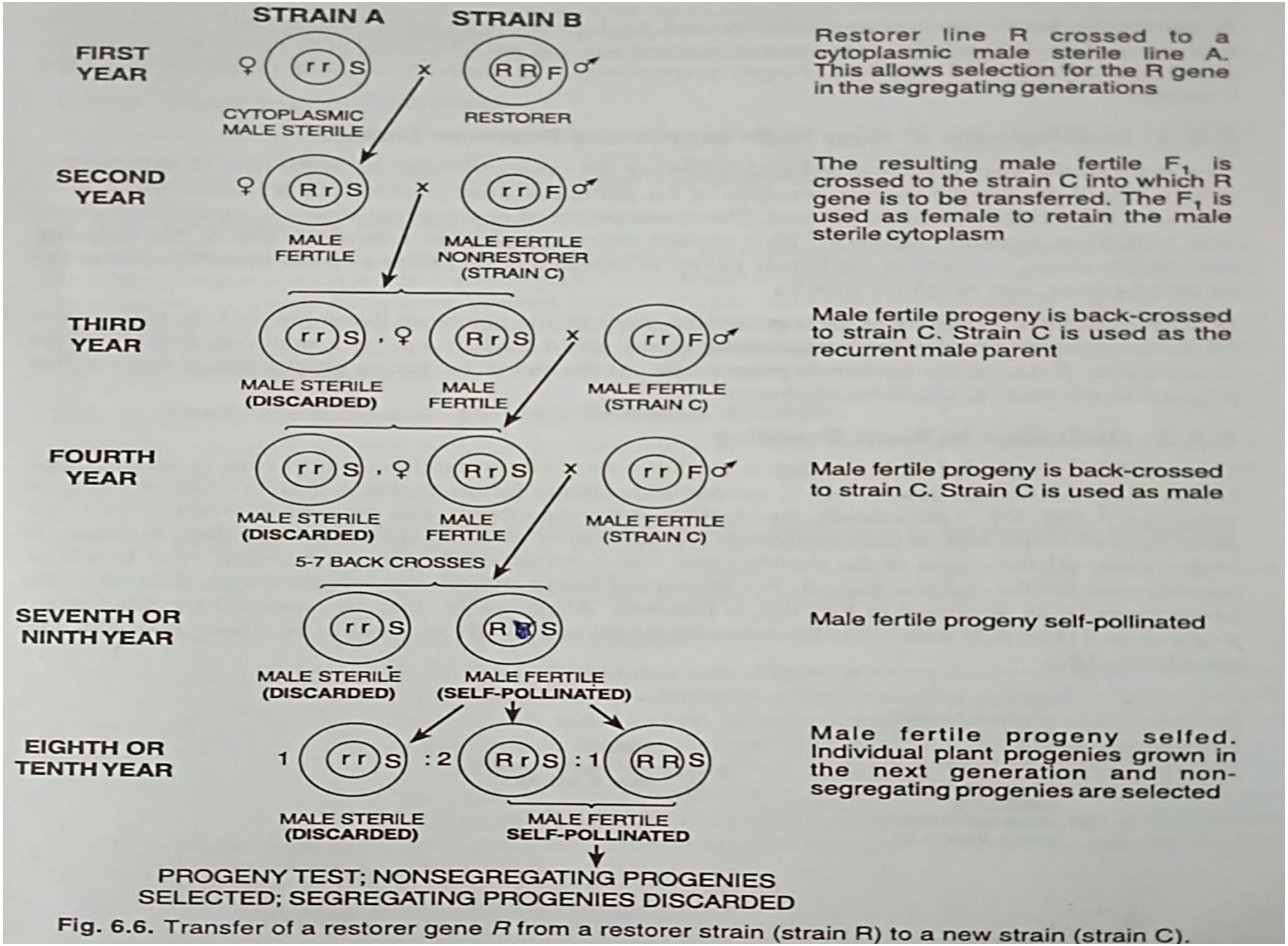
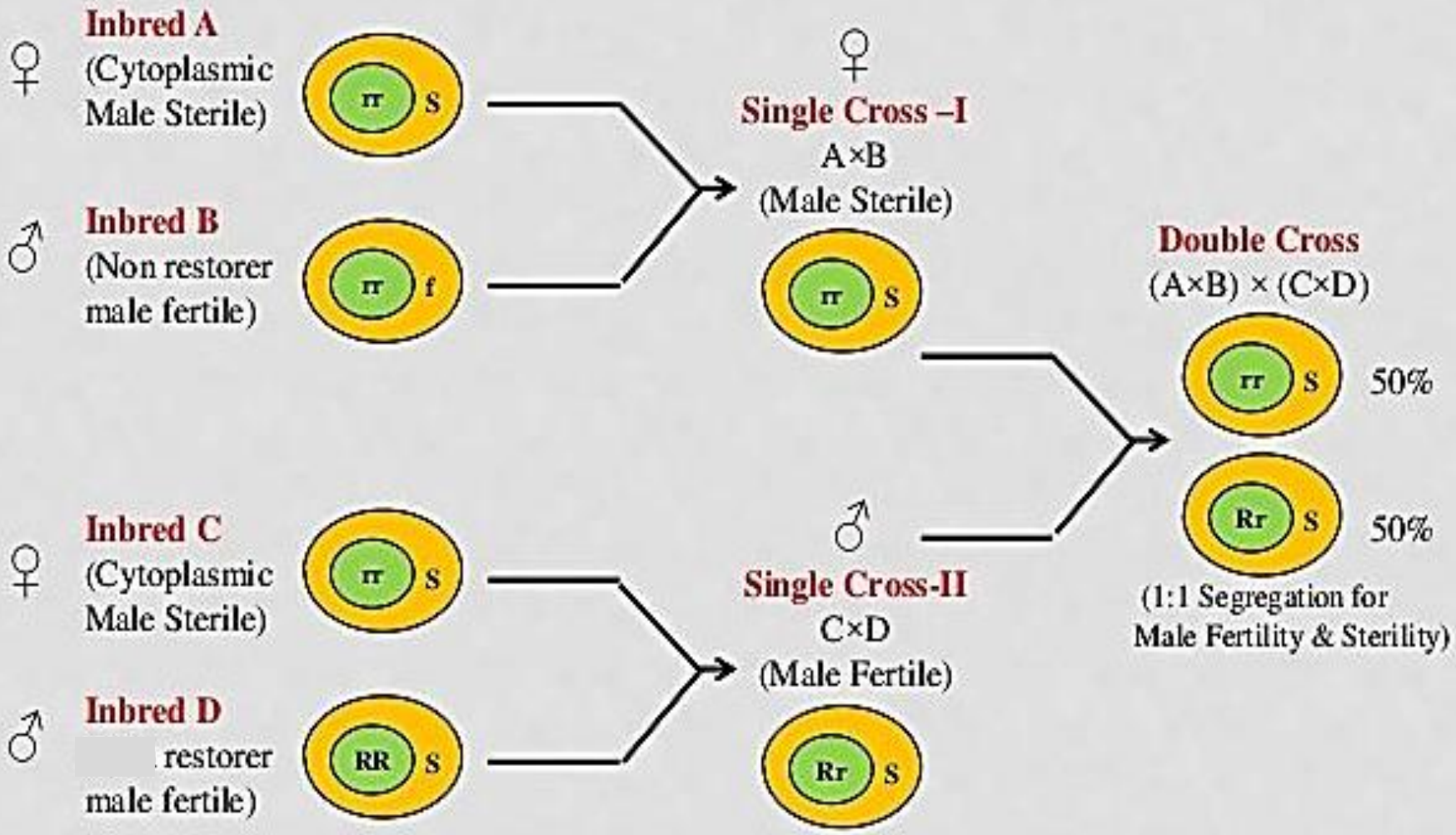


Fig. 6.6. Transfer of a restorer gene *R* from a restorer strain (strain R) to a new strain (strain C).

Utilization in Plant Breeding:

- Cytoplasmic genetic male sterility is widely used for hybrid seed production of both seed propagated species and vegetatively propagated species.
- It is used commercially to produce hybrid seed in maize, Bajara, cotton, rice, jowar, sunflower etc.

Production of Double cross maize hybrids using CGMS



Chemically induced Male Sterility

- CHA is a chemical that induces artificial, non-genetic male sterility in plants so that they can be effectively used as female parent in hybrid seed production.

- Also called as Male gametocides, male sterilants, selective male sterilants, pollen suppressants, pollenocide, androcide etc.

- The first report was given by Moore and Naylor (1950), they induced male sterility in Maize using maleic hydrazide (MH).

McRae (1985) used the single term chemical hybridizing agent (CHA)