



**MAHARASHTRA ANIMAL AND
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SELECTION FOR COMBINING ABILITY

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SELECTION FOR COMBINING ABILITY

- Combining ability,
- Selection for general combining ability,
- Selection for general and specific combining ability,
- Recurrent selection and
- Reciprocal recurrent selection

Combining ability

- Combining ability in crosses is defined as the ability of parents to combine amongst each other during the process of fertilization so that favorable genes or characters are transmitted to their progenies.
- Two types of combining ability, general (GCA) and specific (SCA), have been recognized in quantitative genetics (**Sprague and Tatum, 1942**).

GCA & SCA

- The term GCA is used to designate the **average performance** of an inbred line in hybrid combinations.
- SCA is used to designate those cases in which **certain combinations do relatively better or worse** than would be expected on the basis of the **average performance** of the lines involved.
- According to **GCA** is due to genes which are **largely additive** in their effects and **SCA** is due to genes with **Dominance or Epistatic effect** .
- GCA and SCA are expressed as **variance** and not as values.

Feature of General Combining Ability

- It is due to **additive genetic variance** and **additive x additive gene interaction**.
- It denotes combining ability of genotype esp. inbred with various testers.
- Helps in **identification and selection of best genotype** to use it in hybridization, as a parent.
- Estimated by **half sib mating**
- Have relationship with **narrow sense heritability**

Features of Specific Combining Ability

- It represents **deviation from GCA.**
- It is due to **dominance genetic variance** and all the three types of **gene interactions.**
- Helps into identification and hence selection of best cross combinations i.e. those with the desired output.
- When we see that a inbred line combines well in any cross, it is due to **specific combining ability.**
- Estimated by **full sib mating**
- Have relationship with **heterosis**

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- Inbred lines are evaluated for their general combining ability (GCA).
- There are three methods used: **top cross, poly cross, and single cross.**
- Specific combining ability is tested by **diallel crosses.**

To estimate the combining ability of two or more lines, “diallel mating system” is followed.

The diagram below explains the diallel mating system and the combining abilities of four lines, x_1 , x_2 , x_3 and x_4 .

Line	x_1	x_2	x_3	x_4	GCA
x_1	x_1x_1	x_1x_2	x_1x_3	x_1x_4	x_1
x_2	x_2x_1	x_2x_2	x_2x_3	x_2x_4	x_2
x_3	x_3x_1	x_3x_2	x_3x_3	x_3x_4	x_3
x_4	x_4x_1	x_4x_2	x_4x_3	x_4x_4	x_4

SCA: The diagonals elements

In symbols, the performance of a combination of lines is composed as follows:

$$G(x_1x_2) = GCA(x_1) + GCA(x_2) + SCA(x_1x_2)$$

where,

$G(x_1x_2)$ denotes the genotypic value of the cross “ x_1x_2 ”.

Recurrent Selection

- The term **recurrent selection** was first coined by **Hull in 1945**.
- Recurrent selection is defined as **reselection generation after generation, with intermating of selected animals to produce the population for the next cycle of selection**.
- The basic steps in a cycle of recurrent selection are **intermating, evaluation, and selection**.
- The idea of this method was to ensure the isolation of superior inbreds from the population subjected to recurrent selection.

Contn..

- The principle of recurrent selection is developed out of **convergent improvement**.
- In this a highly inbred line presumably homozygous at most loci is selected as a **tester**.
- A large number of individuals are crossed with this line and their progeny are evaluated.
- Those giving **best progeny** are subsequently inter mated and a large number of their progeny are tested in the crosses on the inbred tester.
- The cycle is repeated over and over.
- This is done to take greater advantage of the interaction of genes and the resultant **overdominance** by selecting inbred lines during their developmental process for the purpose of better complementing each other.

Contn..

- The success depends on the ability of the breeder to accumulate a greater number of genes having additive effects in two different parental lines that interact to greater advantage.
- If heterosis is largely dependent upon **overdominance**, this procedure should result in the line selected on cross performance becoming homozygous for different alleles than the inbred used as the tester.
- In other words when tester is aa, the selected line would become AA; the tester is BB, the selected line becomes bb etc.

Contn..

- **The application of recurrent selection to animal breeding appears to be more difficult than its application to plant breeding because**
 - The overall effects of inbreeding are **deleterious**
 - The degree of fertility is lacking. It depends on **survivability**
 - More number of animals are required and it involves **longer generation interval** and make this selection

Contn..

- Recurrent selection is used for traits that are polygenically inherited.
- Recurrent selection increases or decreases the frequency of alleles by selecting within a normal distribution of genotypes.

The isolation of an outstanding inbred line depends on two factors:

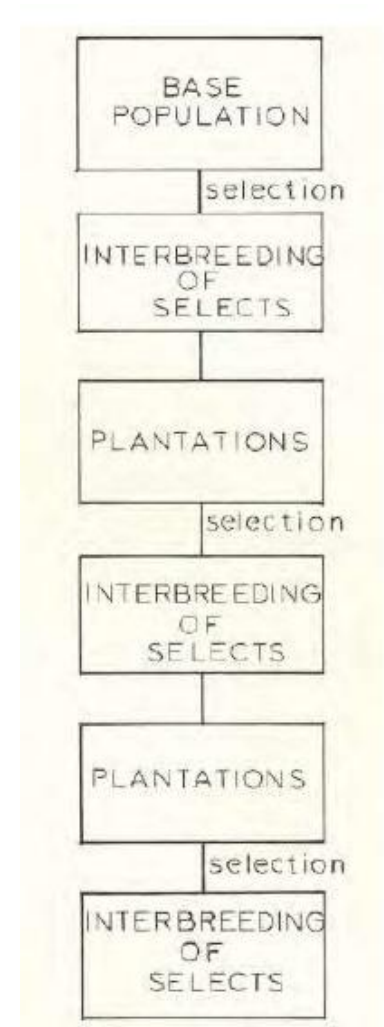
- 1) The proportion of superior genotypes present in the base population from which lines are isolated.**
- 2) The effectiveness of selection during the inbreeding of desirable genes.**

Types of Recurrent Selection:

- i) Simple recurrent selection (SRS)**
- ii) Recurrent selection for general combining ability (RSGCA)**
- iii) Recurrent selection for specific combining ability (RSSCA)**
- iv) Reciprocal recurrent selection (RRS)**

Simple Recurrent Selection (SRS)

- A type of recurrent selection that does not include tester is referred as simple recurrent selection. It is also known as phenotypic recurrent selection.



Recurrent Selection for General Combining Ability (GCA):

- A form of recurrent selection used to improve the general combining ability of a population for a character and the **heterozygous tester** is referred to as RSGCA. It is also known as **half sib** recurrent selection.

Recurrent Selection for SCA:

- It was originally proposed by **Hull in 1945**.
- Its a form of recurrent selection that is used to improve the SCA of a population for a character by using homozygous tester is referred as (RSSCA) recurrent selection for specific combining ability.
- It is also known as half site recurrent selection with homozygous tester.

Reciprocal Recurrent Selection (RRS):

- A form of recurrent selection used to improve both GCA and SCA of a population for a character using **two heterozygous testers** is known as RRS.
- It is also known as recurrent reciprocal half sib selection.
- Comstock *et al.* in 1949, proposed this method.

Main Features of these Methods:

- 1) It is used for improvement of **polygenic characters**.
- 2) Selection is made on the basis of **test cross performance**.
- 3) Two heterozygous tester are used as a source of population.
- 4) It is used for improving population for GCA and SCA for specific characters.
- 5) It is equally effective with **incomplete, complete and over dominance**.
- 6) It is used for improvement of those characters, which are governed by **both additive and non-additive gene action**.

Recurrent Selection

- **Merits:**

- 1) Recurrent selection is an efficient breeding method for increasing the frequency of superior genes for various economic characters.
- 2) It helps in breaking repulsion phase of linkage.
- 3) It helps in maintaining high genetic variability due to repeated intermitting of heterozygous population.

- **Demerits:**

- 1) It is not directly used for the development of new varieties.
- 2) This method involves lot of selection crossing and selfing work.
- 3) It permits selfing, which leads to loss of genetic variability.