MARUMEGH

Kisaan E- Patrika

Available online at www.marumegh.com

 ISSN: 2456-2904

PRE-BREEDING FOR EFFECTIVE USE OF GENE POOL IN PLANT BREEDING

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Introduction

Plant breeding is an art, science and technology of improving genetic make up plants for the benefit of humankind. It is practiced worldwide by profession al plant breeders and farmers with a proven track record over the centuries. The genetic diversity of crop plants is the foundation for the sustainable development of new varieties for present and future challenges which arises due to the various biotic and abiotic stresses. Genetic diversity provides an option to farmers and plant breeders to develop new and more productive crops / varieties through selection, hybridization and breeding, that are resistant to virulent pests and diseases and adapted to changing environmental conditions. Pre-breeding is necessary for making the germplasm usable in traditional breeding. It is useful in creating vast genetic diversity, broadening genetic base of the population, improving adaptation, value addition by transferring useful alleles from un-adapted sources to adapted cultivars etc. However, use of genes from wild species poses several problems such as cross incompatibility, hybrid inviability, hybrid sterility and linkage between desirable and undesirable alleles. Pre-breeding work has yielded significant results in many field crops such as maize, sorghum, barley, rice, potato, cotton, oilseeds, pulses etc. .The aim should not only be to exploit intraspecific variation within a crop but also to increase interspecific diversity in agriculture through genetic improvement and promotion of less popular, neglected or underutilized crop species (e.g. Padulosi *et al*., 2002).

What is Pre Breeding?

Pre-breeding also called genetic enhancement refers to all activities designed to identify desirable characteristics and/or genes from unadapted materials that cannot be used directly in breeding populations programme, and to transfer these traits to an intermediate set of materials that breeders can use further in developing new varieties for farmers. It is a necessary first step in the "linking genetic variability to utilization" use of diversity arising from wild relatives and other unimproved materials in genestock. These activities are a collaboration between the germplasm curator and the plant breeder who need to work together to understand the scope and value of germplasm collections and how novel traits from these collections can be bred into new varieties. The term genetic enhancement was first used by Jones in 1983. It refers to transfer of useful genes from exotic or wild types into agronomically acceptable background. In 1984, Rick used the term pre-breeding to describe the same activity. Now terms genetic enhancement and pre-breeding are used as synonyms and interchangeable. However, the term genetic enhance is in more usage.

Gene Pool Concept-Gene pool: "All the genes and their alleles present in the individuals, which hybridize or can hybridize with each other**".** The gene pool is classified into four

groups by (Haussmann *et al*., 2004).

1. Primary Gene Pool (GP_1)

It includes all such strains and species, which hybridize readily with each other and give rise to fertile hybrids. It consists of all the different strains or varieties of a crop species and some related species. The members of primary gene pool are the most commonly used in breeding programmes.

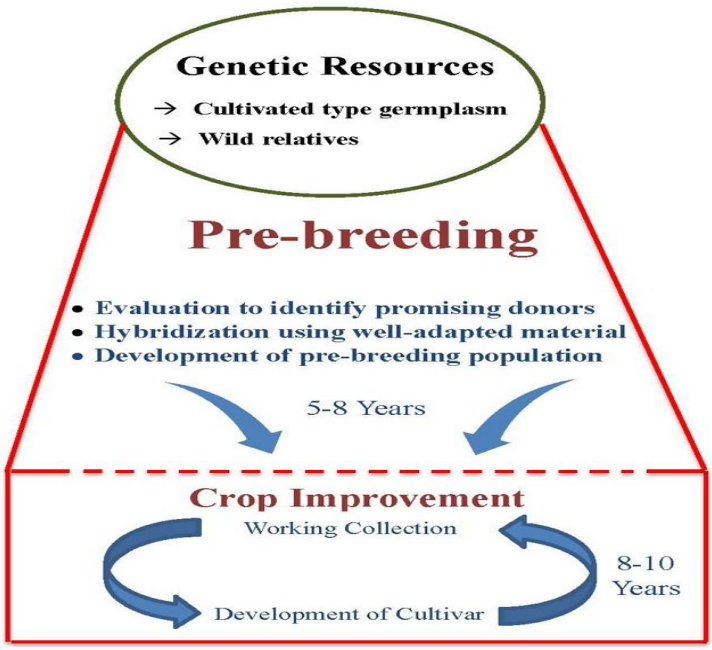
2. Secondary Gene Pool (GP_2)

Members of secondary gene pool are all those species that hybridize with the members of primary gene pool with some to considerable difficulty and the hybrids are partially fertile. These species are difficult to hybridize with those of GP1 due to ploidy differences, chromosome alterations or genetic bariers.

Gene transfers from GP_2 to GP_1 are possible but usually difficult. Members of this group are often used in breeding programmes.

3. Tertiary Gene Pool (GP3)

The species belonging to this group cross with the members of primary gene pool with considerable to great difficulty, and hybrids, if produced, are anomalous, lethal or completely sterile. Gene transfers from this group to the primary gene pool are very difficult and require special techniques. Hybrids are invariably sterile. Gene transfers from GP3 to GP2 are relatively easier. GP3 is used only occasionally in breeding programmes.



4. Quaternary Gene Pool (GP 4)

It refers to crop cultivars that have been developed through biotechnological approaches. It have trasgeneic varieties and other value added strain.

Merit of Pre-Breeding

1. It helps in broadening the genetic base of the population which is essential for achieving stability in yield over multilocational.
2. The genetic diversity has depleted in the improved variety which invites danger of uniformity. Genetic enhancement is benefit in restoring genetic diversity in such cultivars.
3. It helps in combining useful genes or gene combination from landraces, perennials and wild species into the cultivated or well adapted genotypes. Such traits include resistance to biotic and abiotic stresses, earliness and improvement in quality parameters.
4. It helps in developing plant types which are suitable for machine harvesting.
5. It also leads to creation of new genetic variability in various economic traits, Thus it leads to value addition in the germplasm.

6. The germplasm lines developed through genetic enhancement become usable in traditional breeding programmes for development of productive cultivars/hybrids.

Demerit of Pre-Breeding

1. In the Introgressive hybridization using wild species, there are problems of cross incompatibility, hybrid in-viability and hybrid sterility.
2. Linkage between desirable and undesirable alleles poses problems in utilization of desirable alleles.
3. Generally, the genetic re-combinations are restricted in introgressive breeding.
4. Small populations are available due to poor seed setting in interspecific crosses.

Achievements of Pre-Breeding

i. Maize:

In maize new inbred lines have been developed through pre- breeding which are used as parents for development of productive single cross hybrids. These single cross hybrids are superior to double cross hybrids. The heterotic pool has been developed by Nass and Paterniani (2000).

ii. Sorghum:

In sorghum, desirable traits have been introgressed from Ethiopian and Sudanense land races into adapted Indian cultivars at ICRISAT(2004)

iii. Sugarcane:

In sugarcane, pre-breeding has resulted in development of interspecific genetic stocks of *S. spontaneum, S. sinense* and *S. offcinarum* by Seetharam (2007).

iv. Barley:

In barley, pre-breeding has resulted in creating vast genetic diversity and broadening the genetic base of breeding populations.

v. Potato:

In potato, day long tretraploid populations have been developed through introgressive hybridization. The new germplasm is being used widely in potato Improvement. In potato, genetic enhancement has been achieved mainly through polyploidy breeding.

The genetic enhancement has also been achieved in other crops such as oil seeds, lentil, tomato, chick pea, ground nut, cassava etc. This work is in progress at various International and National Crop breeding centres. Various plant characters such as yield, quality parameters, resistance to biotic and abiotic, stresses, adaptation, genetic base, crop maturity, plant type, photo and thermo insensitivity, etc. are kept in mind during pre-breeding programmes.

v. Cotton:

In cotton, fibre quality parameters and resistance to biotic and abiotic stresses have been introgressed from wild species by Lokanathan *et al*., (2003).

Conclusion

For field crops improvement, enough genetic diversity exists in the form of landraces and wild relatives, which carry several useful genes for cultivar improvement. However, utilization of these resources in breeding programs is time-consuming and resource demanding. To overcome this, pre-breeding activities should be initiated to generate new genetic variability using promising landraces and wild relatives for use by the breeders in

crop improvement programs. Pre-breeding should focus on the continuous supply of useful variability into the breeding pipeline to develop new high-yielding cultivars with a broad genetic base, pre-breeding should not focus on increasing yield. Though pre-breeding is useful to enrich the primary gene pool for cultivar improvement, it is a time-consuming and difficult affair as well.

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