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Pre-Breeding: Role in Crop Improvement

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Introduction

The narrow genetic base of cultivars coupled with low utilization of genetic resources are the major factors limiting grain production and productivity globally. Exploitation of new and diverse sources of variation is needed for the genetic enhancement of crops. Wild relatives with enhanced levels of resistance/tolerance to multiple stresses provide important sources of genetic diversity for crop improvement. However, their exploitation for cultivar improvement is limited by cross-incompatibility barriers and linkage drags. Pre-breeding provides a unique opportunity, through the introgression of desirable genes from wild germplasm into genetic backgrounds readily used by the breeders with minimum linkage drag, to overcome this.

What is Pre-breeding ?

Pre-breeding refers to all activities for identification of desirable characteristics and/or genes from unadapted materials that cannot be used directly in breeding populations (exotic or semi-exotic; wild species) and to transfer these traits to an intermediate set of materials that breeders can manipulate further in producing new varieties for farmers (GIPB/FAO, 2008).

Using crop wild relatives (CWR) in crop improvement is much more difficult than breeding with domesticated varieties. Pre-breeding aims to isolate desired genetic traits (e.g. disease resistance) from unadapted material like CWR and introduce them into breeding lines that are more readily crossable with modern, elite varieties. Pre-breeding broadens the elite gene pool by re-capturing lost beneficial genetic diversity. Pre-Breeding term was first coined by Rick in 1984. It is an alternative term used for "genetic enhancement" and in recent times it has become an essential, planned part of all plant breeding activities. It refers to all activities designed to identify materials that cannot be used directly in breeding programmes,

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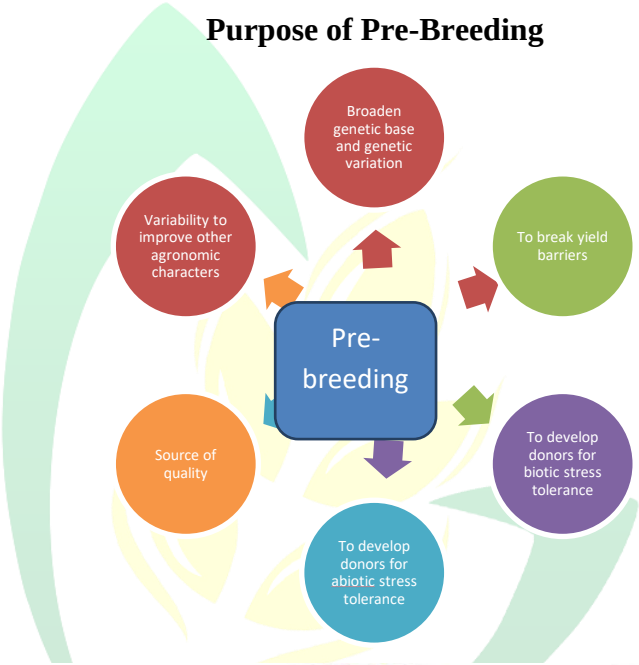
and further to transfer these traits to an intermediate set of materials that breeders can use further in producing new varieties for farmers.In order to break these bottlenecks and to create superior gene pools, genetic enhancement or pre-breeding is required to enhance the value of germplasm.There is very little difference between genetic enhancement and traditional breeding. Enhancement does not include cultivar development and refers only to the improvement of germplasm. Enhanced germplasm can be more readily used in breeding programmes for cultivar development.

Purpose of Pre-Breeding



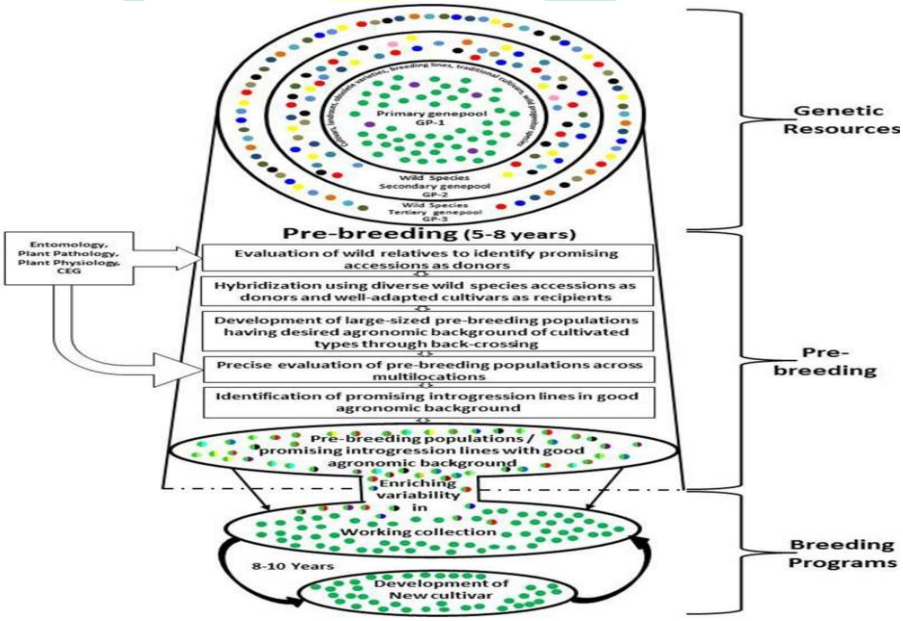


Fig: Procedure for Pre-breeding and breeding programs

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The main objectives of pre-breeding

- Improved germplasm and associated genetic knowledge that enhance resistance expression and diversity
- Improved parental stocks which can be readily utilized within breeding programs
- Improved selection methodologies
- Identify potentially useful genes in a well-organized and documented gene bank
- Design strategies to develop improved germplasm that are ready to use in varietal development
- Pre-breeding is a collaborative endeavor, that is buttressed by communication, between gene bank curators and breeders.

(Shankar, *et al.* 2012)

Various activities involved in Pre-breeding

1. Characterization of landrace populations
2. Creation of new parent populations
3. Introgression of new traits from other useful sources
4. Creation of novel traits
5. Creation of polyploidy
6. Acquisition of new information on crop genetics
7. Development of new plant breeding techniques
8. Cultivar development
9. Applications of doubled haploids in plant breeding
10. Pre-breeding and wide crosses (Shimelis and Laing, 2012)

Methods of Pre-Breeding

1. Introgression through back cross: Dr. Edgar Anderson

- ✓ Recurrent backcross
- ✓ Inbred backcross: Wehrhahn and Allard, 1965
- ✓ Congruity backcross: Haghighi and Ashcher, 1988

2. Incorporation: Simmonds, 1993

a. Direct hybridization or wide hybridization or natural crossing

b. Biotechnological tools

1. Vector aided transformation or direct transfer

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- ✓ Agrobacterium mediated gene transfer
- ✓ Viral vector mediated gene transfer

2. Direct transfer

- ✓ Biolistic transformation or particle bombardment
- ✓ Lipofection or liposome mediated gene transfer
- ✓ Microinjection
- ✓ Macroinjection
- ✓ Electroporation
- ✓ PEG method
- ✓ Tranformation using pollen or pollen tube
- ✓ Fibre mediated DNA delivery orsilicon carbide mediated gene transfer

Pre-Breeding Vs Commercial Breeding

Pre-Breeding	**CommercialBreeding**
• Leads to genetic enhancement of germplasm	• Leads to development of productive cultivars
• Broaden the genetic base	• Narrow the genetic base
• Long term programme	• Short or medium termprogramme
• Chief method is backcross, MABS, GE	• All breeding methods are followed
• By public sectors	• By public and private sectors

Major applications of pre breeding in crop improvement

1. Broadening the genetic base, to reduce vulnerability
2. Identifying traits in exotic materials and moving those genes into material which are more readily accessed by breeders
3. Introgression genes from wild species into breeding populations

4. Identification and transfer of novel genes from unrelated species using genetic transformation techniques