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Climate Smart Plant Breeding

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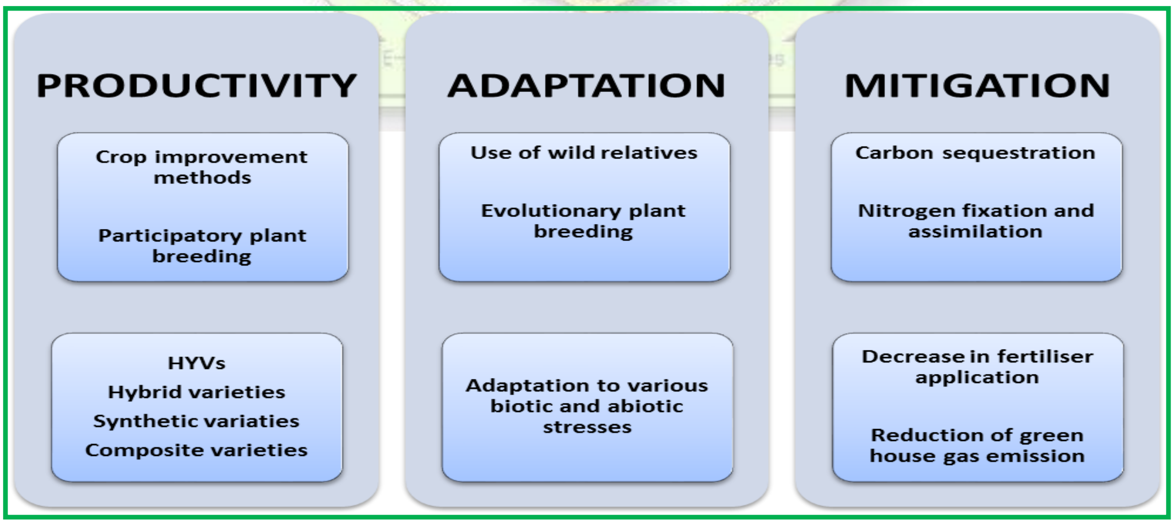
The main challenges from climate change to agriculture and food production are the increased frequency and severity of abiotic stresses, and higher infestation of insects and diseases. Cutting edge plant breeding depends on the accessibility to large germplasm collections and populations with desirable traits, proficient technologies, big data management tools, and combined classical plant breeding, biotechnology and molecular breeding activities.

How plant breeding acts smart?

Plant breeders acquire knowledge of the physiological, morphological and molecular mechanisms that allow plants to respond stress due to climate change and its adaptation. - Plant breeding also provides miscellaneous strategies to develop climate-resilient cultivars and expedite the rate of genetic gain. Plant breeding and climate smart agriculture:-

Assessment of climate-smart breeding needs:

Climate-smart breeding seeks to deliver more productive and resilient crops that keep pace with climate change. Delivery of new varieties is currently limited by the cost and time required for developing and selecting new breeding material. The breeding of new material for adaptation to broad geographic areas where multiple stresses occur can slow yield gain due to substantial GxE interactions. Therefore, understanding the stability (i.e. frequency of occurrence) and spatial distribution of seasonal patterns of heat and drought stresses, and assessing affected plant processes helps targeting breeding activities better.



Breeder's Toolbox for Facing the Challenges Imposed by Climate Change

a) Genetic Resources in the form of wild species, wild relatives, and landraces are cornerstones for competitive plant breeding by residing several desirable traits which can be inrtogressed in to the cultivars.

b) Conventional plant breeding methods like mass selection, bulk method, pedigree selection, backcross breeding, recurrent selection and several others have played wonderful roles in crop improvement.

However, the demand for the resiliency can't alone be fulfilled by the conventional methods hence, plant breeding includes the biotechnological tools to be more efficient.

Front line technologies for plant breeding

i) Marker-Assisted Selection:

It is the application of molecular markers (RFLPs, RAPDs, SSRs, SNPs etc.), in combination with linkage maps to alter and improve plant traits on the basis of genotypic assays. This includes several modern breeding strategies like marker-assisted selection (MAS), marker-assisted backcrossing (MABC), and marker-assisted recurrent selection (MARS).

ii) Genomic Selection:

Genomic selection (GS) facilitates the selection of superior genotypes, shortening the breeding cycle, and reduce the cost of breeding line development. It includes two population, firstly, a training population (TP) and secondly, a breeding population (BP).

WHY GS?

- Marker assisted selection handles oligogenes and QTLs with large effects.
- MABC does not generate new gene combinations.
- MARS is based on markers showing significant association with the traits.

iii) Speed breeding:

A very new technique in order to expedite the genetic gain. This has the components of extended photoperiods, controlled temperature, fully enclosed growth rooms or glasshouses, rapid generation cycling. Four to seven generations per year can be achieved in six crop species including wheat, durum wheat (Triticum turgidum), barley (Hordeum vulgare), chickpea (Cicer arietinum), pea (Pisum sativum), and canola (Brassica napus).

(iv) Combining participation and evolution: participatory– evolutionary plant breeding:

In Participatory Plant Breeding, farmers are actively involved in the breeding process, selecting desirable variation and earlygeneration material. Evolutionary breeding involves creation of genetic diversity with repeated sowing and harvesting of the population in one or more agronomic environment without active selection of individual plants, and use of the seed as food or feed, or use of the seed as a basis for further breeding (Döring *et al*., 2011).

Achievements of Conventional Plant Breeding

Crop	Variety and Year of Release	Method Of Development	Genes	Traits Improved	Yield (T/Ha) In Different Conditions
RICE	CR DHAN 801 (IET 25667)-2019	MABC (SWARNA) IR81896-B-B-195/2 x Swarna sub 1	Sub1 and QTLs, qDTY1.1, qDTY2.1, and qDTY3.1	Submergence and drought	6.3- normal 4- submergence 2.9- drought
	CR DHAN 802 (SUBHAS-IET 26673) - 2019	MABC(SWARNA SUB-1 X IR81896-B-B-195)	Sub1 qDTY1.1, qDTY2.1, qDTY3.1, Xa21, xa13, xa5 and Xa4	Submergence and drought	6.6-Normal 4.3- Submergence 2.3- DROUGHT

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