Plant Breeding: Scope and Achievements

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Objectives of Plant Breeding

The scope of plant breeding programs are to find objectives of various improved characteristics in plants for sustainable survival and optimum economic yield.
The objective of plant breeding are to develop improved characteristics of plants for more demanding economically as well as agronomically. Improved varieties of crops contain balance of traits which make them more profitable for growers

Thus main objectives of plants breeding are as follows:

- **Higher yield**
- **Improved quality**
- **Disease and insect resistance**
- **Agronomic characteristics**
- **Change in maturity duration**
- **Photo and thermo - insensitivity**
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- **Synchronous maturity**

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- **Dormancy**
- **Varieties for new seasons**
- **Moisture stress to tolerance**
- **Salt stress tolerance**
- **Elimination of toxic substances**

IMPORTANT ACHIEVEMENTS

India's important achievements in plant breeding programs are:

- Present day crop have mainly arrived through plant breeding of wild weed varieties by humans initiated through naturally domestication practices.
- Sometimes due to extent of breeding the cultivated plants become quite different from original wild variety.

Few examples of extensive plant breeding in India are -

Semi-dwarf wheat and rice-

- First developed by N.E. Borlaug at CIMMYT (international centre for wheat and maize improvement), Mexico.
- They used the dwarfing gene of a Japanese variety *Norin 10*.
- In India major wheat varieties grown today are semi-dwarf varieties.
- Semi-dwarf varieties were first introduced in 1963 in India.
- Major examples of these semi-dwarf varieties are Kalyan Sona and Sonalika.

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- These semi-dwarf varieties are resistant to diseases like **rust**, photoinsensitives. The **photoinsensitivity** has enabled farmers to grow such crops in non traditional areas also, e.g. west Bengal.
- Dwarfing genes are ***Rht1*** and ***Rht2***.These are mainly dwarfing genes but their side effect can increase the yield of crop plants.
- Similarly, photoperiod sensitive genes are *Ppd1* and *Ppd2*, which when present together give low yields. But when present singly i.e. either *Ppd1* alone or *Ppd2* alone give better yield due to photoinsensitivity.
- So, the best combination which due to plant breeding a semi-dwarf variety of wheat has are – *Rht1* + *Ppd1* or *Ppd2* and *Rht2* + *Ppd1* or *Ppd2*.
- Semi-dwarf rice varieties have been developed from Dee-geo-woo-gen variety of dwarf and early maturing Japonica rice from Taiwan.

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- First semi-dwarf rice varieties introduced in India in 1966 were Taichung Native 1 (TN 1) , developed in Taiwan and IR 8, developed by International Rice Research Institute, Philippines.
- Now even these varieties have been replaced by even more superior semi-dwarf rice varieties developed in India itself like Jaya, Ratna , etc
- These varies in comparison to wild varieties are lodging resistant, more fertilizer responsive, high yielding and photoinsensitive .
- photoinsensitivity has again enabled us to grow rice in non-traditional states like Punjab.

Semi-dwarf rice variety

Semi-dwarf wheat variety

Sugarcane improvement

- *Saccharum barberi (*Indian sugarcane) had hard stem but poor yield and low sugar content and could only grown in North India, while *Saccharum officinarum* (noble sugarcane) were having high sugar content but couldn't be grown in north India.
- C.A. Barber and T.S. Venkatraman at sugarcane breeding institute, Coimbatore took out genes for desired characters like thicker stem and high sugar content from noble cane i.e. *Saccharum officinarum* and introduced them into Indian cane i.e. *Saccharum barberi*.**This is called Noblisation of Indian cane.**
- Today , the sugarcane breeding in whole world is done by noblisation technique.

Sugarcane (Saccharum officinarum L.)

Hybrid Millets(maize, jowar and bajra hybrids)

- Hybrid maize development programme was launched in India in 1957 in collaboration with Rockfeller and Ford Foundations.
- In 1961 they released four successful hybrid varieties of maize.
- After that several hybrid **Hybrid Millets(maize, jowar and bajra hybrids)-** varieties were developed which became popular in few states like Karnataka.
- Popularity was limited in other states because farmers had to replace their seeds every year as these hybrid varieties were double crossed hybrids. So, composite varieties were developed ,**e.g., Manjari, Vikram, Sona, Kisan, CO 1, Renuka, etc.**
- **Current emphasis is on development of single crossed varieties of maize, like, Vivek Maize hybrid 9, Malviya Hybrid Makka 2, Vivek QPM 9, etc.**
- **Some hybrid varieties of maize: Deccan Hybrid Makka, DHM 101, Varun, DHM 103, DHM 107, DHM etc. developed by IIMR, Hyderabad**

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- These hybrid maize give 40% more yield than local open-pollinated (not controlled pollinated) varieties.
- Programmes for development of hybrid jowar(sorghum) and bajra(pearlmillet) was started in 1961 and their first hybrid varieties were introduced in 1962.
- **First hybrid sorghum was CSH 1 and first hybrid pearlmillet was HB 1**.
- Today India has several hybrid varieties of these crops as follows- **sorghum- CHS (2,3,4,5,6,9,10,11,etc), Pearl millet - PHB 10, PHB 14, BJ 104, BK 560, etc**

Hybrid Cottons

- Cotton accounts for 85% of raw material for textile industries in India. ICAR in 1967 Launched **All India Co-ordinated Cotton Improvement Project,** establishing headquarters at Coimbatore (Tamil Nadu)
- ICAR also established Central Institute For Cotton research at Nagpur and two regional stations at Coimbatore and Sirsa (Haryana) for multidisciplinary research on Cotton
- Laxmi, jayadhar ,suvin ,MCU5 , Bikaneri nerma Savitri, Jayalaxmi etc. are some important cotton varieties.
- First hybrid cotton variety was **H4** which was developed in 1970 by Gujarat Agriculture University from two *G.hirsutum strains*.
- **G- cot. Dh-7 and G- cot. Dh-9** are recently released varieties. Recently, cytoplasmic male sterility (CMS) is being used to produce hybrid cotton varieties. But hand pollination and hand emasculation is essential for CMS hybrids.

Cotton plants

Molecular Breeding

- It utilizes Marker Assisted Selection (MAS)
- It enables dependable indirect selection for desirable genes using highly reproducible DNA markers.
- E.g. of crops developed by MAS are Bacterial blight resistant rice varieties of Improved Pusa Basmati 1 and Improved Sambha Mahsuri, Submergence tolerant rice variety Swarna Sub-1 , and Improved protein quality maize hybrid Vivek QPM 9.
- Genome sequencing has also proved to be very helpful. First dwarf rice genome was published in 2002 and sequence of pigeonpea genome was published in 2011.
- Scientists are trying to identify and confirm the alleles of desired traits by using genomics tools and genetic transformation to enhance the efficiency of breeding efforts for marker assisted selection.

Transgenic varieties

- Recombinant DNA technology or transgene technology is most popular and powerful tool for creating crops with novel desired phenotypes.
- These are also called Designer crops.
- E.g. are Bt-cotton hybrids since 2002.
- Recently an indigenous insect resistant Bt-cotton variety, Bikaneri Narma and a hybrid, NHH- 4, have been released.
- India has now become a major cotton exporter due to these hybrid varieties.
- Indigenously developed insect resistant Bt-brinjal is under consideration for approval of its commercial cultivation.

Bt-Brinjal

Some Transgenic plants

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