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Plant Breeding its Applications and Future Prospects

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ABSTRACT

Plant breeding is the art and science of changing the traits of plants in order to produce desired characteristics. It has been used to improve the quality of nutrition in products for humans and animals.Plant breeding can be accomplished through many different techniques ranging from simply selecting plants with desirable characteristics for propagation, to methods that make use of knowledge of genetics and chromosomes, to more complex molecular techniques (see cultigen and cultivar). Genes in a plant are what determine what type of qualitative or quantitative traits it will have. Plant breeders strive to create a specific outcome of plants and potentially new plant varieties.Plant breeding has been practiced for thousands of years, since near the beginning of human civilization. It is practiced worldwide by individuals such as gardeners and farmers, and by professional plant breeders employed by organizations such as government institutions, universities, crop-specific industry associations or research centers.International development agencies believe that breeding new crops is important for ensuring food security by developing new varieties that are higher yielding, disease resistant, drought tolerant or regionally adapted to different environments and growing conditions.It has many aims, objectives,scope, tools,activities,disciplines etc.

KEYWORDS Phenotype, Breeder, Mutagenes,Polyploidy,Cytogenetics,Nobilization,Evaluation,Biometrics etc.

WHAT IS ACTUALLY PLANT BREEDING

Plant breeding is the purposeful manipulation of plant species in order to create desired genotypes and phenotypes for specific purposes.This manipulation involves either controlled pollination, genetic engineering, or both, followed by artificial selection of progeny.Plant breeding often, but not always, leads to plant domestication.Plant breeding has been practiced for thousands of years, since near the beginning of human civilization.It is now practiced worldwide by government institutions and commercial enterprises.The Above impressive increase in foodgrains production has resulted from an increase in net cropped area, increased quantum and better management of inputs, such as fertilizers,irrigation water, plant protection and cultural practices and from improved crop varieties.Classical plant breeding uses deliberate interbreeding (crossing) of closely or distantly related individuals to produce new crop varieties or lines with desirable properties. Plants are crossbred to introduce traits/genes from one variety or line into a new genetic background.

DEFINITION AND HISTORY OF PLANT BREEDING

Plant breeding is an applied branch of Botany, which deals with improvement of agricultural crops. This branch of agricultural science has contributed maximum to the increase in food production all over the world and therefore, now a day it assuming ever increasing importance in field of agriculture in every country.

Riley, 1978 defined plant breeding as a technology of developing superior crop plants/ varieties for various purpose.Frankel, 1958 defined plant breeding as the genetic adjustment of plants to the service man.

Plant breeding is a branch of biology concerned with changing the genotype of plant so that they become more useful.The food grain production of India has increased from 54 millions tonnes to 206 million tonns. As a result of this the nation has become almost self sufficient in food grain, this thing is achieved only due to green revolution has tookes place in 1965-66. Green revolution in our country particularly in Rice and Wheat increases our food grain production in our country particularly in Rice and Wheat increases our food grain

production and today we are exporting several million tonns food grain to many developed and developing country.On the other hand population of our country after independence also increasing at an arming rate of 2.5% per year, this make it necessity that the food grains production should increases at least at the same rate or faster than the population rate. Therefore, it is the necessity of modern farmers. Progressive farmers to apply plant breeding science, techniques for the development of new high yielding varieties, to meet the need of this tremendous growing population.In India more than 70% population is depend on agriculture, however majority of them are marginal farmers and landless labour. The input like fertilizer, pesticides, insecticides required for agriculture are expensive and therefore farmers are looking forward for improved high yielding, disease and pest resistance and Earliness varieties. Govt of India also trying to made every effort after independence for increasing agricultural production.Plant breeding started with sedentary agriculture and particularly the domestication of the first agricultural plants, a practice which is estimated to date back 9,000 to 11,000 years. Initially early farmers simply selected food plants with particular desirable characteristics, and employed these as progenitors for subsequent generations, resulting in an accumulation of valuable traits over time.

SCOPE OF PLANT BREEDING (Future Prospects)

- Genetic manipulation of population by increasing the frequency of desirable alleles in cross pollinated crops and introducing male sterile in self pollinated crops like wheat and Rice.
- Intensive breeding of pulses and oil seed crops as it was done in cereals and other crops.
- Proper breeding methods with improved crop management practises.
- Use of heritability methods with improved crop management practises.
- Development of improved high yielding varieties of vegetable and seed crops.
- Quality Improvement in Oil seed and Vegetables.
- Use of transgenic plants as a medicine. E.g. Potato.
- Development of varieties which are desirable for mechanical threshing and cultivation.

TOOLS OF PLANT BREEDING

New tools of plant breeding include.

- **Mutation Breeding-**Mutation is a sudden heritable change in a characteristic of an organism and utilization of variation created by mutation in crop improvements is known as mutation breeding. Agents used for induction of mutation known as mutagenes. It may be physical or chemical mutagenes.
- **Polyploidy -**An individual with more than two sets of homologous chromosome or genome known as polyploidy. Changes in chromosome number may involve loss or gain of one of few chromosomes or the whole genome. Polyploidy may be induced spontaneously or can be induced artificially by using chemicals.
- **Plant Biotechnology-**Utilization of biological agents or their components for generation products for the welfare of mankind, known as biotechnology. Plant biotechnology is related to such activities other than conventional approaches. It aims at improving the genetic make up, phenotypic performance and multiplication of economical plants.
- **In Vitro Techniques-**It is the cultivation of plant organs, tissue or cell in test tube on artificial media. In certain situation conventional breeding methods are not efficient. In that situation these methods have been supplemented by in vitro techniques/ tissue culture to increase the efficiency of crop.Ex: Eucalyptus – Yashwant, Banana- Shrimati
- **Genetic Engineering-**Isolation of the desired from an organize, its integration into a suitable vector and its introduction into another organism (host) with a view to obtain multiple copies (Replica) of the desire gene. The gene may remain in vector or may got integrated into the chromosome of the host later it produces transgenic plant.

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NATURE OF PLANT BREEDING

Plant breeding is an art or science and is as old as agriculture, started since man learnt to cultivate the plants. In earlier days, man depends on his skill and judgement in selecting better plants. His knowledge about the plant was very limited. He knew nothing about the inheritance of characters, role of environment in producing them and the basis of variation in various plant characters. His method of selection was designed without the understanding of the principle of inheritance. Therefore during primitive time plant breeding was largely an art and very less science was involved in that, but the present breeding methods are entirely based on the scientific principles of plant sciences, particularly of genetics a cytogenetic. Thus, plant breeding is purely science with very little art involved. Science is the knowledge gathered through scientific method. The scientific method consists of observation, formulation of hypothesis, experimentation and conclusion either to accept or reject the hypothesis.

Plant breeding is considered as the current phase of crop evolution. As the knowledge of genetics and other related science progresses plant breeding become less art and more science. Especially discovery of Mendels work in 1900, added lot to the knowledge of science. Selection of desirable plant even today is an art it depends on the skill of a person but alone skill is not enough, modern plant breeding is based on through understanding and use of genetics principles.To be successful, a plant breeder must know each and everything about the crop with he is working. He should have an understanding of principles of difference disciplines viz. genetics, cytology, Morphology and Taxonomy, plant Physiology , Plant Pathology, Entomology, Agronomy, and Soil Science, Biochemistry, Statistics, and Biometrics. Computer and Plant biotechnology. Thus plant breeding is an art science and a technology of developing genetically superior plants in terms of the economics utility for the mankind.

THE DISCIPLINES A BREEDER OUGHT TO KNOW

To be successful, a plant breeder must know all -he can about the plants he is working with. Thus he should have an under-standing of the botany, genetics and cytogenetics, agronomy, plant physiology, plant pathology, entomology, bacteriology, plant biochemistry and statistics.

Botany- A plant breeder must have a clear understanding of the morphology and reproduction of the plants he aims to improve. He should also be familiar with the taxonomy of the plant.

Genetics and cytogenetics- The principles of genetics and cytogenetics provide the basis for plant breeding methods. Therefore, a thorough knowledge of these subjects is essential for a rapid and efficient improvement of a crop plant.

Agronomy- A good breeder is first a good agronomist. He must be able to raise a good crop in order to select and evaluate his material.

Plant Physiology- Adaptation of a variety is determined by its response to environmental factors like heat, cold, drought, salinity etc. A knowledge of the physiological basis of these responses would help the breeder in developing cold, drought or salinity tolerant varieties. In addition, several physiological approaches to breeding for higher yields are being developed.

Plant Pathology- Breeding for disease resistance is an important objective of plant breeding. For an effective breeding for resistance, a sound knowledge of plant diseases and their pathogens is essential.

Entomology- Insect pests cause considerable damage to crops. A knowledge of insect pests would be necessary in order to breed insect resistant varieties, and to protect susceptible breeding materials from pest damage.

Bacteriology-legumes have root nodules containing Rhizobium, which fix atmospheric nitrogen. The efficiency of this system depends upon both the host and Rhizobium genotypes. Therefore, in legume improvement a knowledge of Rhizobium would be helpful. This aspect of legumes is receiving a great deal of attention these days.

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OBJECTIVES OF PLANT BREEDING

The prime aim of plant breeding is to improve the characteristics of plants that they become more useful automatically and economically. Some of the objectives may be summarized as follows:

- **Higher Yield**Higher yield of grain, fodder, fibre, sugar, oil etc. developing hybrid varieties of Jawar, Maize, Bajara, etc.
- **Improved Quality**The quality characters may vary from one crop to another such as grain size, shape, colour, milling and backing quality of wheat, cooks quality in rice, malting in barley. Size shape and flavour in fruits and keeping quality of vegetables, protein contents in legumes, methionine and tryptophan contents in pulses etc.
- **Disease and Pest Resistance**Resistant varieties offer the cheapest and most convenient method of disease and pest control. They not only helps to increase the production but also stabilize the productivity e.g. Rust resistance in wheat.
- **Maturity Duration**It permits new crop rotation and extends crop area. Thus breeding for early maturing varieties suitable for different dates of planting. This enables the farmer to take two-three crops in a year.
- **Agronomic Characters**Three includes the characters such as dwarf, profuse tillering, branching erect resistance and fertilizer responsiveness.
- **Photo and Thermo Insensitivity**Development of photo and thermo insensitive varieties in rice and wheat will permit to extend their cultivation to new areas. E.g Cultivation of wheat in Kerala and West Bengal, Cultivation of rice in Punjab and Himachal Pradesh.
- **Synchronous Maturity**It is desirable in crops like mung (Vigna radiate) where several pickings are necessary.
- **Non-Shattering Characteristics**E.g.Mung, Black Gram, Horse Gram, etc.
- **Determinate Growth Habit**It is desirable in mung, pigeon pea and cotton, etc.
- **Dormancy**In some crops, seeds germinate even before harvesting if there are rains at the time of maturity. E.g Mung, barley, etc. A period of dormancy in such cases would check the loss due to germination while in other cases it may be removed it.
- **Varieties for a New Season**Breeding crops suitable for seasons. E.g Maize (Kharif) which is grown in Rabi and summer also.
- **Moisture Stress and Salt Tolerance**Development of varieties for a rainfed area and saline soils would help to increase crop production in India.
- **Elimination of Toxic Substance**It will help to make them safe for consumption E.g Khesari (Lathyrus sativus) seeds have a neurotoxin causing paralysis.
- **Wider Adaptability**It helps in stabilizing the crop production over region and seasons.
- **Useful for Mechanical Cultivation**The variety developed should give response to application of fertilizers, manures andirrigation, suitable for mechanical cultivation etc.

ACTIVITIES IN PLANT BREEDING

The desired changes in the 'genotypes of crop species mi the consequent benefits to the farmers are brought about by a series Interrelatedand largely interdependent activities. These activities' are

Creation of variation Genetic variation is a prerequisite for any improvement in a crop. Therefore in any breeding programme, this is always the first step unless variation preexists. Genetic variation can be created by domestication,germplasm collections, plant introduction,hybridization,mutation, polypolidy, somaclonal variation and genetic engineering.

Selection The next step consists of identification and isolation of plants having the desirable combinations of characters, and growing their progeny, this is called selection.Selection is necessarily based on phenotype. The efficiency of this activity determines the success of a breeding programme. Various breeding methods

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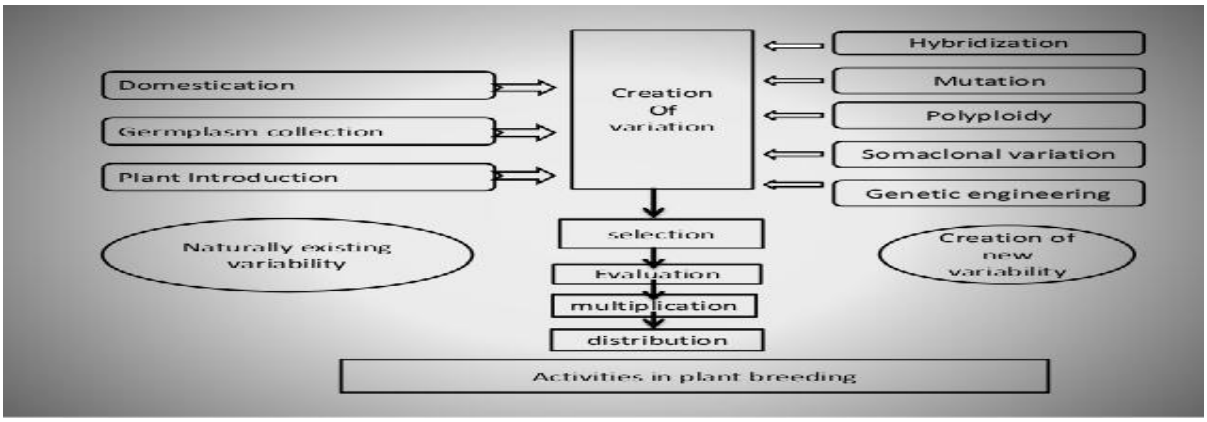
have been designed to increase the efficacy of selection . Selection finally yields an improved line/ stream of population.

EvaluationThe newly selected lines/strains/population are tested for yield and other traits and their performance is compared with the existing best varieties called checks. Evaluation is a stepwise process,ordinarily conducted at several locations for three or more years under the concerned. All India coordinated crop improvement project. If the new line/strain/population is superior to the checks , it is released and notified as the new variety and its seed can now be multiplied and, more importantly, certified by a seed certification agency for quality.

MultiplicationThis step concerns with the large scale production of certified seed of the released and notified variety. Seed production is usually done by seed production agencies in a step wise manner, and the seed is certified by a seed certification agency.

DistributionCertified seed is ultimately sold to the farmers who use it for commercial crop cultivation. This activity alone makes it possible to reap the economic benefits from the above activities in form of: (i) an enhanced and (ii) Stable production of (iii) Superior produce (iv) often at a lower cost.



VARIOUS METHODS IN PLANT BREEDING

{A} Self-Pollinated Plants

1.Mass Selection
2.Pureline Selection
3.Pedigree Selection
4.Bulk Method
5.Backcross Method

{B}Cross- Pollinated Plants

1. Mass Selection
2. Progeny Selection
3. Recurrent Selection

ACHIEVEMENTS IN PLANT BREEDING

Today crop plants are different from the crop from which they are originated i.e is wild species. This change has been brought about man through plant breeding. The important achievement of plant breeding are :

- **Production of Dwarf and Semi Dwarf Cereal Varieties**

Many dwarf and semi dwarf varieties are developed in crop like wheat and Rice Dr. Borlaug used a apenese variety NORIN-10 as a source of dwarfing gene, in wheat at CIMMYT (Mexico). In 1963 ICAR has introduced some dwarf selection from CMMYT. Variety Kalyansona and Sonalika were selected from these

materials. In India majority of the wheat varieties grown are semi dwarf, and are resistant to water lodging, responsive to fertilizer doses etc.Similarly the development of semi dwarf varieties of Rice has revolutioned rice cultivation. These varieties were developed by introducing the gene Dee-Geo-Woo-Gene. Ex TN. 1 developed at Taiwan and IR-8 at IRRI Philippines, both were introduced in India in 1966.

- **Nobilization of Sugarcane**

The Indian canes were of Saccharum barberi, largely grown in North India. They were hardy but poor in yield and sugar content, while tropical cane of Saccharum oficinarum had thicker stem and higher sugar content but it performed badly in North India due to low winter temperature. C.A Barber and T.S Venkatraman at Sugarcane Breeding Institute, Coimbtore transferred thick stem higher sugar content and other desirable characters from the noble cane to Indian cane is commonly referred as nobilization on of Indian canes.

- **Development of Hybrid and Synthetic**

a) Maize- Canga series of hybrid, Ganga safed-2, African Tall, Manjari, Deccan etc.

b) Sorghum -CSH-1,2,3,4,5,6,7,8,910,12,14 and 15 R.

c) Bajara-WCC-75, PHB-10, ICTP-8203, Shradha and Saburi.

d) Cotton-H-4, Var.Laxmi, Savitri, NH-44, Jaylaxmi, etc.

ADVANTAGES OF PLANT BREEDING

- The method is inexpensive to conduct,The base population can be a land-race. The population size selected is variable and can be small or large, depending on the objective,The cultivar developed by this method has great “eye appeal.
- It is applicable to improving traits of low heritability, because selection is based on progeny performance.
- Mass selection may include some inferior pure lines. In pure line selection, only the best pure line is selected for maximum genetic advance.
- Large number of plants are selected.
- Consumes less time of the breeder.
- It helps in improving the variety further.
- It is less demanding and uniform.

DISADVANTAGES OF PLANT BREEDING

- The purity of the cultivar may be altered through admixture, natural crossing with other cultivars, and mutations. Such off-type plants should be rogue out to maintain cultivar purity.
- The cultivar has a narrow genetic base and, hence, is susceptible to devastation from adverse environmental factors because of uniform response.
- A new genotype is not created. Rather, improvement is limited to the isolation of the most desirable or best genotype from a mixed population.
- The method promotes genetic erosion because most superior pure lines are identified and multiplied to the exclusion of other genetic variants.
- Progeny rows takes up more resources.
- Difficulty in identification,maintenance of accurate pedigree record takes up valuable time.

FUTURE PROSPECTS

The past achievements of plant breeding fully illustrate its future possibilities. The improvements made in the crop plants so far represent only a small portion of the possible improvements. There is considerable scope for further modifying the present-day crop species. It is believed that the genetic makeup of the plants may be

modified to a much greater extent than we normally appreciate. Further, breeding of several crop plants, like pulses and oilseeds, has not been so intensive as that of wheat and rice. Much improvement in yields and other characteristics can be made in these crops.

CONCLUSION

Plant breeding is a silence based on principles of genetics and cytogene- tics. It aims at improving the genetic makeup of- the crop plants. Improved varieties are developed through plant breeding. Its objectives are to improve yield, quality# disease resistance, drought and frost tolerance aod other charac- â– tensile^ of the crops. Plant breeding has been crucial in increasing agricultural production. Some ^ well known achievements are development of ' semidwarf wheat and rice varieties, noblisation of Indian canes, and production of hybrid and composite varieties of maize, jowar and bajra . Plant breeders should be able to make similar contributions in the future as well.

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