9. ***Increase in economic yield*** is the most noticeable as well as desirable change und domestication. This is self-evident in every crop species.
10. In many crop species, ***asexual reproduction has been promoted*** under domesticatio *e.g.*, sugarcane, potato (*Solanum tuberosum*), sweet potato (*Ipomoea batatas*), etc.
11. There has been a ***preference for polyploidy*** under domestication. Many of th domesticated plant species are polyploids, *e.g.*, potato, wheat, sweet potato, tobacc (*Nicotiana* sp.), etc., while diploid counterparts are present in nature.
12. In many species, there has been a ***shift in the sex form*** of the species. In man dioecious fruit trees, bisexual forms have developed under domestication. Sel incompatibility has also been eliminated in many crop species.
13. ***Variability within a variety has drastically decreased*** under domestication. Th extreme case is represented by pureline varieties, which are completely homozygou and homogeneous genotypically.

2.2. PATTERNS OF EVOLUTION IN CROP PLANTS

It is apparent that selection by nature and man has been responsible for the evolution of cro plants. However, selection is effective in altering a species only when genetic variabilit exists in the populations of that species. There are three major ways in which geneti variability has arisen in various crop species, *viz.*, (1) Mendelian variation (generated mainl by gene mutation), (2) interspecific hybridization, and (3) polyploidy. The patterns o evolution of various crops may, therefore, be broadly classified according to the mode o origin of genetic variation crucial for evolution of that species.

2.2.1. Mendelian Variation

Many crops have evolved through variation generated by gene mutation, and b hybridization between different genotypes within the same species, followed b recombination. Ultimately, all the variability in any species originates from gene mutations Most of the gene mutations are harmful and are eventually eliminated. But some mutation are beneficial and are retained in the population. The mutations may be grouped into tw categories: (1) macromutation and (2) micromutation. *A **macromutation** produces a large an distinct morphological effect, and often affects several characters of the plant.* A singl macromutation is believed to have led to the differentiation of modern maize (*Zea mays*) plan from the grassy pod corn. This mutation has affected the positions of male and femal inflorescences, the habit of the plant and several other characters. Similarly, cabbag (*Brassica oleracea*), cauliflower (*B. oleracea*), broccoli (*B. oleracea*), and Brussel's sprout (*B. oleracea*) have originated from a common wild species and they differ from each othe with respect to a few major genes.

The greater part of variation, however, has resulted from *mutations with small and les drastic effects, i.e.*, ***micromutations***. Since micromutations have only small effects, they ten to be accumulated in a population. Natural selection would accumulate and select for mor favourable gene combinations. Man would have selected from the populations desirable plan types leading to the differentiation of domesticated species from the wild ones. Several important crops have evolved through Mendelian variation, *e.g.*, barley, rice beans (*Phaseolus* sp.), peas (*Pisum sativum*), tomatoes (*Lycopersicon esculentum*), linseed (*Linum usitatissimum*), jowar (*Sorghum bicolor*), bajra (*Pennisetum americanum*) and many other crops.

2.2.2. Interspecific Hybridization

***Interspecific hybridization** refers to crossing of two different species of plants.* The resulting F_1 is generally more vigorous than the parents. But segregation in F_2 and later generations produces a vast range of genotypes. This is because the parental species are likely to differ from each other for a large number of genes. Most of the recombinants in the segregating generations are likely to be weak and undesirable. Often interspecific hybrids are highly sterile and do not set seeds. There is little evidence to suggest that interspecific hybridization contributed to any great extent in the evolution of crop species.

But in some cases, the interspecific hybrids may have repeatedly backcrossed to one of the parental species. As a result, most of the genotype of that parental species, to which the hybrid had repeatedly backcrossed, would be recovered along with few or several genes from the other parental species. This process is known as ***introgressive hybridization**; it leads to the transfer of some genes from one species into another.* The modern maize is postulated to have developed through introgressive hybridization between the primitive maize and a wild grass, *Tripsacum*. It is supposed that some genes from *Tripsacum* were transferred to the primitive maize, which resulted in the origin of the modern maize.

Interspecific hybridization has led to the development of several strawberry varieties. The F_1 from a cross between two species of strawberries, *Fragaria virginiana* and *Fragaria chiloensis*, was backcrossed to the two parental species to produce many varieties of commercial value. In certain fruit trees, such as, pears, plums, cherries and grapes, and ornamentals, *e.g.*, irises (*Iris* sp.), roses (*Rosa* sp.), lilies (*Lillium* sp.), etc., vegetative propagation is commonly used. In such species, many varieties are interspecific hybrids (F_1).

2.2.3. Polyploidy

Generally, autopolyploidy leads to increased vigour, larger flowers and fruits, etc. over the diploid forms. Many varieties of ornamental plants are autopolyploids. The commercial banana (*Musa paradisiaca*) is an autotriploid ($3x$); it has larger and seedless fruits in comparison to the diploid banana. Triploid varieties are known in apples (*Pyrus malus*), watermelons (*Citrullus vulgaris*), sugarbeets (*Beta vulgaris*) and some other crops. The commonly grown potato (*S. tuberosum*) may be regarded as an autotetraploid, although interspecific hybridization may also be involved. *S. tuberosum* has $3x$, $2x$ and $4x$ types. Some of the $2x$ progeny obtained from the $4x$ potato are fully fertile and as vigorous as the $4x$ types, indicating that it is largely an autotetraploid. Other autopolyploid crop species are sweet potato ($6x$), oat (*Avena abyssinica*, $4x$) and alfalfa (*Medicago sativa*, $4x$). Thus autopolyploidy has played a limited role in crop evolution.

Allopolyploidy, in contrast, has been considerably more important in crop evolution. Allopolyploidy results from chromosome doubling of interspecific F_1 hybrids. About 50 per cent of the crop plants are allopolyploids. Some of the important allopolyploid crop plants are wheat, tobacco, cotton, sugarcane, oats (*Avena* sp.), rai (*Brassica juncea*), rapeseed (*Brassica napus*), etc. Origins of wheat, tobacco, cotton, and oats have been extensively investigated. Common bread wheat (*Triticum aestivum*) is an allohexaploid, while cotton (*Gossypium hirsutum* and *G. barbadense*) and tobacco (*Nicotiana tabacum* and *N. rustica*) are allotetraploids. There is evidence to suggest that *N. tabacum* originated from chromosome doubling of the F_1 hybrid from *N. sylvestris* × *N. tomentosa*. *Triticale hexaploide* is a man made allopolyploid developed by chromosome doubling of the F_1 between rye (*Secale cereale*) and tetraploid wheats. Triticale has shown much promise particularly in areas of moisture or temperature stress.

2.3. GERMPLASM

The genes required for crop improvement are present in different lines, varieties, strains or populations of the crop species and their relatives. Some useful genes, often critical genes, are contributed by the wild relatives of crops. The various lines, strains, populations of a crop species and its related wild species constitute the germplasm of the crop. Thus the ***germplasm*** *of a crop may be defined as the sum total of hereditary material,* i.e., *all the alleles of various genes, present in a crop species and its wild relatives.* Therefore, germplasm consists of the following five types of materials: (1) land races, (2) obsolete varieties, (3) varieties in cultivation, (4) breeding lines, and (5) wild forms and wild relatives.

2.3.1. Land Races

These are primitive varieties, which had evolved over centuries or even millenia through both natural and artificial selection, but without a systematic and sustained plant breeding effort. They are storehouses of genetic variability and, ordinarily, are adapted to the local soil type, climatic conditions, etc. They are sources of many valuable genes, including those for adaptation. Genetic variation is present both within and between varieties. They are adapted to survive under unfavourable conditions and have low but stable yields.

2.3.2. Obsolete Varieties

These varieties were developed by systematic breeding effort, were once commercially cultivated, but are no more grown. They, however, do have some desirable features. For example, wheat varieties K65, K68, Ph591, many NP series varieties, etc. are obsolete varieties.

2.3.3. Varieties in Cultivation

The varieties in cultivation are the easiest to use in breeding programmes. They form a major part of a working collection (Section 2.11.2.2). They are good sources of genes for yield, quality, etc. They can be introduced in a new area, and directly released for cultivation. These have been evolved through planned plant breeding, are ordinarily highly homogeneous and highly genetically variable.