**Chapter 2. Domestication, Plant Introduction and Acclimatisation**

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**I. Domestication**

The process of bringing wild species under human management is known as domestication. It came into existence when man began agriculture ~ 10,000 years ago. Domestication of wild species is still being done and is likely to continue for a long time in the future. This is because, with time the human needs are likely to change. Subsequently, the wild species of little importance today may assume great significance tomorrow.

From the wild weedy species, the present-day cultivated plants have been derived. The first step is the development of cultivated plants was their domestication. Most of the crops were domesticated by the prehistoric man. Knowingly or un- knowingly he must have selected for the characteristics that made the plants more suited to his needs. Under domestication, the crop species have changed considerably as compared to the wild species from which they originated. The change is often so great that they are categorized as distinctive species. As a result, in many cases, the parental, wild species of the cultivated plants are not definitely known. This great difference between wild relatives and cultivated plants was brought about through selection by man along with nature. The domesticated species were selected for characteristics entirely different from those for which the wild species were selected in nature. Therefore, the two groups of plants developed in two different, often opposite, directions.

Domestication of wild- species is still being done and is likely to continue for a long time in the future. This is because the human needs are likely to change with time. Consequently, the wild species of little importance today may assume great significance tomorrow. This is particularly true for microorganisms producing antibiotics, involved in nitrogen fixation, and producing other compounds of industrial or medical interest; forest trees producing timber and other commercial products; medicinal plants; and plants rewarding definite wants. A notable case of recent domestication is that of several members of Euphorbiaceae producing latex. For extraction of petroleum products, including petrol and diesel the latex of these plants may be commercially used. A large scale cultivation of these plants is being done in U.S.A. and Japan.

Project for cultivation of jojoba (*Simmondsia* sp.) initiated by the Department of Science and Technology, Government of India in arid zones of Rajasthan, Gujarat, Maharashtra and Uttar Pradesh. Seeds of jojoba contain oil which is comparable to sperm whale oil and is highly suitable as an industrial lubricant. The plants producing latex are gopher plant (*Hevea* sp.), milkweed (*Euphorbia lathyrus*) etc. They are hardy desert plants and their latex compares favourably with petroleum crude, and is being used for extraction of petroleum products. As a result, fields of these plants are often, called living oil fields.

1. **Natural and Artificial Selection under Domestication**

The precise sequence of events in evolution of crop plants under domestication is not known. But it may be generalised that in the early stages a considerable variability existed in the domesticated species. New variability arose from hybridization followed by recombination and from mutation. The extent and manner of selection exerted by man on the domesticated species is not known. Selection may be described as a phenomenon of some genotypes from a population leaving behind more progeny than others. Those genotypes that produce more progeny are selected for and the others are selected against. By natural forces, there is a continuous selection, eg., temperature, soil, weather, pests, diseases, etc. Consequently, those genotypes more suited to a given environment have behind more progeny than the less adapted ones. This method is termed as natural selection. Thus natural selection is one of degree and it rarely stops a genotype from producing some progeny. The selection by man (artificial selection), on the other hand, often permits only the selected plants to reproduce; the progeny from the remaining plants are generally discarded. Thus natural selection retains considerable variability in the species, while artificial selection progressively reduces this variability.

There is without a doubt, nevertheless, that man exercised considerable for selection on domesticated plant species. It may be expected that he would have selected those plant types that best suited to his needs. It is likely that he selected for larger fruit and grain sizes. It may he expected that his methods of selection were primitive, in that they were not based on scientific principles. His sole criterion of selection would have been the phenotype of plants. But there could be no doubt that this, combined with the natural selection under domestication, was highly effective. Artificial and natural selections have led to several distinct changes in the characteristics of domesticated species.

1. **Changes in Plant Species under Domestication**

Under domestication, nearly all the traits of plant species have been affected. The characters that show more distinct changes are those that have been objects of selection and are still plant breeding objectives in many cultivated species. Some of the important changes that have occurred under domestication are briefly listed below.

1. Exclusion of or lessening in shattering of spikes or pods etc. In most of the cultivated species, this change has taken place.
2. % Elimination of dormancy has taken place in several crop species. Lack of dormancy has become a problem in crops like barely (*Hordeum vulgare*), wheat (*Tritucum aestivum*), mung (*Vigna radiata*) etc.
3. Decrease in toxins or other undesirable substances have been decreased. The bitter principle of cucurbitaceous plants is an example.
4. Plant type has been extensively modified. The cultivated plants show altered tillering, branching, leaf characters, etc.
5. In several crop species, there has been a decrease in plant height, e.g., cereals, millets. This is often associated with a change from indeterminate to determinate habit.
6. Under domestication, conversely, there has been an increase in plant height in some species, e.g., jute (*Corchorus* sp.), sugarcane (*Saccharum officinarum*), forage grasses etc.
7. Life cycle has become shorter in case of some plant species. This is particularly so in case of crops like cotton (*Gossypium* sp.), arhar (*Cajanus cajan*), etc.
8. Most of the crop plants show an increase in size of grains or fruits.
9. Increase in the economic yields is the most noticeable as well as desirable change under domestication. This is self-evident in every crop species.
10. In many crop species, asexual reproduction has been promoted under domestication, e.g., sugarcane, potato (*Solanum tuberosum*), sweet potato (*Ipomoea batatas*), etc.
11. There has been a preference for polyploidy under domestication. Many of the domesticated plant species are polyploids, e.g., potato, wheat, sweet potato, tobacco (*Nicotiana* sp.), etc., while diploid plants are present in nature. Thus domestication seems to have favoured polyploidy in these crop species.
12. There has been a change in the sex form of the species in many species. In many dioecious fruit trees, bisexual forms have developed under domestication. Self- incompatibility has also been eliminated in many crop species.
13. Variability within a variety has drastically decreased under domestication. The extreme case is that of pureline varieties which are completely homozygous and homogeneous genotypically.

**II. Plant Introduction:**

In plant introduction, the group of genotype of plants or a single genotype is to be taken into new atmospheres where they have not grown previously. Introduction might include novel varieties of a crop which are already grown in the area, a totally new crop species or wild relatives of the crop species. Generally from other countries or continents, materials are introduced. However within a country, movement of crop varieties from one environment into another is also called as introduction. Certain instances of introduction in the country introduction are popularization of grape cultivation in Haryana, Introduction of wheat in West Bengal, Rice in Punjab etc.

1. **Primary Introduction**: When the introduced variety is well-matched to the new atmosphere, for commercial cultivation, it is released without any alteration in the original genotype, this constitutes primary introduction. It is less common, mainly in countries having well organized crop improvement programmes. There are some examples of primary introductions like varieties Sonora 64, Lerma Roja are the semi dwarf wheat introductions and semi dwarf rice varieties are IR-8, IR-36 and Taichung Native 1 (TN-1).
2. **Secondary Introduction:** To isolate a superior variety, the introduced variety may be subjected to selection. Instead, to transfer one or few characters from this variety to the local ones, it may be hybridized with local varieties these processes are termed as secondary introduction. Secondary introduction is very common than primary introduction. Kalyan Sona and Sonalika wheat varieties are some instances of secondary introduction which are selected from material introduced from CIMMYT, Mexico.
3. **History of Plant Introduction:** Crop plants have travelled into many new areas from their centres of origin. The movement of man leads to movement of plants. Most of these introductions occurred very early in the history. For example, the crops pear, mustard, apple, mung and walnut were introduced from the Central Asian Center of origin into several parts of India. Similarly in Africa crops like Sesame, Jowar, Arhar, Asian Cotton and Finger millet were originated and travelled to India in the prehistoric period. For some eras A.D. the agencies of plant Introduction were invaders, settlers, traders, travellers, explorers and naturalists.

The plant introductions were made either knowingly or unknowingly. Cherries and grapes were introduced in India by Muslim invaders from Afghanistan by 1300 A.S. In the 16th century A.D. crops like Maize, Groundnut, Chillies, Potato, Sweet potato, Guava, Pineapple, Papaya, Cashewnut and Tobacco were introduced by Portuguese.

From China, tea, litchi, and loquat crops were brought by East India Company. Vegetable crops like Cabbage, cauliflower and other vegetables were brought to India from the Mediterranean; from West Indies, Annatto and Mahogany are brought in the last quarter of 18th century. A number of botanic gardens played an important role in plant introduction, during 19th century.

The Calcutta botanic garden was established in 1781. Introduction of quinine and rubber trees were arranged by The Kew botanic gardens, England from South America into India. Various agricultural and horticulture research stations were established during and after the last part of 19th century in the country. The various horticulture and agriculture plants were introduced by these stations independent of each other. There was lack of co-ordination amid these organizations about their introduction activities.

1. **Plant Introduction Agencies in India**:

In 1946, at the Indian Agricultural Research Institute (IARI), New Delhi a centralized plant introduction agency was initiated. In the Division of Botany, the agency began as a plant introduction scheme and was financed by ICAR. During the second five year plan in 1956, the scheme was expanded as the Plant Introduction and Exploration Organisation. Then in 1961, a separate Division of Plant Introduction was made in IARI. In 1976, the division was renamed as National Bureau of Plant Genetic Resources (NBPGR). The bureau has the responsibility of the introduction and maintenance of agricultural and horticultural plants germplasm.

There are some other agencies concerned with plant introduction along with the National Bureau of Plant Genetic Resources. One of the institution is Forest Research Institute (FRI), Dehradun, which play an important role in the introduction, maintenance and testing of forest trees germplasm. Another such organization is the Botanical Survey of India (BSI). It was established in the year 1890 and it was responsible for the introduction, testing and maintenance of plant materials of botanical and medicinal interest. Nevertheless right now, introduction and improvement of medicinal plants is actually observed by NBPGR. For various crops, e.g. Tobacco, sugarcane, potato, tea, coffee, rice etc., Central Research Institute introduce, test and maintain plant materials of their interest. But NBPGR coordinates their actions, NBPGR has the final duty for introduction activities. Individual scientists, universities and other research organizations can also done the introductions of plant materials. However in India, all the introductions must be routed through the NBPGR, New Delhi.

1. **The National Bureau of Plant Genetic Resources (NBPGR)**:

The bureau has its head office at IARI, New Delhi. For the testing of introduced plant materials, NBPGR has four substations. These substations represent the many climatic zones of India, they are listed under.

1. Simla - It is situated in Himachal Pradesh and represents the temperate zone; approximately 2,300 m above sea level.

2. Jodhpur, Rajasthan - It represents the arid zone

3. Kanya Kumari, Tamil Nadu - It represents the tropical zone

4. Akola, Maharashtra - It characterizes the mixed climatic zone. It was recently shifted from Amravati. Furthermore, for collection of germplasm from North-east India at Shillong, a new substation has recently been established. a large genetic variability occurs in this part of the country for several crop species, e.g., Maize, citrus, rice, etc. The bureau functions as the central agency for the export and introduction of germplasm of economic importance. The bureau is assisted in its activities by the various Central Research Institutes of ICAR.

The actions of the agency are described in brief as follows.

1. It introduces the required germplasm from its counterparts or other agencies in other countries.

2. To collect valuable germplasm, it arranges explorations inside and outside the country.

 3. It is responsible for the inspection and quarantine of all the introduced plant materials.

4. From various sources, the multiplication, testing and maintenance of germplasm is to be done. The bureau itself can be done this at one of its substations otherwise by any of the concerned Central Institutes of ICAR.

5. To supply, on request, germplasm to various scientists or institutions. The germplasm may be supplied ex-stock or may by procured from outside in case it is not available in the country.

6. The records of plant name, variety name, propagating material, special characteristics, source, date and other relevant information about the materials received is to be managed.

7. To provide germplasm to its equivalents or further organizations in other nations.

8. For publication of exchange and collection lists. the Food and Agriculture Organisation (FAO) published, an Introduction News Letter with such lists since 1957 at irregular intervals. Some lists have also published by NBPGR and they are in the process of publishing some other catalogues.

9. To set up natural gene sanctuaries where genetic resources are endangered of plants.

10. Improvement of aromatic and medicinal plants.

**f) Procedure of Plant Introduction**: Introduction comprises of the following stages, Procurement, quarantine, cataloguing, evaluation, multiplication and distribution.

**1. Procurement:** In India, germplasm can be introduced by any individual or institution. But through the NBPGR, New Delhi all the introductions must be sent. For plant introduction, there are two ways. In first method, the individual or the institution makes a straight demand to an individual or institution overseas, who has the desired germplasm, to send it through the NBPGR, New Delhi. In second procedure, a requirement of germplasm is to be submitted by the individual or institute to the NBPGR with a request for their import.

**2. Quarantine:** To prevent the spread of diseases pests to keep materials in isolation is called as quarantine. Inspection of weeds, diseases and insect pests for contamination of all the introduced plant propagules is done. To get rid of the contamination Materials that are suspected to be contaminated are given the fumigation treatment or other treatments. The materials are grown in isolation if necessary for taking observation of diseases, insect pests and weeds. The whole procedure is termed as quarantine and the rules suggesting them are called as quarantine rules.

**3. Cataloguing:** An entry number is given to the introduction when it is received. Additional, information about species name, origin place, variety, adaptation and its several features are recorded. The plant materials are categorized into three groups.

1. The prefix ‘EC’ is given to Exotic collections

2. The prefix ‘IC’ is given to Indigenous collections and

3. ‘IW’ is marked as Indigenous wild collections

4. Evaluation: For the assessment of performance at different substations of the Bureau new introductions are evaluated. The crops like potato, sugarcane, Tobacco, rice etc. which are functioning under Central Research Institutes, their evaluation and maintenance is done by these institutes. The diseases and pests resistance is assessed in environments which favours heavy attacks by them.

5. **Multiplication and Distribution:** After the necessary trials, favourable introductions or selections from the introductions may be increased and released as varieties. Most of the introductions, however, are characterized for desirable traits and are maintained for future use. Such materials are used in crossing programmes and are readily supplied by the bureau on request.

**g) Purpose of Plant Introduction:** To improve the plant wealth of the country is the chief purpose of plant introduction. The principal aims of plant introduction may be grouped as belows.

1. To obtain an entirely new crop plant: An entirely new crop species may provide by plant introductions. Many crops like, e.g., tomato, potato, maize, Tobacco, etc., are introductions. Soybean, gobhi sarson, oil palm are some recently introduced crops etc.
2. To serve as new varieties: Occasionally introductions are directly released as superior commercial varieties. Sonora 64 and Lerma Rojo are the Mexican semi dwarf wheat varieties, TN 1, IR-8 and IR-36 are the semi dwarf rice varieties are more recent examples of this type.
3. To be used in crop improvement: To develop improved varieties, frequently the introduced material is utilized for hybridization with local varieties. A cross between Meeruty and Sioux is Pusa Ruby tomato which is an introduction from U.S.A.
4. To save the crop from diseases and pests: Sometimes to protect a crop from diseases and pests it is introduced into a new area. To prevent losses from leaf rust Coffee was introduced from Africa in South America. On the other hand, from South America *Hevea* rubber was brought to Malaya to protect it from a leaf disease.
5. For scientific studies: For studies on biosystematics, evolution and origin of plant species, collections of plants have been used. The concept of centres of origin is developed by N.I. Vavilov and also the homologous series of variation.
6. For aesthetic value: To satisfy the finer sensibilities of man, ornamentals, shrubs and lawn grasses are introduced. In social life, these plants are used for adornment and are of great value.
7. Varieties selected from introductions: Through selection, several varieties have been developed from introductions. Kalyan Sona and Sonalika are the two varieties of wheat were selected from introductions were from CIMMYT, Mexico.
8. Varieties developed through hybridization: For the development of crop varieties through hybridization introductions have contributed enormously. from crosses with Mexican semi-dwarf wheat all the semidwarf wheat varieties are derived. Through either TN1 or IR 8 all but few semidwarf rice varieties have the dwarfing gene from Dee-geo-woo-gen. From crosses involving introductions, almost all these semi-dwarf rice and wheat varieties have been developed. From the introduced noble canes, all the sugarcane varieties have been derived.

Some other examples of varieties which are developed by using hybridization with introductions are Pusa Ruby tomato obtained from a cross between Meeruti and Sioux; from the cross Meeruti x Red Cloud, Pusa Early Dwarf Tomato, Pusa Kanchan turnip and Pusa Kesar carrot

**h) Merits of Plant Introduction**

1. It provides completely novel crop plants.

 2. Superior varieties are provided either directly or after selection & hybridization.

3. The only feasible means of collecting germplasm are introduction and exploration and to protect variability from genetic erosion.

4. When the introductions are released as varieties either directly or after a simple selection, it is very rapid and cheap way of crop improvement.

5. To protect the plants from damage they may be introduced in new disease free areas, e.g., coffee and rubber.

**i) Demerits of Plant Introduction**

The introduction of weeds, diseases and pests are some of the disadvantages of plant introduction.

**III) Germplasm Collections:** “In a plant species, the sum total of genetic material or genes present is known as the germplasm of that species”. Therefore, a germplasm collection is the group of a large number of genotypes of a crop species and its wild relatives. Gene banks (or world over the world) are also known as germplasm collections. Further, the richest sources of variability are the germplasm collections. Crop improvement would eventually depend upon the presence of this variability which is to be exploited in breeding programmes. Large tracts of land have been put under pureline varieties of self-pollinated crops and hybrid varieties of cross-pollinated species, with the modernization of agriculture. This has led to a gradual disappearance of local or land varieties (‘desi’ varieties) and open pollinated varieties-both reservoirs of considerable variability. Many wild species along with their breeding grounds are gradually destroying by the cultivation and grazing.

Wild relatives of crops may be eradicated by introduced species of weedy nature or even by the cultivated forms derived from such weedy species. Genetic erosion is the gradual damage of variability in the cultivated forms and in their wild relatives. Over an extremely long period of time this variability arose in nature and if it is lost during a short period it wouldn’t be reproduced. Many countries are significantly worried about genetic erosion. To coordinate germplasm conservation activities throughout the world the establishment of IBPGR reflects this concern. In germplasm collections conservations of many genotype is possible and their maintenance is also possible. Land varieties, various wild forms, primitive races, exotic collections and highly evolved varieties constitutes the germplasm collections.

The list of several important germplasm collections is given as follows.

1. Institute of Plant Industry, Leningard. A total of 1,60,000 entries of crop plants.

2. Royal Botanic Gardens, Kew, England, It has over 45,000 entries.

3. Bellsville, U.S.A., maintains germplasm collections of small grain crops.

4. World collections of some of the crops are maintained at the following places.

i) Sugarcane. Canal Point, Florida, U.S.A. and Sugarcane Breeding Institute, Coimbatore (2,800 entries).

ii) Groundnut. Bambey, Senegal (Africa).

iii) Potato. Cambridge, U.K. and Wisconsin, U.S.A.

iv) Annual New World Cottons. Near Tashkent, U.S.S.R.

v) Coffee. Ethiopis (Africa).

vi) Sweet Potatoes. New Zealand

5. Large collections of Sorghum, Bajra, Barley, Rice, Wheat, Oats, Maize and other agricultural and horticultural crops is maintained at the National Bureau of Plant Genetic Resources, New Delhi.

For example, Cotton collection is maintained at Nagpur, groundnut collection is maintained at Junagarh, Tobacco at Rajahmundhry, Potato at Simla, tuber crops (other than potato) at Trivandrum etc. At Central Institute for Cotton Research (CICR, Nagpur), the Cotton collection maintained are as follows ; *Gossypium barbadense*-300 entries; *Gossypium hirsutum*- 4,100 entries; *Gossypium herbaceum*- 393 entries, *Gossypium arboreum*- 1755 entries; (1991).

6. More than 15,000 entries are maintained at CRRI, Cuttack and IRRI, Philippines is maintaining 42,000 rice strains and varieties.

7. Collections of many species were maintained at the various International Institutes because they are building up and maintaining. Most species seeds lose viability rapidly. Therefore, after every few years germplasm collections have to be grown. (1) Much time, labour, land and money is required for growing, harvesting and storing huge collections which is a costly affair. (2) There is also risk of errors in labelling. (3) when the genotypes are grown in surroundings significantly dissimilar from that to which they are adapted, the genotypic constitution of entries may also change. Particularly in case of cross-pollinated species and for local varieties of self-pollinated species, this is true. By using cold storage of seeds these problems may be considerably reduced. At low temperatures and low humidity, seeds of most of the plant species can be stored for 10 years or more. Therefore instead of every one or two years the entries could be grown every 10 years or so. At Fort Collins, U.S.A and at IRRI, Phillippines, cold storage facilities are being utilized. Cold storage facilities at NBPGR have developed for germplasm maintenance and this is termed as ‘National Germplasm Repository’.

**IV) Gene Sanctuaries**: It has been proposed that inside the centres of origin, regions of the highest diversity should be demarcated and they were prevented from human turbulences. The evolutionary potential of the indigenous populations and the environment would be preserved in such parts. Because of this we preserve the variability as well as it would also permit evolution to continue and generate novel forms. Gene sanctuaries were proposed to establish by NBPGR in Meghalaya for Citrus and for crops Musa, Citrus, Oryza, Saccharum and Mangifera in the North-Eastern Region.

Thus a gene sanctuary may be termed as “A zone of diversity which is protected from human interference”. The germplasm is conserved in-situ i.e. within the environment where it grows naturally by the gene sanctuary. With very little labour and expense it conserves the germplasm and furthermore permits evolution to continue on its natural sequence. Because of this the appearance of new gene combinations and new alleles which are not present in the preceding plant population.

**V) Exploration:** For the purpose of collection of various crop forms of plants and their related species, some trips are arranged those are known as explorations. those areas which are likely to show the greatest diversity of forms are generally cover under the explorations. exploration teams often visited such areas which are the centres of origin. Land races and open-pollinated varieties are also collected in addition to wild forms. The primary source of all the germplasm is exploration which is maintained in germplasm collections.

**VI) Acclimatization: ‘**The adaptation of a variety to a new environment is generally termed as Acclimatization’. The process in which distinct plant or animal adjusts to a variation in its environment (such as a change in temperature, altitude, photoperiod, humidity or pH), is acclimatization. It is moreover termed as acclimation or acclimatation is allowing it to maintain performance through a variety of environmental conditions.

When superior cultivars are introduced in a new area from neighbouring or distant regions, to produce a phenotypic expression similar to that in their place of origin, they usually unsuccessful primarily. But far ahead they become acclimatized to the new ecological sphere and in other words, give ideal phenotypic performance. Consequently the ability of crop variety to become adapted to new climatic and edaphic conditions is acclimatization. There is an increase in the frequency of those genotypes which are well adapted to the new atmosphere. There are two factors which determines the success of acclimatization i) Place effect ii) Selection of new genotypes. A faster multiplication of better adapted genotypes to the new environment is brought about by acclimatization. Hence acclimatization works basically under natural selection. The degree of acclimatization is determined through, Mode of pollination, Range of genetic variability present in the original population and Duration of life cycle of the crop. As a result, in acclimatization self-pollination is much more helpful than the cross-pollination.

Usually, the introduced varieties are often not adapted to the new environment and because of it they perform poorly. Sometimes, with the number of generations grown there, the performance of a variety in the new environment improves. For acclimatization to occur in the original population, variability must be present. Thus, purelines are not likely to get acclimatized, while land varieties are likely to.

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