Selection refers to the process that favours survival and further propagation of some plants having more desirable characters than others. The end product of selection process is also known as selection. Natural selection operates in nature without human interference. Natural selection favours those characteristics that are essential for survival of a species.

Thus survival or adaptation is the main concern in the natural selection. Artificial selection, on the other hand is made by human. It favours those characteristics of plants that are related to yield and quality. Thus productivity of economic product is the main concern in human selection. Human selection refers to identification and retention of those plants from heterogeneous populations that are more useful for human than others.

Selection is an important activity in plant breeding programmes. Various selection procedures, such as pure-line selection, progeny selection, clonal selection, recurrent selection, and disruptive selection are commonly used in crop improvement programmes depending upon the mode of pollination of a crop species, the predominant gene action, and the breeding objective.

Selection is practised both in homozygous as well as segregating populations.

The effectiveness of selection largely depends on two main factors, viz.:
(i) The extent of genetic variability present in the base population in which selection has to be practised, and

(ii) The heritability of the character.

Selection is more effective when sufficient genetic variation is present in the base population. Similarly, selection is more effective for those characters having high heritability than those having low heritability. Selection leads to depletion of genetic variability in a population.

2. Concept of Pure-Line Selection:
The concept of pure-line selection was developed in the middle of 19th century in Sweden. However, the genetic basis of pure lines was explained by Johannsen, a Danish biologist in 1903. Pure-line refers to the homogenous progeny of a self pollinated homozygous plant.

Development of new variety through identification and isolation of single best plant progeny is known as pure-line selection or individual plant selection. This method is commonly used

in self-pollinated species. Vilmorin in Sweden used this method for the improvement of wheat and barley. The best pure line may be used as a variety or as a parent in the hybridization for the development of superior cultivars.

3. Features of Pure-Line Selection:

Pure line selection is practised in heterogeneous populations such as introduced materials, landraces and mass selected varieties of self-pollinated species to isolate superior genotypes.

The main features of pure-lines are briefly presented below:

1. Homogeneous:

All the genotypes of a pure-line are homogeneous i.e. genetically identical and phenotypically similar. Thus pure-lines are homozygous and homogeneous.

2. Non-Heritable Variation:

The variation within a pure-line is entirely due to environmental factors. Thus the variation is non-heritable in the pure-lines.

3. Highly Uniform:

A variety developed by pure-line selection is highly uniform in quality due to absence of genetic variation.

4. Selection is Ineffective:

Selection is ineffective in a pure-line due to lack of heritable variation. Selection is effective when heritable variation is present.

5. Narrow Adaptation:

Generally, pure-line varieties have narrow adaptation and poor adaptability than heterogeneous populations. The poor adaptability is due to narrow genetic base.

6. More Prone to New Diseases:

Pure-line varieties are more prone to the attack of new diseases due to genetic uniformity and narrow genetic base.

7. Isolation of Pure-Lines:

Pure-lines can be isolated from heterogeneous population as well as segregating populations through individual plant selection and progeny testing.

8. Sources of Variation:

In a pure-line variety, natural outcrossing, mutations and mechanical mixtures are the important sources of genetic variation. The spontaneous mutations cannot be controlled. Other two factors can be controlled.

4. Theory of Pure-Line Selection:

Johannsen (1903, 1926), a Danish biologist, developed the concept of pure-line theory working with Princess variety of common bean (Phaseolus vulgaris).

The common bean is a self-pollinated species. Johannsen isolated 19 different lines on the basis of seed weight form the original seed of the princess variety. Each of the 19 isolated lines had characteristic mean weight of seed. The line No. 1 with largest seed had a mean weight of 640 mg and the line No. 19 with smallest seed showed mean seed weight of 350 mg.

There were seeds of various sizes within each line but the variability within the line was much lesser than the original seed lot. When the seeds in each line were separated into various classes of 100 mg difference and grown separately, the seeds of different classes within a pure-line produced progeny with the same mean weight.

In other words, the largest and smallest seed from a line produced progeny with the same mean weight.

He concluded that (i) continuous inbreeding (selfing) leads to homozygosity, (ii) variation within a pure-line results from environmental factors only, (iii) selection within a pure line is not effective because all the plants in a pure-line have exactly the same genotype, and (iv) selection in the original population is effective because the plants have genetic variation.

The main effect of self-pollination is increase in homozygosity. The homozygosity refers to the proportion of homozygous individuals in a population. Thus there is difference between homozygous and homozygosity. The term homozygous is used for individuals having like alleles on the corresponding locus and homozygosity refers to the proportion of homozygous plants in a population.

The homozygosity is calculated with the help of following formula:

Homozygosity = $[(2^m - 1)/2^m]^n$

where,

m = Number of generations of self-pollination, and

n = Number of gene pairs segregating.

This formula is based on two assumptions, viz.:

(1) Equal survival of all genotypes, and

(2) Absence of linkage.

Linkage increases the proportion of homozygous individuals by producing more parental types than recombinants. The final result of self-pollination or selfing is a homozygous but not a homogeneous population, because end product of self-pollination consists of several homozygous lines. The number of various lines that can be obtained by selfing is equal to 2^n, where n is the number of heterozygous gene pairs.

5. Procedure of Pure-Line Selection:

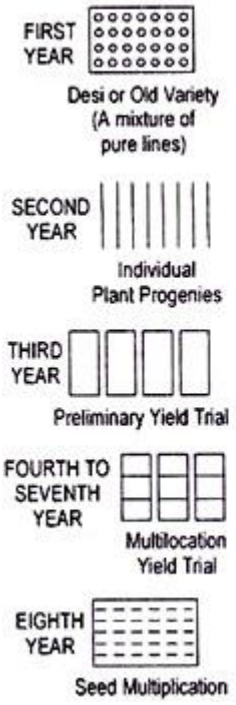
Pure-line selection consists of four major steps, viz.:

(1) Selection of a heterogeneous population from which pure-lines have to be isolated,

(2) Isolation of pure-lines by individual plant selection,

(3) Testing of pure-lines in field trials, and

(4) Release of the best pure-line as a variety.



(a) 200-3000 plants are selected on the basis of their superior and similar phenotype.

(b) Individual plant progenies are grown separately.

(c) Undesirable progenies are rejected.

(d) Remaining progenies are planted for preliminary yield trial.

(e) Low yield or inferior progenies are rejected.

(f) Replicated yield trials conducted at several locations.

(g) Inferior progenies are rejected.

(h) Disease resistance and quality tests are done.

(i) Best progeny released as a new variety.

(j) Seed multiplication and distribution are performed.

The year wise procedure is given as follows:

First Year:

An old variety or land race is used for pure-line selection. Single plants are selected from the heterogeneous population keeping in view the objective of selection. The number of individual plants to be selected may vary from 200 to 1000 in various crops.

Second Year:

The progeny of each selected plant is grown separately in few rows and evaluated for the character under consideration. The top 15-20 progenies are selected and seed of all plants in each progeny is bulked which constitutes strains.

Third Year:

The strains constituted in second years are evaluated in replicated field trials and top performing few strains are selected for further evaluation.

Fourth to Seventh Year:

The selected strains are evaluated in field trials for 2-3 years for yield performance. In India, the selected entries (strains) are evaluated in All India Coordinated Crop Improvement Project. The best genotype is identified on the basis of yield performance.

Eighth to Tenth Year:

The best performing strain is released and notified as a variety. Then the breeder, foundation and certified seeds are produced. The production of certified seed takes two years after release of a variety. Thus, the seed of new variety reaches the farmers in tenth year.

Step I.	At the times of harvest large number of single plants (200-1000) are selected from the mixed population of ryot's field. Produce from individual plants are picked, separated and numbered.	**I Year**
Step II.	20 to 50 seeds of individual plants are grown in individual rows for observations. Defective rows (like susceptibility of diseases) are discarded and the superior, *i.e.*, the desired progenies of rows are harvested. Seeds from plants within each row are composited together and this composite produce of each row becomes an **experimental strain.**	**II Year**
Step III.	Preliminary yield trials are conducted by repeating step II. Desired progenies are selected on final visual observations and seeds are composited separately.	**III Year**
Step IV.	Selected plants of step III are tested in larger plots taking standard checks in replicated plots (These are main trials)	**IV to VI Year**
Step V.	Seeds selected in step IV are multiplied.	**VII Year**
Step VI.	Seed of superior strain is sent to progressive farmers in different regions for district yield trials on riot's field. On the basis of performance, one or two strains are selected, named, multiplied and distributed to the farmers for general cultivation in subsequent years.	**VIII to X Year**

6. Merits and Demerits of Pure-Line Selection:

The important merits and demerits of pure-line selection are briefly presented below:

Merits:

1. This is a good method of isolating the best genotype for yield, disease resistance, insect resistance, earliness, quality, etc. from a heterogeneous, or mixed population of an old variety.

2. The variety developed by this method is uniform and more attractive than mass selected variety.

3. This is an easy and cheap method of crop Improvement.

Superior varieties have been isolated by pure-line selection from the heterogeneous populations in several self-pollinated crops like wheat, barley, paddy, peanut, chickpea, black-gram, green-gram, linseed, cotton and tobacco. Pure-lines are used either as varieties or

as parents in hybridization for development of superior varieties or hybrids in self-pollinated species.

Demerits:

1. This method can isolate only superior genotypes from the mixed population. It cannot develop new genotypes.

2. This method is applicable to self-pollinated species only. It cannot be used for development of variety in cross pollinated species.

3. The varieties developed by pure-line selection have poor adaptability due to narrow genetic base. All the plants of a pure-line have identical genotypes. Hence, such varieties are more prone to the attack of new disease due to genetic uniformity.
