Deterioration of Crop Varieties – Causes and Maintenance

Deterioration of Genetic Purity

The genetic purity of a variety or trueness to its type deteriorates due to several factors during the production cycles. Kadam (1942) listed the following important factors responsible for deterioration of varieties.

1. Developmental variations
2. Mechanical mixtures
3. Mutations
4. Natural crossing
5. Minor genetic variations
6. Selected influence of pest and diseases
7. The techniques of the plant breeder

1. Developmental Variations

When seed crops are grown under environments with differing soil fertility, climate, photoperiods, or at different elevations for several consecutive generation's developmental variations may set in as differential growth responses.

It is therefore, preferred to grow the varieties of crops in the areas of their natural adaptation to minimize developmental shifts.

2. Mechanical Mixtures

Mechanical mixtures, the most important reason for varietal deterioration, often take place at the time of sowing if more than one variety is sown with the same seed drill, through volunteer plants of the same crop in the seed field, or through different varieties grown in adjacent fields. Two varieties growing next to each other field is usually mixed during harvesting and threshing operations. The threshing equipment is often contaminated with seeds of other varieties. Similarly, the gunny bags, seed bins and elevators are also often contaminate, adding to the mechanical mixtures of varieties.

Roguing the seed fields critically and using utmost care during seed production and processing are necessary to avoid such mechanical contamination.

3. Mutations

Mutations do not seriously deteriorate varieties. It is often difficult to identify or detect minor mutations occurring naturally. Mutants such as, 'fatuoids' in oats or 'rabbit ear' in peas may be removed by roguing from seed plots to purify the seeds.

4. Natural Crossing

Natural crossing can be an important source of varietal deterioration in sexually propagated crops. The extent of contamination depends upon the magnitude of natural cross-fertilization. The deterioration sets in due to natural crossing with undesirable types, diseased plants or off types. In self-fertilized crops, natural crossing is not a serious source of contamination unless variety is male sterile and is grown in close proximity with other varieties. The natural crossing, however, can be major source of contamination due to natural crossing are the breeding system of the species, isolation distance, varietal mass and pollinating agent. The direction of prevailing winds, the numbers of insects present and their activity and mass of varieties are also important considerations in contamination by natural crossing.

The isolation of seed crops is the most important factor in avoiding contamination of the cross-fertilized crops.

5. Minor Genetic Variations

Minor genetic variations can occur even in varieties appearing phenotypically uniform and homogenous when released. The variations may lost during later production cycles owing to selective elimination by the nature. The yield trials of lines propagated from plants of breeder's seed to maintain the purity of self-pollinated crop varieties can overcome these minor variations. Due care during the maintenance of nucleus and breeder's seed of cross-fertilized varieties of crop is necessary.

6. Selected Influence of Pest and Diseases

New crop varieties often are susceptible to newer races of pests and diseases caused by obligate parasites and thus selectively influence deterioration. The vegetatively propagated stock also can deteriorate quickly if infected by virus, fungi or bacteria. Seed production under strict disease free conditions is therefore essential.

7. The Techniques of the Plant Breeder:

Serious instabilities may occur in varieties owing to cytogenetic irregularities in the form of improper assessments in the release of new varieties. Premature release of varieties, still segregating for resistance and susceptibility to diseases or other factors can cause significant deterioration of varieties. This failure can be attributed to the variety testing programme.

In addition to these factors, other heritable variations due to recombination's and polyploidisation may also take place in varieties during seed production, which can be avoided by periodical selection during maintenance of the seed stock.

Maintenance of Genetic Purity during seed Production

The various steps suggested, to **maintain varietal purity**, are as follows.

a. Use of approved seed only in seed multiplication.
b. Inspection and approval of fields prior to planting.
c. Field inspection and approval of growing crops at critical stages for verification of genetic purity, detection of mixtures, weeds, and for freedom from noxious weeds and seed borne diseases etc.
d. Sampling and sealing of cleaned lots
e. Growing of samples of potentially approved stocks for comparison with authentic stocks.

The various steps suggested for **maintaining genetic purity** are as follows:

a. Providing adequate isolation to prevent contamination by natural crossing or mechanical mixtures
b. Rouging of seed fields prior to the stage at which they could contaminate the seed crop.
c. Periodic testing of varieties for genetic purity.
d. Avoiding genetic shifts by growing crops in areas in their adaptation only.
e. Certification of seed crops to maintain genetic purity and quality of seed.
f. Adopting the generation system.
g. Grow out tests.

Genetic Purity Maintenance in Hybrid Seeds

Maintenance of the genetic purity of hybrid seeds is a complicated one requiring elaborate procedures.

Nucleus Seed of Inbred Lines

- The nucleus seed of inbred lines can be maintained by self pollination, sib-pollination, or a combination of the two procedures (hand pollination).
- Some breeders prefer 'sibbing" because it maintains vigour. "Selfing" is used to stabilize inbred lines if a change in breeding behavior is noticed.
- Some parental material is preferably maintained by alternate selfing and sibbing from one generation to other.
- Individually selfed or sibbed ears should be examined critically, discarding off types or inferior characteristics (texture, colour, seed size, chaff color and shape of earhead).
- The uniform ears are then threshed separately and planted in ear to row method to easily detect and discard off types from individual ears if any.
- Alternatively all of the ears from an individual inbred line may be composited for bulk planting in the next season.
- The hand pollination seed is sown on clean, fertile soil having no previous crop of the same kind or variety during the previous year (bearing maize).

- It is rather important to ensure that the crop is well isolated, with the requirement varying from crop to crop and depending upon the nature of the material to be protected by isolation, the nature of the contaminant, and the direction of the prevailing wind.
- The isolation can be achieved either by distance or by time (maize). The inbred line may be composited for bulk planting in the next season.
- Maintenance of genetic purity in inbred lines through hand pollination and adequate isolation alone is not enough to achieve perfection.
- The isolated fields must be critically rogued for off types and other impure types prior to the shedding of pollen.
- The nucleus seed crop is harvested after physiological maturity if artificial drying facilities exist.
- Ear to harvest lines are harvested separately and piled; These are again critically examined for ear characteristics, sorting out of all off-coloured, diseased, or otherwise undesirable ears.
- If the overall percentage of off types exceeds 0.1%, hand pollination should be repeated to produce the second year's breeders seed.
- The uniform ears are bulked, dried in a clean dry bin at temperatures not exceeding 43^0C, shelled, cleaned, treated with pesticides, and stored under ideal storage conditions as breeder stock seed. This seed may be increased during the following season by paying adequate attention to isolation, roguing, etc., to maintain high genetic purity of the seed.

Nucleus Seed of Non-Inbred Lines

- To maintain in the genetic purity of the nucleus seed of non-inbred lines, the number of plants for hand pollination should be large enough to preserve genetic make up of the variety, narrowing the genetic base by sibbing only a few plants (about 5000 plants or more).
- The sibbed ears are examined critically, discarding of colour, texture, or diseased ones.
- Uniform ears are bulked, dried, shelled, cleaned, treated and stored as usual.

- Other practices of seeding sibbed nucleus seeds are similar to those described earlier for inbred lines.
- Roguing however, needs to be observed more critically by individuals with good knowledge of the material.
- The breeder's stock seed thus produced from the nucleus seed can be utilized to increase the breeder's stock of non-inbred lines, paying adequate attention to land requirements, isolation, roguing, harvesting and handling of seed to achieve maximum genetic purity.
- The breeder's seed of the established varieties of cross-pollinated crops can be maintained by raising breeder's seed crop in isolation and roguing the crop thoroughly at various stages.
- It is often purified by mass selection.
- The crop is grown in isolation and rogued carefully as described earlier.
- At maturity about 20,000 - 25000 true to type plants are selected, harvested separately, and bulked after careful examination.
- This constitutes the breeder's stock seed. The seed may be carried over to ensure against possible failures or unforeseen shortages