2. Objectives of plant and animal breeding

2.1. Objective of plant breeding

- ✓ **Plant breeding** is the art and science of improving the heredity of plant for the benefit of mankind.
- ✓ **Plant breeding** deals with the genetic improvement of crop plants also known as science of **crop improvement**.
- ✓ **Plant breeding** is a science of changing and improving the heredity of plants.
- ✓ The ultimate goal of plant breeding is to develop improved crops or to improve the characteristics of plants so that they become more desirable agronomically and economically.
- ✓ Improvements can be made in
    - **Crop productivity** (e.g., grain yield; adaptation to a specific region; disease and pest resistance; tolerance to drought, heat, cold, or salinity),
    - **Crop processing** and **marketing** (e.g., milling or baking/ cooking/fermentation quality, biofuel yield, visual appeal, postharvest storability, shelf life), and/or
    - **Consumer quality** (e.g., flavor, protein content, oil profile, fiber quality, nutritional value).

Specific objectives of Plant Breeding

1. **Increase of yield (higher yield)**
    - ➢ The ultimate aim of plant breeding is to improve the yield of "economic produce on economic part".
    - ➢ It increase may be grain yield, fodder yield, fibre yield, tuber yield, cane yield or oil yield depending upon the crop species.
    - ➢ Improvement in yield can be achieved either by evolving high yielding varieties or hybrids.
2. **Improved quality**: Quality of produce is another important objective in plant breeding. The quality characters vary from crop to crop.

    Example:

    - ➢ Grain size, colour, milling and baking quality in wheat.
    - ➢ Cooking quality in rice,
    - ➢ Malting quality in barley,
    - ➢ Colour and size of fruits, nutritive and keeping quality in vegetables,

- protein content in pulses,
- Oil content in oilseeds, fibre length, strength and fineness in cotton.

3. **Abiotic resistance**: Crop plants also suffer from abiotic factors

   Such as

   - Drought,
   - Soil salinity,
   - Extreme **temperatures**, **heat**, **wind**, **cold** and **frost**, breeder has to develop resistant varieties for such environmental conditions.

4. **Biotic resistance**:
   - Crop plants are attacked by various diseases and insects, resulting in considerable yield losses. (To develop varieties resistant to diseases and insects).
   - Genetic resistance is the cheapest and the best method of minimizing such losses.
   - Resistant varieties are developed through the use of resistant donor parents available in the gene pool.
5. **Wider adaptability**:
   - Adaptability refers to suitability of a variety for general cultivation over a wide range of environmental conditions.
   - Adaptability is an important objective in plant breeding because it helps in stabilizing the crop production over regions and seasons.
6. **Eliminating undesirable chemicals and structures**:
   - It is essential to develop varieties free from toxic compounds in some crops to make them safe for human consumption.
   - For example,
     - Removal of neurotoxin in Khesari – lentil (Lathyruys sativus) which leads to paralysis of lower limbs, erucic acid from Brassica which is harmful for human health, and
     - Gossypol from the seed of cotton is necessary to make them fit for human consumption. Removal of such toxic substances would increase the nutritional value of these crops.
7. **The other objectives** are dormancy, change in desirable agronomic traits including qualitative and quantitative traits, change in earliness etc.

2.2. Objective of Animal breeding

- ✓ Mankind started to create breeds accompanied with artificial selection 250 years ago.
- ✓ Nowadays, breeding of **high productive farm animals**, like **cattle, pigs** and **poultry** is in the hands of multinational companies which invest a lot of money in state of the art breeding programs.
- ➢ **Animal Breeding** is the application of genetic principles to the improvement of farm animals.
- ➢ It involves the selective breeding of domestic animals with the intention to improve desirable (and heritable) qualities in the next generation.
- ➢ It only uses males and females for breeding that have passed a certain quality criterion.
- ➢ **Animal breeding** is aiming at the improvement of animals by changing their **genetic abilities** for important traits.
- ➢ These traits are determined by the **requirements** and wishes from the **society** which might change over time.
- ➢ **Animal breeding** is **highly influenced** by research and developments in population-, quantitative- and molecular genetics.
- ➢ Sometimes, unexpected negative effects of animal breeding are observed that require adequate corrections.

The objectives of animal breeding

- ➢ The objective of animal breeding should be to increase the efficiency of production and economic purpose
  - o Increase yield by selecting the best parents: to improve the productivity of milk, egg, wool, meat, etc.
  - o Identify and avoid animals with bad genes/genetic defects: such as congenital defects and lethal abnormalities.
  - o Produce disease tolerant animal: such as disease-resistant strains of chickens and heat resistant breeds of cattle
- ➢ **Animal breeding** relates to **intentional selection by humans** based on animal performance in a certain environment for predefined and heritable traits.
- ➢ In most practical animal breeding schemes selection will be on more than one trait simultaneously.

- The animals that are superior in this combination of traits will be selected as breeding animals. In general this combination of traits will consist of traits related to performance (e.g. milk production, number of eggs, growth, and sport performance), health, and reproduction.

3. Variation in plant and animal populations

3.1. Genetic variation as the basis of plant and animal breeding

What is genetic variation?

- ✓ **Genetic variation** can be defined as the genetic makeup of organisms within a population is change.
- ✓ Genes are inherited segments of DNA that contain codes for the production of proteins.
- ✓ Genes exists in alternate versions, or alleles that determine distinct traits that can be passed on from parents to offspring.
- ✓ Genetic variation can be described as the differences between organisms caused by alternate forms of DNA.
- ✓ Genetic variation in combination with environmental *variation* causes the total *phenotypic variation* seen in a population.
- ✓ The phenotypic variation is what is seen by the observer; the height of a plant for instance.
- ✓ The environmental variation is the difference in what each individual experiences.
- ✓ **Genetic variation** is a measure of the variation that exists in the genetic makeup of individuals within population.

3.2. Discontinuous and continuous variation

- Variations are the different characteristics that exist in organisms of a natural population or species.
- Variations can be of two different forms: continuous variation and discontinuous variation.
- The two forms of variation contain many differences.

1. **Discontinuous variation**
   - ❖ Few characteristics of individuals in a population may exhibit a limited form of variation.
   - ❖ These individuals possess precise variations within them **without the presence of any intermediates for the particular characteristic.**
   - ❖ Blood groups in the human population are an example for discontinuous variation. In human blood group system, only four blood groups are possible (**A, B, AB, and O**). Since no intermediate values are present for the human **ABO** blood group system, it is considered as a discontinuous variation.
   - ❖ **Discontinuous variations** are decided by a single gene or a small number of genes. The phenotypic appearances of them are generally not affected due to environmental factors.

- Discontinuous variation is distinct phenotypic classes.
  - **For examples**: - Mendelian traits like **height** (tall and short), pod color, pod shape, seed shape and seed color etc…
- **Discontinuous variation does not** show a normal distribution. It does not produce a curve and can be represented using only a bar graph.
- An average or mean cannot be seen in **discontinuous variation.**

2. **Continuous variation**
   - In continuous variation, a series of **successive changes** of a particular characteristic in a population is demonstrated from one extreme to the other without a break.
   - This is the **multiple gene (polygene)** hypothesis and is commonly observed for most metric traits, i.e., traits (characters) that are measured and generally distributed "normally" in natural populations
   - It is continuous gradation, with **no distinct phenotypic classes**.
   - Different characteristics of a population might show continuous variation.
   - Such characteristics are formed by the **combined effect of polygenes** and **environmental factors.**
     - **For example: -** quantitative traits
   - If **a population of cows** is considered as an example, the milk yield is **not only influenced by genetic factors but also by environmental factors.**
   - If the genetic factors are present for a high yield of milk, it can be suppressed by environmental factors like quality of pasture, inadequate diet, extreme weather conditions, diseases, etc.
   - The frequency distribution of a characteristic that presents a continuous variation is a normal distribution curve with a typical bell shape.
   - In such a curve, the mean, mode and median are considered to be the same.
   - The height of humans, weight, hand span and shoe size are several examples of continuous variation.

➡ Continuous variation caused by genes with graduated effects