

Chapter 9

Strategies for Enhancement in Food Production

Food is any substance that is provided in order to meet the body nutritional requirement. Food contain proteins, carbohydrates and fats. With the increase in population, enhancement of food production becomes a primary issue. Plant breeding and animal husbandry are major efforts to enhance the food production and to meet the requirements of increasing population.

Animal breeding

A significant aspect of animal husbandry deals with breeding of animals. It aims to increase the yield of the animals and introduction of desirable trait into the animal. The word breed is defined as group of animals that are related by features, size configuration, general appearance etc. Breeding between the animals of the same breed is known as inbreeding and breeding between animals of different breed is known as outbreeding.

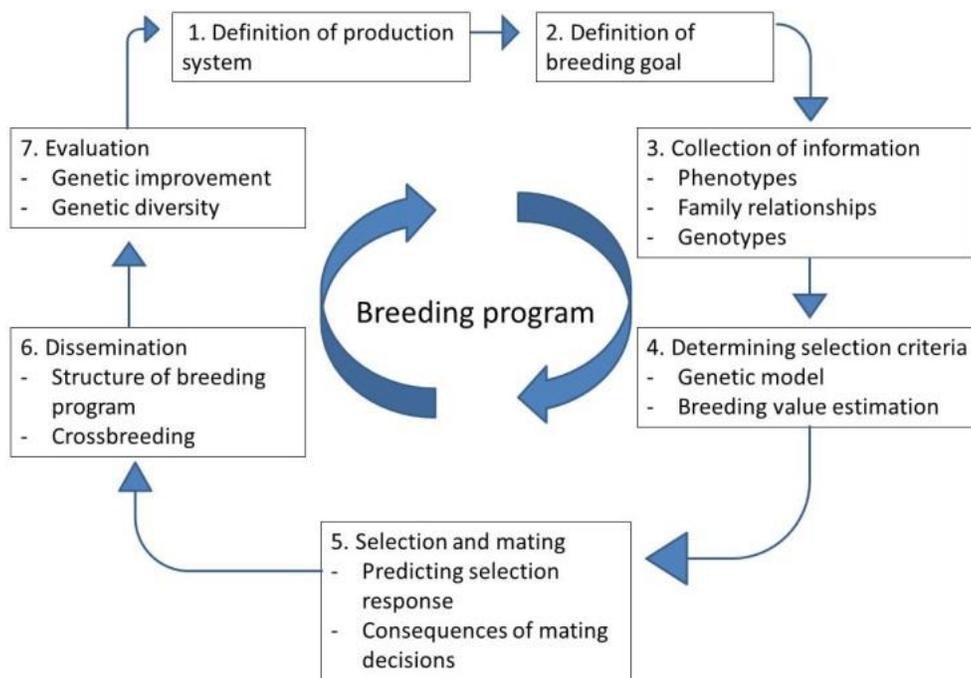


Fig.1. Steps of breeding program

Inbreeding occurs between members of closely related individuals within the same breed for about 4 to 6 generations. Males and females with superior traits are identified and mated in pairs. Generally it is the cow that carried the superior desired trait like increased milk production and superior male is the bull which can give superior progeny.

Inbreeding results in increased homozygosity. This is harmful as it can lead to the expression of harmful recessive allele. Superior traits can be eliminated. Continued inbreeding leads to **inbreeding depression**. Inbreeding depression is the loss in desired traits due to successive inbreeding. This affects both productivity and fertility.

A = Dominant allele **a** = Recessive deleterious allele

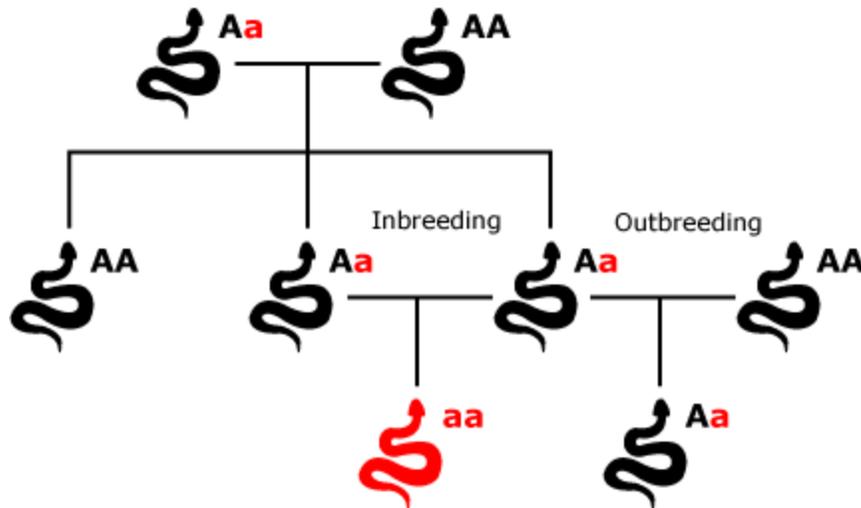


Fig.2. Inbreeding leads to homozygosity

Outbreeding is the breeding among the unrelated animals. Animals are chosen such that they do not have common ancestors for 5 to 6 generations.

Cross- breeding involves breeding between superior male of one breed and superior female of another breed. Desired trait can be obtained through cross-breeding. The animals or the offspring obtained is known as hybrid. The animal produce has both the desired trait from both the parents.

S.No.	Inbreeding	Outbreeding
(i)	Mating of closely related individuals within the same breed for 4 - 6 generations.	Breeding the unrelated animals of the same or different breed not having common ancestor.
(ii)	It cannot be divided into further types.	It includes out-crossing, cross-breeding, and inter-specific hybridisation.
(iii)	Mating is between same species.	Mating can be between different species.

Fig.3. Difference between inbreeding and outbreeding

Interspecific hybridization involves mating between two unrelated animals. Two different related species can be used for interspecific hybridization. Progeny will get desirable trait from both the parents.

Artificial insemination and multiple ovulation embryo transfer technology

For controlled breeding experiments artificial insemination is carried out. The semen collected from the male parent and allowed to inject in the female reproductive tract of the selected female by the breeder. The semen can be stored or kept freeze and can also be transported for injection into the required female animal. The one of the disadvantage of artificial insemination is that the success rate is low. To improve the success rate, multiple ovulation embryo transfer technology (MOET) came into picture. This is hormonal based technology where female animal is injected with FSH-like hormone to induce follicular maturation and super ovulation (more than one egg). This technology has been demonstrated for cattle, sheep, rabbits, buffaloes, mares, etc. Using this method breeds of females that are high yielding for milk and bullas yielding high quality meat (lean meat with less lipid) have been bred successfully. This helps to increase the number of organisms in a short time.

The main steps for MOET are:

- controlling oestrus in donor and recipient animals
- increasing ovulation (super-ovulating)
- inseminating the donors
- collecting the embryos from the donor animals
- implanting the embryos in recipient animals.

Fig.4. Main steps of MOET

What is Animal husbandry?

Agriculture practice of breeding and raising the livestock is known as animal husbandry. It is a science of managing and caring of farm animals by human beings. It can also be defined as a practice of raising livestock for promoting desirable traits in animals for human welfare. It is estimated that more than 70 percent of the world livestock population is in India and China.

Management of farms and farm animals

1. Poultry farm management

Use of domesticated fowl (birds) for food and egg is known as poultry farm management. It includes chickens and ducks and sometimes turkey and geese. During poultry farm management few points should be considered on priority such as proper feed and water, hygiene and health care, proper and safe farm conditions etc. Brooding temperature is also of utmost important.



Fig.5. Poultry farm management

2. Dairy farm management

The management of animals for the milk and milk products includes the dairy farm management. It includes the management that can improve the quality and yield the milk. Quality of breeds in farm determine the yield of the milk. Good breeds include those which have high yielding potential and resistance to diseases. In order to get the good yielding potential, cattle should be well looked, proper hygiene, food and disease-free environment should be provided. Apart from this, proper storage and transport of milk should also be managed.

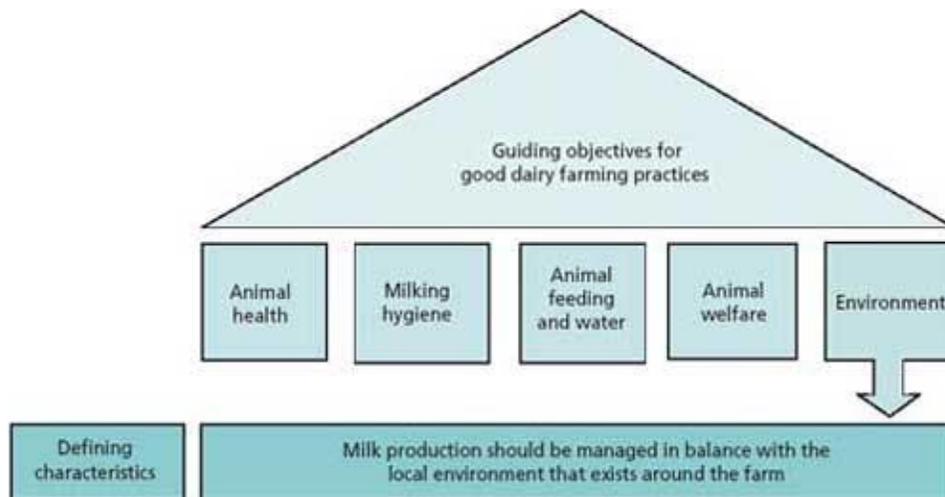


Fig.6. Good dairy practices

3. Bee keeping

Apiculture or bee keeping is the maintenance of honey bees for honey and other products such as beeswax, propolis, pollen and royal jelly. The products obtained from apiculture are commercially significant. For example, beeswax is used in cosmetic and medical industries. It is also used as a food additive and for cheese coating. Recently, it has been discovered that venom obtained from honey bees can be used to treat AIDS. It has the potential to kill the HIV virus. Common commercial species of honey bees that are used for apiculture include *Apis dorsata* (rock bee), *Apis indica* (Indian bee), *Apis florea* (little bee) and *Apis mellifera* (Italian bee).



Fig.7. Bee-keeping or apiculture

For successful bee keeping, following points can be kept in mind:

- Knowledge of nature and habits of bees.
- Selection of suitable location the beehives. Ideally should be present sufficiently close to a forage area.

- Catching and hiving of swarms.
- Management of beehives during different seasons.
- Handling and collection of honey and of beeswax.

4. Aquaculture/Pisciculture

Management of catching, processing as well as selling fishes such as Rohu, Catla, and Hilsa etc. is known as pisciculture. Due to more requirement of fishes' different methods are employed to promote pisciculture. Aquaculture is defined as growing of aquatic animals and selling them for commercial purpose. There are two types of aquaculture- **extensive aquaculture** and **intensive aquaculture**. Extensive aquaculture is done in ocean, natural and man-made lakes, rivers etc. Intensive aquaculture exists in ponds and tanks.

Plant breeding

Plant breeding is the practice of selecting and breeding specific desired plant species in order to obtain desirable traits such as more yield, pest resistance, herbicide resistance etc.

The main steps in breeding the new genetic crop are-

- Collection of variability is the root of any breeding programme. It is essential to collect and preserve all the different wild varieties, species and relatives of the cultivated species for effective exploitation of natural genes available in the populations. The entire collection (of plants/seeds) having all the diverse alleles for all genes in a given crop is called **germplasm collection**.
- Evaluation and selection of parents with desirable characteristics.

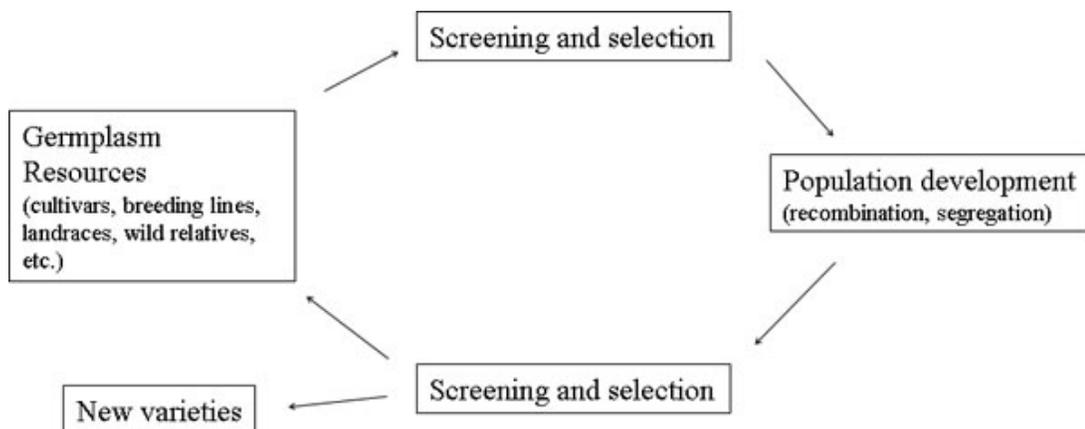


Fig.8. Steps of plant breeding

- Desired characters are now cross hybridized among the selected parents. This combine the characters genetically in the progeny. This is a time consuming and tedious process.

- Selection and testing of superior recombinants. Those plants that contain desired characters are selected. The selection process is crucial to the success of the breeding objective and requires careful scientific evaluation of the progeny.
- Testing, release, and commercialization of new cultivars. The newly selected lines are evaluated for their yield and other agronomic traits of quality, disease resistance, etc. The testing of new varieties and cultivars is conducted by growing them in the research fields. Their performance under ideal fertilizer application, irrigation, and other crop management practices is then recorded and analysed.

Plant breeding for disease resistance

Bacteria, fungi, and virus affect different crop species. Approximately 20-30% of crops are lost due to different pathogens. Plant breeding is used to produce disease resistant plants. To produce disease resistant plants, causative agent, and mode of transmission of the disease should be understood.

Methods of breeding for disease resistance

Breeding can occur through conventional method such as hybridization and selection. It includes steps such as screening germplasm for resistant gene, hybridization of selected parents, selection and evaluation of the hybrids, testing and release of new varieties. But the conventional method has certain disadvantages such as in terms of few disease resistant genes are known.

Mutational breeding

It is one of the method of plant breeding that modifies base sequence/nucleotide sequence of a gene to obtain new traits other than those observed in parents. These mutations or changes are introduced in plants either by chemicals or radiations such as X-rays.

“For example: Mung bean variety is obtained through mutation. This variety is resistant to yellow mosaic virus”.

Breeding to obtain insect or pest resistant variety

Insect or pest resistant plants are produced based on different strategies such as-

- They are modified in such a way that they become tasteless. So, animals avoid eating these plants.
- They produce some toxins that paralyzed the infected insect.
- They are modified morphologically such as hairier, pointed leaves, odor etc.

Plant breeding has helped to develop several useful and important varieties of certain crop plants such as tobacco, potato, okra.

Plant breeding for improved food quality

Plant breeding is important for improving the quality of food as well as meet the nutritional requirement of food. Diets, especially the plant based diets that lack essential micronutrients increases the chances of diseases, reduce life span and reduce mental abilities. The objective of plant breeding for improved food quality is to improve nutrient content, protein content, oil content, vitamin and mineral content.

Biofortification

The process by which the nutritional quality of food is enhanced through agronomic practices, conventional plant breeding and modern biotechnology is called **biofortification**. In 2000, maize hybrids were developed that had twice the amount of the amino acids, lysine and tryptophan, compared to existing maize hybrids. Wheat variety, having a high protein content, Atlas 66, has been used as a donor for improving cultivated wheat. It has been possible to develop an iron-fortified rice variety containing over five times as much iron as in commonly consumed varieties. The Indian Agricultural Research Institute, New Delhi has developed several vegetable crops that are rich in vitamins and minerals, e.g., vitamin A enriched carrots, spinach, pumpkin; vitamin C enriched bitter gourd, *bathua*, mustard, tomato; iron and calcium enriched spinach and *bathua* and protein enriched beans – broad, lablab, French and garden peas

Single cell protein (SCP)

It is an alternative source of protein for both animals and humans. Edible unicellular microbes can also be defined as single cell protein. Spirulina is a rich source of protein, minerals, fats, carbohydrates, and vitamins. This is also one of the method of reducing environment pollution.

Tissue culture

Tissue culture is defined as the capability to develop the whole plant from the part of the plant. This capacity to form whole organism/plant is known as totipotency. For tissue culture, nutrient medium, growth regulators such as auxins, cytokinins are needed. This method of producing large number of plants in a very short span of time is known as micropropagation. It will produce genetically identical plants known as somaclones. Meristem (cells which have a capability of repeated cell division) can be used to grow virus-resistant plants such as banana, sugarcane etc.