

Strategies for Enhancement in Food Production

1. **Animal Husbandry:** It is the branch of agriculture that deals with the breeding, caring and raising of livestock.
2. **Livestock:** the domestic or farm animals reared for the use or profit of man are called livestock. It includes cattle, pigs, goats, sheep, camels, etc.
3. **Management of farm and farm animals:**
 - a. **Dairy Farm Management:** It is the scientific method of management of cattle for the production and marketing of milk and milk products for human consumption. Cows and buffaloes are commonly reared for dairy purpose. It includes the following steps
 - i. **Good breed/ quality of the breed:** It involves selection of good breed producing high quality milk, resistant to diseases and having the ability to adjust to various climatic conditions. (desi breed, Eg: Sindhi, Sahiwal. exotic breed. Eg: Jersey, Holstein – Friesian, Red Dane).
 - ii. **Proper care:** The cattle need to be kept in clean well ventilated sheds with sufficient light along with a good drainage system.
 - iii. **Feeding:** To increase the milk production, high nutrient and good quality food should be given which includes concentrates along with fodder.
 - iv. **Hygiene:** Using mechanized processes for milking, storage, transport of the milk helps in reducing the chances of direct contact of the producer and handler and thus reduces the chances of infection.
 - v. **Regular inspection:** It involves the regular inspection of the farm animals by a vet for vaccination and regular health check-ups
 - b. **Poultry Farm Management:** Poultry is the scientific rearing of domestic birds for the purpose of meat and eggs. The common poultry birds are chicken, ducks, turkey, geese etc. poultry management also includes:
 - i. Selection of disease free and suitable breeds
 - ii. Proper and safe farm conditions
 - iii. Proper feed and water
 - iv. Cleanliness and hygiene
 - v. Health care

Bird Flu: It is the fever of the fowls caused by the viruses. The virus can be transmitted through eggs and meat of the infected birds. The bird flu can be prevented by separating sick birds from healthy birds and burying or burning the dead birds and their excreta.

4. **Animal breeding:** It is an important aspect of animal husbandry and aims at increasing the yield and improving the quality of the breed or their genotype through selective mating.

Breed: it is a group of related animals with common ancestry which are similar in most of the characters like the general appearance, features, size etc.

Methods of animal breed:

- i. **Inbreeding:** It is the mating between more closely related individuals within the same breed for 4-6 generations. Superior males and females of the same breed are identified and mated. The progeny obtained from such mating are evaluated and superior males and females among them are identified for further mating.

Advantages of inbreeding:

- a) It increases homozygosity and in developing develop pure line in any animals
- b) It exposes harmful recessive genes and helps in eliminating them
- c) It helps in accumulation of superior genes.

Disadvantages: It causes inbreeding depression.

Inbreeding depression: It is the reduction in the fertility of a breed due to continuous inbreeding

ii. **Out breeding:** It is the crossing or mating between unrelated breeds. Out breeding is of 3 types:

a. **Out crossing:** It is the mating of animals within the same breed, which do not have common ancestor up to 4-6 generations. The offspring produced through outbreeding is called as an outcross

It helps in overcoming inbreeding depression. It helps in increasing the productivity of a below average milching cows, growth rate in beef cattle.

b. **Cross breeding:** It is a method of out breeding in which superior males of one breed are mated with superior females of another breed.

The progeny produced by cross breeding is called hybrid

It helps to bring desirable qualities of two different breeds together.

It helps to produce new and superior breeds to the existing ones. Example: Hisardale is a new breed of sheep developed by crossing Bikaneri ewes and Marino rams.

c. **Interspecific hybridisation:** It is a method of out breeding wherein male and female of different related species are mated. The progeny obtained from interspecific hybridisation is different from both the parental species. It is done to combine the desirable characters of both species.

Example: mule is produced from a cross between female horse and a male donkey. Mules are harder than their parents and suitable for hard work in mountain region.

iii. **Controlled breeding experiments:**

a. Artificial insemination (AI): It is a technique of controlled breeding in which the semen of superior male is collected and injected into the reproductive tract of the selected female. The semen can be used immediately or can be frozen and used later.

Advantages:

- The semen of a single bull can be used for inseminating many females.
- The semen can be used for inseminating cows in other places as it can be stored.
- The chance of spread of disease can be avoided.

b. **Multiple Ovulation and Embryo Transfer (MOET):** It is a technique of controlled breeding where in multiple ovulation is induced in selected female and transfer of embryo into the uterus of surrogate mothers. It involves the following steps:

- Multiple Ovulation: The selected female is induced to produce multiple eggs in the ovary by injecting with FSH.
- Artificial insemination: the super ovulated female is either mated with a superior bull or artificially inseminated to form many zygotes and in turn embryos.
- Collection of embryos: The embryos at 8-32 celled stage are collected the female non-surgically.
- Transfer of embryos to the uterus of surrogate: The collected embryos are transferred into the uterus of the surrogate mothers with same oestrus period.

The high milk yielding and high quality meat producing cattle have been successfully developed in a short time in this method.

5. **Apiculture/ Bee – Keeping:** It is the scientific method of rearing of honeybees and maintaining the hive for the production of honey and bee wax for commercial purposes.

Advantages of bee keeping:

- Low investment and high profit
- Does not require much labour
- It can be practised in any area where there is sufficient wild shrubs, trees and cultivated crops.
- It can be easily maintained in courtyards, verandah or even on the terrace

- Honey bees are the pollinators of many crops such as sunflower, mustard, apple and pear. Keeping beehives in the crop fields during flowering period increases pollination and improves the yield

Successful bee keeping involves the following steps:

- Knowledge of the nature and habits of bees.
- Selection of suitable location for keeping the beehives
- Knowledge of catching and hiving of swarms
- Management of beehives during different seasons
- Knowledge of handling and collection of honey and bee wax.

The most commonly reared species of bees are *Apisindica* and *Apismellifera*.

- Fisheries:** It is the scientific method of rearing, breeding, catching and selling of aquatic animals like fishes, shell fishes or other aquatic animals.

Food fishes include fresh water species like the Rohu, Catla, Mrigal, Carps etc. and marine water species include – Hilsa, Swidines, Pomfrets, Mackerel etc.

Importance of fisheries:

- It has an important place in the Indian economy.
- It provides income and employment to many fishermen and farmers.
- Fishes are used as food, they are very rich source of proteins, vitamins and minerals like the iodine.

Pisciculture and aquaculture:

Pisciculture is the process of rearing of only fishes for commercial purposes while aquaculture is rearing of all aquatic forms of life.

- Plant Breeding:** It is the technique of manipulation of plant species in order to create desired plants that are suitable for cultivation, gives better yields and has resistance to pathogens, abiotic stresses and insects & pests.

Main steps in plant breeding:

- Collection of variability:** It is the collection and preservation of all the different wild varieties, cultivated species and relatives of the cultivated species. It is necessary for the effective exploitation of natural genes available in the population. The collection of all the varieties of plants or seeds having the different alleles and genes for all the characters in a given crop is called germplasm collection.
- Evaluation and selection of parents:** Plants with desirable combination of characters are selected and multiplied. Pure lines are created by self-pollination.
- Cross hybridization among the selected parents:** The two selected parents are hybridized to produce a hybrid having the desirable characters of both parents. Example: high protein quality of one plant is combined with the disease resistant quality of another parent, to produce a plant with having both characters.
- Selection and testing of superior recombinants:** In this step, among the progeny plants, the ones that have desired character combination are selected carefully and evaluated scientifically. The selected plants are self-pollinated for several generations till they reach a stage of stability, so that the new characters will not segregate in the progeny.
- Testing, release and commercialisation of new cultivars:** The newly selected hybrids are tested for their yield and characters like quality, nutritional content, disease resistance etc. It is done by growing the plants in research fields and recording their performance under ideal conditions like fertilizer application, irrigation and other crop management practices. Then the plants are grown in the farmer's field for at least 3 growing seasons in different climatic zones. The material is then compared with the locally available best variety and then marketed.

- Some Indian hybrid crop of high yield:

- Wheat and Rice:** Many semi-dwarf varieties were developed at the International Centre of Wheat and Maize, Mexico by Norman E Borlaug and International Rice Research Institute. Some of the varieties include:

Wheat - Sonalika, KalyanSona.

Rice – IR – 8 (International Rice 8), Jaya and Ratna (Indian varieties developed at Indian Agricultural Research Institute)

- b. Sugar cane: Saccharumbarberi a variety well suited for North Indian climate was crossed with Saccharumofficinarum, the South Indian variety that had high sugar content, to develop varieties having the desirable qualities of both varieties, to grow in North India

9. Plant breeding for disease resistance:

- a. Crops are infected by fungi, bacteria virus and nematodes. They reduce about 20-30% of the yield.
- b. Plant breeding and development of disease resistant varieties helps to increase the yield, reduces the dependence on use of fungicides and other chemicals.
- c. Some of the plant diseases are
- Fungal diseases: brown rust of wheat, red rot of sugarcane and late blight of potato.
 - Bacterial diseases: black rot of crucifer
 - Viral diseases: tobacco mosaic disease, turnip mosaic etc.
- d. Methods of plant breeding: Disease resistant plants can be developed either by the conventional breeding techniques or by mutation breeding.
- i. Steps involved in conventional breeding techniques are:
- Collection of germ plasm of disease resistant plants.
 - Selection and hybridisation of parents
 - Selection and evaluation of the hybrids
 - Testing and release of new varieties.

Some disease resistant crops developed by hybridisation:

Crop	Variety	Resistance of disease
Wheat	Himagiri	Leaf and strip rust, hill blight
Brassica	PusaSwarnim	White rust
Cauliflower	PusaShubhra Pusa Snow ball K	Black rot & Curl blight Black rot
Cow pea	PusaKomal	Bacterial Blight
Chilli	PusaSadabhar	Chilli Mosaic Virus
Ladies finger	ParbaniKrant	Yellow mosaic virus

- ii. Mutation breeding: It is a process by which genetic variations are created by changing the base sequence in the genes. Mutations can be induced through chemical or physical mutagens (agents that induce mutation are called mutagens).
- Chemical mutagens: Nitrous acid and mustard gas
- Physical mutagens: UV radiations, gama radiations.
- Disease resistant plants developed through induced mutation: Green gram (mung bean) – resistant to yellow mosaic virus and powdery mildew.

10. Plant breeding for developing insect and pest resistant plants: Insect resistance in host crop plant may be due to morphological, biochemical or physiological characteristics like

- hairy leaf of plants like cotton and wheat makes them resistant to jassid insects and cereal beetle
- Presence of solid stem in wheat makes it resistant to stem sawfly.
- Presence of smooth leaves and absence of nectar in cotton plants makes them resistant to bollworms.
- High aspartic acid, low nitrogen and low sugar content in maize makes them resistant to stem borers.

Insect resistant plants developed by hybridisation:

Crop	Variety	Insect pests
Mustard	Pusa Gaurav	Aphids
Flat bean	Pusa sem2 Pusa sem3	Jassids, aphids and fruit borers
Ladies finger (okra)	Pusasawani Pusa A – 4	Shoot and fruit borers

11. Plant breeding for improved food quality: Increasing the nutrient content in the crops helps in overcoming micronutrient, protein and vitamin deficiencies.

Biofortification: It is the breeding of crops with high level of vitamins and minerals or high protein and fats to improve human health.

Crop varieties developed with improved food quality:

- a) Maize with twice the amount of amino acids like lysine and tryptophan.
- b) Atlas - 66 -Wheat with high protein content.
- c) Iron fortified rice variety containing 5 times more iron than the normal rice varieties.
- d) Vitamin A enriched – carrot, pumpkin, spinach
- e) Vitamin C enriched bitter melon, tomato mustard.
- f) Iron & Calcium enriched spinach
- g) Protein enriched beans, garden peas.

12. **Single Cell Protein (SCP):** It is the proteins obtained from micro-organisms. They form an alternate source of proteins for animals and human beings.

Microbes like **Spirulina** grown on large scale in industries are the source for proteins.

Economic value of Spirulina:

- a. It serves as food rich in protein.
- b. It reduces the pressure on agricultural production
- c. It helps in reducing environmental pollution.
- d. It can be grown waste water from potato processing plant, straw, molasses, animal manure and sewage.
- e. 250 grams of the bacteria *Methylophilus methylotrophus* can be expected to produce 25 tonnes of proteins in a day.

13. **Tissue culture:** It is the artificial technique of growing plants from the parts of the plant body on artificial nutrient medium under controlled and aseptic condition.

Any part of the plant body that is selected for growing in artificial conditions on a nutrient media is called **explant**.

Totipotency: the ability of plant cell to generate into a whole new plant is called totipotency.

Nutrient medium: It is the artificial medium on which plants are grown from explants in the lab. It contains all nutrients like sucrose, inorganic salts, vitamins, amino acids and growth regulators in required quantities.

Micropropagation: It is the method of producing thousands of plants using explant through tissue culture.

Soma clones: They are plants produced by micro propagation using somatic cells.

Types of tissue culture: - organ culture, pollen culture, single cell culture, protoplast culture, meristem culture.

Somatic hybridization/ protoplast culture: It is the technique of fusion of protoplast of somatic cells of two different plants with desirable characters. Example protoplast of tomato is fused with that of potato and then they are grown to form new hybrid plants combining tomato and potato characteristics.

Importance of tissue culture:

1. Micropropagation
2. Production of haploid plants
3. Production of virus free plants
4. Production of somatic hybrids.