[Topic 1] Animal Husbandry

Animal husbandry is the agricultural practice of breeding and raising livestock. It deals with the care and breeding of livestock like buffaloes, cows, pigs, horses, cattle, sheep, goat, etc. It also includes poultry farming and fisheries. More than 70% of the world's livestock population is in India and China. However, the contribution of these countries to world farm produce is only 25%, i.e. productivity per unit is very low. Many new technologies have been applied to achieve improvement in quality and productivity. The various aspects that come under animal husbandry have been described below:

1.1 Management of Farms and Farm Animals

Dairy Farm Management

Dairy farm management is the management of animals to get milk and its products for human consumption. Such as butter, curd, cheese, etc.

(*i*) It deals with processes and systems to improve quality and quantity of milk.

(*ii*) Milk yield depends mainly on the quality of breeds in the farm.

(*iii*) The process of management of dairy farms include:

- Selection of good breeds having high yielding potential and resistance to the diseases. For example, Jersey and Brown Swiss breed of cow.
- Cattles should be housed-well, should have sufficient water and should be kept in disease-free conditions.
- They should be fed in a scientific manner, with good quality and quantity of fodder.
- Stringent cleanliness and hygiene of both the cattle and the handlers are very important, during milking, storage and transport of milk and its products.
- Regular inspection and keeping proper records of all the activities of dairy is also mandatory.
- Regular visits of a veterinary doctor for assessment of stock is necessary.

Poultry Farm Management

Poultry farm management includes the management of poultry which is the class of domesticated fowl (birds) used for food or for their eggs, e.g. chicken, ducks, Turkey, geese and some varieties of pigeons. Poultry is often refer to the meat of only these birds, but in a more general sense it may refer to other birds too. The poultry farm management includes following processes:

(*i*) Selection of disease-free and suitable poultry breeds. For example, Leghorn, Aseel.

(*ii*) Housing should be proper and safe.

(*iii*) Proper food and water should be provided.

(*iv*) Healthcare and hygiene of poultry birds is mandatory.

Bird Flu and Its Prevention

Bird flu is a pandemic viral disease of birds. It is caused by H_5N_1 virus. This virus affects millions of birds. If birds are infected then either they are burned or buried in the earth. So, this virus cannot spread further.

Bee-keeping or Apiculture or Bee Culture

Bee-keeping is the maintenance of hives of honeybees for the large scale production of honey and beewax. The excessive demand of honey for its nutritive value and in the indigenous systems of medicine and bees wax for cosmetics, etc., led to the large scale bee-keeping practices. Bee-keeping can be practiced in any area, where there are sufficient bee pastures of wild shrubs, fruit orchards and cultivated crops.

There are several species of honeybees, but most common species reared by bee-keepers is *Apis indica*. Bee-keeping is not a labour intensive and time consuming procedure.

The important points for successful bee-keeping are:

(*i*) Knowledge of the nature and habits of bees.

(*ii*) Selection of suitable location for keeping the beehives.

(*iii*) Catching and hiving of swarms, i.e. group of bees.

(*iv*) Management of beehives during different seasons.

(*v*) Handling and collection of honey and beeswax.

(*vi*) Keeping beehives in crop fields such as sunflower, *Brassica*, apple and pear, during flowering period increases pollination efficiency and improves the yield of both crop and honey. So, it is very beneficial to farmers.

Fishery

Fishery is an industry, which includes catching, processing or selling of fish, shellfish and other aquatic animals like prawn, crab, lobster, edible oyster, etc.

(*i*) The common freshwater fishes are *Catla*, rohu and common carp.

(*ii*) Some of the marine fishes that are eaten include *Hilsa, Sardines, Mackerel* and *Pomfrets*.

(*iii*) Fisheries provide income and employment to millions of fishermen and farmers, especially in coastal states in Indian economy.

(*iv*) To meet the increasing demand on fisheries, different techniques like aquaculture and pisciculture are applied. **Pisciculture** is related to catching, production or selling of fish, shellfish only while aquaculture (also known as aquafarming) includes culture of aquatic plants alongwith aquatic animals.

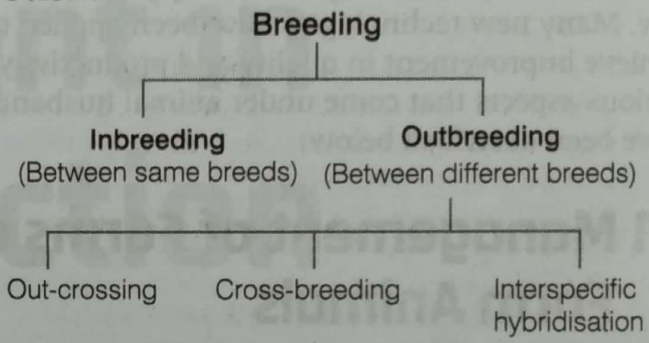
(*v*) **Blue revolution** is the movement launched to increase the production of fish and fish products. It is being implemented in the same lines as **green revolution**.

1.2 Animal Breeding

Animal breeding is an important part of animal husbandry. It aims to increase the yield of animals and improve the desirable qualities of produce.

(*i*) A **breed** is a group of animals related by descent and similar in most characters like general appearance, features, size, configuration, etc.

(*ii*) Breeding can be divided as given in the chart below:



Inbreeding

It refers to the mating between closely related individuals within the same breed for 4-6 generations.

The strategies for inbreeding are as follows:

- **Identification of superior males** and **females** of the same breed. They are mated in pairs.
- **Evaluation of progeny** obtained from the above mating to identify superior males and females among them, for further mating.
- A **superior female**, in case of cattle, is the cow or buffalo that produces more milk per lactation. A superior male is bull, which gives rise to superior progeny as compared to other males.

Effects of inbreeding are:

- It is used to evolve a pureline (inbreeding increases homozygosity).
- Harmful recessive genes are exposed by inbreeding, which are then eliminated by the selection.
- Superior genes can be accumulated by inbreeding.
- Productivity of inbreed population is increased by selection at every step.
- Continued inbreeding reduces fertility and even productivity. This is called **inbreeding depression**.

Outbreeding

It is the breeding of unrelated animals, either of the same breed, but not having common ancestors for 4-6 generations (out-crossing) or of different breeds (cross-breeding) or even different species (interspecific hybridisation).

It can be of the following types:

- **Out-crossing** is the practice of mating of animals, within the same breed, but having no common ancestors on either side of their pedigree up to 4-6 generations.
- In this case, selected animals of the breeding population are mated with unrelated superior animals of the same breed. This helps to restore fertility and yield.
  - The offspring of such mating is called an outcross.
  - It is done to increase milk production, growth rate in cattle's beef, etc.
  - A single out-cross helps to overcome inbreeding depression.
  - It is the best method for animals that are below average in productivity.
- **Cross-breeding** refers to the mating of superior males of one breed with superior females of another breed.
  - It helps to accumulate desirable qualities of two breeds into progeny.
  - The progeny may be used for commercial production themselves. Hybrid is usually better then both the parents.
  - A new sheep breed, Hisardale was developed in Punjab by crossing Bikaneri Ewes and Marino Rams.
- **Interspecific hybridisation** refers to crossing between male and female animals of two different related species.
  - Progeny may combine desirable features of both the parents.
  - Progeny may be of considerable economic value. However, such hybrids are usually sterile.
  - Example of interspecific hybridisation is a Mule obtained by crossing a male donkey with a female horse.

Artificial Insemination

This is a method of controlled breeding. In this procedure, the semen from selected male parent is injected into the reproductive tract of selective female parent.

- Its advantages are as follows:
  - Helps to overcome problems related to normal mating.
  - Semen can be transported very easily from one place to another place in frozen form.
  - Semen can be stored and frozen for the later use.
  - Semen can be used to fertilise many female mates.
- The disadvantage is its fairly low success rate.

1.3 Multiple Ovulation Embryo Transfer (MOET) Technology

MOET is a programme for herd improvement.

(*i*) The method includes following steps:

(a) A cow is administrated with hormones having FSH-like activity, to induce follicular maturation and superovulation.

(b) The cow produces 6-8 eggs instead of one egg, normally released per cycle. So, it is known as **multiple ovulation**.

(c) A cow is now mated with an elite bull or artificially inseminated.

(d) The fertilised eggs at 8-32 celled stages are recovered non-surgically and transferred to surrogate mother. Now further development would take place in surrogate mother.

(e) The genetic mother can again be used for superovulation.

(*ii*) This technology is used for cattle, sheep, rabbits, buffaloes, mares, etc.

(*iii*) High milk-yielding breeds of females and high quality (lean meat with less lipid) meat-yielding bulls have been bred successfully to increase the herd size in a short time.

[Topic 2] Plant Breeding

2.1 Plant Breeding

Plant breeding is a technique of manipulation of plant species, in order to create desired plant types that are better suited for cultivation, give better yields and are disease resistant. All our major food crops are derived from domesticated varieties.

Objective of Plant Breeding

Objectives of plant breeding includes incorporation of certain traits or characters into crop plants in order to enhance the food production are:

(*i*) Increased tolerance to environmental stresses, such as salinity, extreme temperatures, drought, etc.

(*ii*) Resistant to pathogens like viruses, fungi and bacteria.

(*iii*) Increased tolerance to insect pests.

(*iv*) High-yield and improved quality of crop plants.

Plant Breeding Programmes

Plant breeding programmes are carried out in government institutions and commercial companies. The major steps in breeding a new genetic variety of crops are:

Collection of Variability

(*i*) **Genetic variability** is the root of any breeding programme.

(*ii*) **Pre-existing genetic variability** are available in the form of wild varieties, species and relatives of crop species. These can be collected and preserved.

(*iii*) **Evaluation** of their characteristics is a prerequisite for the effective exploitation of natural genes available in the populations.

(*iv*) 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

(*i*) It is carried out by evaluating germplasm, to identify plants with desirable combination of characters.

(*ii*) The selected plants are multiplied and hybridised.

(*iii*) By self-pollination, purelines are created whenever desired.

Cross Hybridisation among Selected Parents

(*i*) Cross hybridisation is carried out to combine desired genetic characters from two different plants (parents).

(*ii*) It is a time consuming and tedious process, as it involves collection of pollen grains from the desired plants and other pollination techniques to incorporate desired traits.

(*iii*) It is not certain that the hybrids would combine desired characters. The chances of desirable combination are usually only one in few hundred to a thousand crosses carried out.

Selection and Testing of Superior Recombinants

(*i*) This step consists of selection of plants among the progeny of the hybrids with desired combination of characters.

(*ii*) It yields plants that are superior than both the parents. This is known as **hybrid vigour / heterosis.**

(*iii*) The selected plants are self-pollinated for several generations, till they reach a state of uniformity or homozygosity, so that the characters will not segregate in the progeny.

Testing, Release and Commercialisation of New Cultivars

(*i*) **Evaluation** is done for newly selected lines for their yield and other agronomic traits of quality, disease resistance, etc.

(*ii*) Selected plants are grown in research fields and their performance is recorded under ideal fertiliser application, irrigation and other crop management practices.

(*iii*) **Testing** of hybrid line is done in farmer's field after evaluation. After testing, the crop is grown at different locations in the country with different agroclimatic zones for atleast three growing seasons.

(*iv*) The tested material is evaluated in comparison to the best available local crop cultivar used as reference cultivar.

(*v*) **Release** of tested material is finally done in bulk after selection and certification.

2.2 Green Revolution

(*i*) It is the movement that led to the development of several high yielding varieties of wheat and rice in the mid 1960s. Dr. MS Swaminathan brought 'Green Revolution in India.'

(*ii*) **Green revolution** was dependent mainly on improved plant breeding techniques for the development of high-yielding and disease-resistant varieties in wheat, rice, maize, etc.

(*iii*) It led to dramatic increase in food production in our country.

(*iv*) In India, agriculture accounts for approximately 33% of India's GDP and employs nearly 62% of population.

(*v*) **Wheat and rice** During 1960-2000, the production of wheat increased from 11 million tonnes to 75 million tonnes, while the production of rice increased from 35 million tonnes to 89.5 million tonnes.

(a) This increased production was due to the introduction of semi-dwarf varieties of wheat and rice.

(b) Nobel Laureate Norman E Borlaug, developed semi-dwarf varieties of wheat, at the International Centre for Wheat and Maize Improvement in Mexico.

(c) Semi-dwarf varieties of rice were developed from **IR-8** at the International Rice Research Institute (IRRI, Philippines) and Taichung Native-1 (in Taiwan).

(d) High-yielding and disease-resistant wheat varieties were introduced in India in 1963, e.g. **Sonalika** and **Kalyan Sona**.

(e) The semi-dwarf varieties were introduced in India in 1966.

(f) Better-yielding semi-dwarf varieties of rice, i.e. **Jaya** and **Ratna** were developed in India.

(*vi*) **Sugarcane** *Saccharum barberi* of North India and *Saccharum officinarum* of South India were crossed to get sugarcane varieties of high yield, thick stems, high sugar and ability to grow in areas of North India. *Saccharum barberi* had low yield while *Saccharum officinarum* had good yield, however it could not be grown in North India. So, both were crossed to bring the desired characters in the same progeny.

(*vii*) **Millets**

(a) **Hybrid breeding** have led to the development of several high yielding varieties of millets that were resistant to water stress.

(b) The successfully developed high yielding hybrid varieties are of maize, jowar and bajra.

2.3 Plant Breeding for Disease Resistance

Plant breeding for disease resistance is required as a wide range of fungal, bacterial and viral pathogens affect the yield of cultivated crop species, especially in tropical climates.

(*i*) Resistance of the host plant is the ability to prevent the pathogen from causing disease and is determined by the genetic constitution of host plant.

(*ii*) Development of resistance in crops enhances production and reduces the dependance on use of fungicides and bacteriocides.

(*iii*) The causative agents of diseases in plants are:

(a) **Fungi** Common diseases caused by fungi are brown rust of wheat, red rot of sugarcane, late blight of potato, etc.

(b) **Bacteria** Common diseases caused by bacteria are black rot of crucifers, blight of rice, citrus canker, etc.

(c) **Virus** Common diseases caused by viruses are tobacco mosaic, turnip mosaic, etc.

Methods of Breeding for Disease Resistance

Conventional Breeding

Conventional breeding is carried out in following steps:

(*i*) Selection and screening of germplasm for the disease resistance.

(*ii*) Hybridisation of selected parent plant.

(*iii*) Selection and evaluation of hybrids.

(*iv*) Testing and release of new varieties into the market.

(*v*) Some important varieties developed by conventional method are:

Crop	Variety	Resistance to Disease
Wheat	Himgiri	Leaf rust, stripe rust and hill bunt
Brassica	Pusa Swarnim (Karan Rai)	White rust
Cauliflower	Pusa Shubhra and Pusa Snowball K-1	Black rot and curl blight black rot
Cowpea	Pusa Komal	Bacterial blight
Chilli	Pusa Sadabahar	Chilli mosaic virus, tobacco mosaic virus and leaf curl

(*v*) Disadvantages of this method are:

- Limited number of disease resistance genes have been identified in crop varieties or wild relatives.

Mutation Breeding

Mutation breeding is a phenomenon by which genetic variation is achieved through changes in base sequences within genes, which creates a new character or trait absent in parental generation.

(*i*) It can also be defined as the process of breeding by artificially inducing mutations using chemicals or radiations.

(*ii*) Mutation breeding is carried out in the following steps:

- Inducing mutations in plants by various means.
- Screening the plant for resistance.
- Selecting the desirable plant for multiplication or for breeding.

(*iii*) In mung bean, resistance to yellow mosaic virus and powdery mildew were introduced by mutations.

(*iv*) Resistance to yellow mosaic virus in bhindi (*Abelmoschus esculentus*) was transferred from a wild species and resulted in a new variety of *A. esculentus* called **Parbhani Kranti**.

2.4 Plant Breeding for Developing Resistance to Insect Pests

(*i*) Insect resistance in host crop plants may be due to morphological, biochemical or physiological characteristics.

(*ii*) The important characters that lead to pest resistance in a plant are:

(a) Hairy leaves in plants, e.g. resistance to jassids in cotton and cereal leaf beetle in wheat.

(b) Solid stem in wheat exhibits non-preference by stem sawfly.

(c) In cotton, smooth leaf and the absence of nectar repel bollworms.

(d) In maize, high aspartic acid, low nitrogen and sugar content protect them from stem borers.

(*iii*) Breeding methods for insect pest-resistance involve the same steps as those for any other agronomic trait like yield or quality.

(*iv*) Some crop varieties produced by hybridisation and selection for insect pest-resistance are:

Crop	Variety	Insect Pest
Brassica (rapeseed mustard)	Pusa Gaurav	Aphids
Flat bean	Pusa Sem 2 Pusa Sem 3	Jassids, aphids and fruit borer
Okra (bhindi)	Pusa Sawani Pusa A-4	Shoot and fruit borer

2.5 Plant Breeding for Improved Food Quality

Plant breeding for improved food quality is required because of the following reasons:

(*i*) Lack of sufficient food having adequate nutritional requirement in the world.

(*ii*) Majority of people are unable to buy enough fruits, vegetables, legumes, fish and meat and thus, suffer from deficiencies or 'hidden hunger'. As the food they have, does not contain main nutrients.

(*iii*) Essential micronutrients are absent from diet that increases risk for disease, reduce lifespan and reduce mental abilities.

(*iv*) **Biofortification** is the process of developing crops with higher levels of vitamins, minerals, proteins and healthier fats in order to improve public health.

(*v*) The objectives of breeding for improved nutritional quality are to improve

(a) protein content and quality

(b) oil content and quality

(c) vitamin content

(d) micronutrients and mineral content

(*vi*) Crops developed with improved nutrient content are as follows:

(a) **Atlas 66** having high protein content was used as a donor for developing improved wheat varieties.

(b) **Maize hybrids** with increased amount of amino acids lysine and tryptophan were developed in year 2000.

(c) **Iron-fortified rice** with increased iron content.

(d) **Indian Agricultural Research Institute** (IARI), New Delhi have released some fortified crop varieties rich in certain vitamins, minerals, etc.

- Carrot, spinach and pumpkin – Vitamin-A.
- Bitter gourd, bathua, mustard, tomato – Vitamin-C.
- Spinach and bathua – Iron and calcium.
- Broad bean, lablab, french and garden pea – Protein.

Single Cell Protein (SCP)

SCP is an alternative protein source for animal and human nutrition that is obtained from certain microorganisms like *Spirulina*.

(*i*) Microbes like *Spirulina* are grown on an industrial scale to obtain good protein.

(*ii*) **Advantages of SCP** are as follows:

(a) Microbes can be easily grown on materials like wastewater from potato processing plants (containing starch), straw, molasses, animal manure and sewage. Thus, they are easy to grow.

(b) SCPs provide nutrient rich food like proteins, minerals, fats, carbohydrates and vitamins.

(c) Reduce environmental pollution due to above mentioned resource utilisation.

(d) Yield is high due to high rate of biomass production and growth, e.g. 250 g of microorganism like *Methylophilus methylotrophus* is expected to produce 25 tonnes of protein.

2.6 Tissue Culture

Tissue culture is a technique of regeneration of whole plant from any part of a plant by growing it on culture medium under aseptic conditions.

(*i*) The capacity of a plant cell (explant) to grow into a whole plant is called **totipotency**.

(*ii*) **Explant** is the part of plant taken for tissue culture. e.g. leaf, stem, embryo, etc.

(*iii*) The method of growing or producing thousands of plants in very less time through tissue culture is called **micropropagation**.

(*iv*) **The nutrient medium** On which an explant is grown must provide a carbon source such as sucrose and also inorganic salts, vitamins, amino acids and growth regulators like auxins, cytokinins, etc.

(*v*) The plants produced from tissue culture are genetically identical to the original plant from which they are grown, so they are called **somaclones**.

(*vi*) Advantages of tissue culture are:

(a) More number of plants can be produced in a short time.

(b) Disease-free plants can be developed from diseased plants.

(c) Seedless plants can be multiplied.

Tissue Culture Technique

Various tissue culture techniques are as follows:

Meristem Culture

Meristem culture can be done to recover healthy plants from diseased plants.

(*i*) Meristem (apical and axillary) is the only virus-free part of a virus-infected plant as meristem cells divide very fast.

(*ii*) Virus-free plants can be obtained by removing the meristem and growing it *in vitro*.

(*iii*) Plants developed successfully from meristem culture are banana, sugarcane, potato, etc.

Somatic Hybridisation

Somatic hybridisation is the process of fusion of protoplast of different varieties or species of plant on a suitable nutrient medium *in vitro* to develop a somatic hybrid.

(*i*) **Procedure**

(a) Single cells from selected plants are isolated.

(b) Cell walls are digested by the enzymes like pectinase and cellulase to expose the marked protoplasts.

(c) Naked protoplasts are isolated from the plasma membrane.

(d) Isolated protoplasts are fused to obtain hybrid protoplasts under sterile conditions in special nutrient medium.

(e) Hybrid protoplasts obtained are cultured in a suitable medium to form new plant.

(*ii*) **Pomato** is a somatic hybrid produced by the fusion of tomato and potato protoplasts.

This plant did not have desirable characters. Hence, it is not used for commercial utilisation.