STRATEGIES FOR ENHANCEMENT IN FOOD PRODUCTION

ANIMAL HUSBANDRY:

- The agricultural practice of breeding and raising livestock.
- Deals with care and breeding of livestock like buffaloes, cows, pigs, horses, cattle, sheep, camels, goats etc.
- Extended form includes poultry farming and fisheries.
- Fisheries include rearing, catching selling etc. of fish, mollusks (shell fish) and crustaceans (prawns, crabs etc.)

Diary farm management:

- Dairying is the management of animals for milk and its products.
- Use of improved breed of cow such as **Jersey**.
- Well housed.
- Should have adequate water
- Maintained disease free
- Feeding should be scientific manner.
- Quantity and quality of fodder
- Stringent cleanliness and hygiene.
- Regular visit by a veterinary doctor would be mandatory.

Poultry farm management:

- Poultry is the class of domesticated fowl (birds) used for food and eggs.
- Selection of disease free and suitable breeds
- The improved breed of poultry is **Leghorn**.
- Proper and safe farm conditions
- Proper feed and water
- Hygiene and health care.

Animal breeding:

- A group of animals related by descent and similar in most characters like general appearance, features size, configuration, etc, are said to be a **breed**.
- **Inbreeding:** crosses between same breed.
- **Outbreeding:** crosses between different breeds.

Inbreeding:

- Mating of more closely related individuals within the same breed for 4-6 generations.
- Superior male and female is identified and mated in pairs.
- Progeny obtained are evaluated and superior males and females among them are identified for further mating.
- **More milk per lactation** is the criteria for superior female for cow and buffalo. Superior male which gives rise to **superior progeny**.
- Inbreeding increases **homozygosity**.
- Inbreeding is necessary to create **pure line** in any animal.
- Inbreeding exposes harmful recessive gens that are eliminated by selection.
- Helpful in **accumulation of superior genes**.

- Continuous inbreeding reduces fertility and even productivity. This is called **inbreeding depression.**

Outbreeding:

- Out-breeding is the breeding of **unrelated animals.**

Out-crossing:

- Mating of animals within the same breed but having no common ancestor on either side of their pedigree upto 4-6 generations.
- Offsprings of such mating is called out-cross.
- A single outcross often helps to overcome inbreeding depression.

Cross-breeding:

- Superior male of one breed are mated with superior female of another breed.
- It allows the desirable qualities of two different breeds to be combined.
- ***Hisardale*** is a new breed of sheep developed in Punjab by crossing **Bikaneri ewes** and **Marino rams**.

Interspecific hybridization:

- Male and female of two different species are mated
- The progeny may combine desirable features of both the parents.(mule)

Artificial insemination:

- **Controlled breeding experiments** are carried out using **artificial insemination.**
- The semen is collected from the male and injected into the reproductive tract of the selected female by the breeder.
- The semen collected may be used immediately or can be frozen for later use. The semen can be transported in a frozen form to where the female is housed.

Multiple Ovulation Embryo Transfer Technology:

- It is used to improve chances of successful production of hybrids.
- Cow is administered hormones with **FSH-like activity**
- induce follicular maturation and **super ovulation**
- Production of **6-8 eggs** instead of one egg per cycle.
- The female is either mated with an elite bull or **artificially inseminated.**
- Non-surgical recovery of fertilized eggs at **8-32 cells** stages.
- Each one transferred to **surrogate mother**.
- The **genetic mother** is available for another round of super ovulation.
- This technology is used to increase **herd size** in a short time.

Bee – keeping:

- Bee-keeping is called apiculture.
- It includes maintenance of hives of honeybees for production of honey.
- Honey is a food of high nutritive values and also used as medicine.

- Honey bees also produce beeswax which has many used in industry, like preparation of cosmetics and polishes of various kinds.
- Bee-keeping practiced in area with sufficient bee pastures of some wild shrubs, fruit orchards and cultivated crops.
- ***Apis indica*** is most common species used in apiculture.
- The following points are important **for successful bee-keeping:**
    - Knowledge of the nature and habits of bees.
    - Selection of suitable location for keeping the beehives.
    - Catching and hiving of swarms (group of bees)
    - Management of beehives during different seasons.
    - Handling and collection of honey and of beeswax.
    - Bees are the pollinator for many plants, hence keeping beehives in crop fields during flowering period, increases pollination and improve honey yield.

Fisheries:

- Fishery industry related to catching, processing or selling of fish shellfish or other aquatic animals.
- Common **fresh water fish:** *Catla, Rohu* and common carp

Common **marine fishes**: Hilsa, Sardines, Mackerel and Pomfrets

- Production of aquatic plants and animals, both freshwater and marine water is increased by **Pisciculture** and **aquaculture.**
- Increasing production of the fish is called **Blue revolution**.

PLANT BREEDING:

- Plant breeding as a technology has helped increase yields to a large extent.
- **Green revolution** was not only responsible to meet the national requirement of food, but also helped us even to export it.
- Green revolution is due to plant breeding techniques which developed high yielding variety of wheat, rice, maize etc.

What is plant breeding?

- Plant breeding is the purposeful manipulation of plant species in order to create desired plant types that are better suited for cultivation, give better yields and are disease resistant.
- Classical plant breeding involved crossing or hybridization of pure lines followed by artificial selection to produce plants with desirable traits of higher yield, nutrition and resistance to diseases.

Trait for which plant breeding done:

- Trait or characters that the breeders have tried to incorporated into the plants are as follows:
    - Increased crop yield
    - Improve quality
    - Increased tolerance to environmental stresses (salinity, extreme temperature, and drought).
    - Resistant to pathogens (viruses, fungi, and bacteria)

- Increase tolerance to insect pest.

Steps in plant breeding techniques:

- **Collection of variability:**
  - Genetic variability is the root of any breeding programme.
  - Pre-existing genetic variability is available from wild relatives of crop.
  - Collection and preservation of all the different wild varieties, species and relatives of the cultivated species.
  - Evaluation for their characteristics.
  - 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:**
  - The germplasm is evaluated so as to identify plants with desirable combination of characters.
  - The selected plants are multiplied and used in hybridization.
  - Pure line is created wherever desirable and possible.
- **Cross hybridization among the selected parents:**
  - Cross hybridization of two selected parent by emasculation and bagging, to produce hybrid of combined character of both parents.
  - For example high protein quality of one parent may need to be combined with disease resistance from another patent.
  - Usually one in few hundred to a thousand crosses offsprings shows desirable combinations.
- **Selection and testing of superior recombinants:**
  - Selection is done from the progeny of hybrids produced by **cross hybridization.**
  - It requires careful scientific observations and evaluation of progeny.
  - Hybrid plants that are superior to both of the parents are selected.
  - These hybrids are self-pollinated for several generations till they reach a state of uniformity (homozygosity)
- **Testing, release and commercialization of new cultivars:**
  - Selected pure lines are evaluated for their yield and other agronomic traits of quality, disease resistance etc.
  - This evaluation is done in the research fields and recording their performance under ideal fertilizer, irrigation
  - Testing is done in the farmers 'fields' at least for three generation.
  - The material is compared with best available local crop cultivar.

Product: Wheat and Rice:-

- Production of wheat and rice increased in many folds due to **semi-dwarf variety** during the period of 1960-2000.
- Nobel laureate **Norman E.Borlaug**, at international centre for wheat and Maize improvement in Mexico, developed semi-dwarf variety of wheat.
- In 1963 several varieties such *Sonalika* and *Kalyan Sona* high yielding variety was introduced in India.
- Semi-dwarf rice was derived from **IR-8**(developed at International Rice Research Institute (IRRI) Philippines) and **Taichung Native –I** (from Taiwan).
- ***Jaya***and ***Ratna,*** semi dwarf rice variety developed in India.

Product: sugarcane:

- ***Saccharum barberi*** of north India with poor sugar content and yield crossed with ***Saccharum officinarum*** with thick stems and higher sugar content to produce sugar cane of high yield, thick stems, and high sugar.

Plant breeding for Disease Resistance:

- A wide range of fungal, bacterial and viral pathogens, affects the yield of cultivated crop species, they lessens he yield upto 20-30 % sometime total.
- Development of cultivars resistant to diseases is essential.
- This also reduce he dependence on he fungicide or insecticide.
- Pathogen causing different diseases in plants:
    - **Fungi:** brown rust of wheat, red rot of sugarcane, late blight of potato.
    - **Bacteria:** black rot of crucifer,
    - **Virus:** tobacco mosaic, turnip mosaic etc.

Method of breeding for disease resistant:

- Screening of germplasm for resistance sources.
- Hybridization of selected parent.
- Selection and evaluation of hybrids
- Testing and release of new varieties.

Mutation breeding:

- Genetic variability is created by induced mutation. (By application of mutagen, chemical or physical).
- Screening and selection of the parent with desirable character used as a parental plant for breeding programme.
- In mung bean, resistance to yellow mosaic virus and powdery mildew were induced by mutation.
- Natural wild varieties of plant with disease resistant genes are available but low yield.
- These wild varieties are hybridized with high yield varieties to make them disease resistant and also high yielding variety.
- Resistance to yellow mosaic virus in bhindi (*Abelmoschus esculentus*) was transferred from a wild species and resulted a new variety of *A.esculentus* called ***Parbhani kranti*.**

Plant breeding for Developing Resistant to insect pest:

- Another major cause of large scale destruction of crop plants is the insect and pest infestation.
- Insect resistance in host crop is due to morphological, biochemical or physiological characteristics.

Characters that make the plant resistance to insect pest:

- **Hairy leaves** in several plants make them resistant to insect pest.
- **Solid stem** in wheat lead to non-preference by stem **sawfly.**
- **Smooth leaves** and **nectar-less** cotton variety do not attract **bollworms.**
- **High aspartic acid**, **low nitrogen** and sugar content in maize make them resistant to **stem borers.**

- Steps for developing insect pest resistant variety of crop are same as others.
- The resistant variety selected either form the wild variety of from other available cultivars.

Plant breeding for Improved Food quality:

- Around three billion people suffer from micronutrient, protein and vitamin deficiencies called **Hidden hunger.**
- Diets lacking essential micronutrients particularly iron, vitamin A, iodine or zinc- increase the risk of diseases; reduce life span, reduce mental ability.
- **Biofortification:-**breeding crops with higher levels of vitamins and minerals or higher protein and healthier fats – is the most practical means to improve public health,
- **Objectives of biofortification: is to improve**
    - **Protein content and quality.**
    - **Oil content and quality**
    - **Vitamin content and**
    - **Micronutrient and mineral content.**
- Hybrid maize developed with twice the amount of amino acids **lysine** and **tryptophan,** compared with existing maize.
- Wheat variety Atlas 66, having high protein content has been used as donor for improving cultivated wheat.
- **Iron fortified** rice developed with five times more iron than existing variety.
- IARI New Delhi developed:
    - Vitamin A enriched carrots, spinach pumpkin.
    - Vitamin C enriched bitter gourd, bathua, mustard tomato.
    - Iron and Calcium enriched spinach and bathua
    - Protein enriched beans- broad, lablab, French and garden peas.

SINGLE CELL PROTEIN (SCP):

- More that 25% of human population is suffering from hunger and malnutrition.
- One of the alternating sources of proteins for animal and human is **SCP.**
- Production of biomass (protein) in large scale using micro-organism and low cost raw material is called **single cell proteins.**
- Microbes like ***Spirulina*** grown on waste water from potato processing plants, straw, molasses, animal manure and even sewage, to produce large quantities of biomass with rich in protein, mineral, fats, carbohydrate and vitamins.
- It has been calculated that 250 kg cow produces 200gm of protein per day. In the same period 250gm of micro-organism like ***Methylophilus methylotophus***, expected to produce 25 tones of protein.
- Another example is production of biomass like mushroom from straw.

TISSUE CULTURE:

- Potency or power or ability of a single cell/ explants to develop a whole plant is called **totipotency.**
- This property led the scientist able to develop whole plant from **explants** – any part of plant, cell grown in a test tube, under sterile condition in special nutrient medium.
- The nutrient medium provides a carbon source such as sucrose. Inorganic salts, vitamins amino acids and growth regulator like auxin, cytokinin.

- The method of production of thousands of plants through tissue culture is called **micropropagation**.
- Plants grown by micropropagation are genetically identical called **somaclones**.

Application of tissue culture:

- Production of large number of plant from small tissue or single cell.
- Production of genetically identical plants (somaclones)
- Recovery of healthy plants from diseased plants by **meristem** culture. Although the plant infected with virus, the meristem is free of virus.

Somatic hybridization:

- Isolation of single cells from the plants.
- Digestion of cell wall to get protoplast of different donor cells, by use of cellulase and pectinase.
- Two protoplast of two different plants with desirable character are fused to form hybrid protoplast, either by using electric field or by PEG (polyethylene glycol).
- These hybrids are called **somatic hybrid** and the process called **somatic hybridization**. E.g. production pomato plant from potato and tomato.

Abbreviation:

- ET : Embryo Transfer
- IARI : Indian Agricultural Research Institute
- IRRI : International Rice Research Institute
- ICAR : Indian Council of Agriculture Research
- MOET : Multiple Ovulation Embryo Transfer
- NDRI : National Dairy Research Institute