



Enhancement in Food Production, Animal Husbandry & Microbes in Human Welfare

Strategies for Enhancement in Food Production

- ❖ Agriculture accounts for approximately 33 percent of India's GDP.
- ❖ Green revolution was dependent to a large extent on plant breeding techniques for development of high yielding and disease resistant varieties in wheat, rice, maize etc.
- ❖ Classical plant breeding involves crossing or hybridization of pure lines, followed by artificial selection to produce plants with desirable traits of higher yields, nutrition and resistant to diseases.

Wheat and Rice

- ❖ During the period 1960 to 2000 in India, wheat production increased from 11 million tonnes to 75 million tonnes. Rice production went up from 35 million tonnes to 89.5 million tonnes. This was due to the development of semi-dwarf varieties of wheat and rice.
- ❖ Nobel laureate Norman E. Borlaug, at International Centre for Wheat and Maize improvement in Mexico, developed semi-dwarf wheat.
- ❖ Sonalika and Kalyan Sona were high yielding and disease resistant wheat varieties.
- ❖ Semi-dwarf rice IR-8 (IRRI, Philippines) and Taichung Native-1 (Taiwan) were developed. Semi-dwarf rice varieties Jaya and Ratna were developed in India.
- ❖ Saccharum barberi and Saccharum officinarum were successfully crossed to get sugar cane varieties combining the desirable qualities of high yield, thick stems, high sugar content.

Breeding of Disease Resistant Varieties

- ❖ In mung bean, resistance to yellow mosaic virus and powdery mildew were induced by mutations.
- ❖ In Bhindi (*Abelmoschus esculentus*), resistance to yellow mosaic virus was transferred from a wild species and resulted in a new variety of *Abelmoschus esculentus* called Parbhani Kranti.
- ❖ Insect resistance in host crop plants may be due to morphological, biochemical or physiological characteristics.
- ❖ Hairy leaves led to resistance against jassids in cotton and cereal leaf beetle in wheat.
- ❖ In wheat, solid stems lead to non-preference by the stem sawfly and smooth leaved and nectar-less cotton varieties do not attract bollworms.
- ❖ High aspartic acid, low nitrogen and sugar content in maize leads to resistance to maize stem borers.
- ❖ Biofortification is the Breeding crops with higher levels of vitamins and minerals or higher protein and healthier fats, most practical means to improved public health.
- ❖ Maize hybrids that had twice the amount of the amino acids, lysine and tryptophan were developed. Wheat variety, Atlas 66 having a high protein content was developed.
- ❖ IARI (Indian Agricultural Research Institute, New Delhi) has developed several vegetable crops that are rich in vitamins and minerals and proteins e.g.
 - Vitamin A enriched carrots, spinach, pumpkin.
 - Vitamin C enriched bitter melon, brinjal, mustard, tomato.
 - Iron and calcium enriched spinach and brinjal and protein enriched beans (Broad, lablab and french) and garden peas.
- ❖ Source of good protein are Spirulina, *Methylophilus methylotrophus*, mushrooms and some fungi.

Tissue Culture

- ❖ The capacity to generate whole plant from explant is called totipotency.



- ❖ Micropropagation is the Propagation of a large number of plants through tissue culture. They are somaclones. E.g., Tomato, banana, apple etc.
- ❖ Meristem culture is an important application for recovery of virus-free healthy plants from diseased plant.
- ❖ Somatic hybridisation: is the technique in which isolated protoplasts from two different varieties of plants can be fused to get hybrid protoplasts which can be further grown to form a new plant. These hybrids are called Somatic hybrids.
- ❖ Protoplast hybrid of potato and tomato called pomato was created but unfortunately, this plant did not have all the desired combination of characteristics for its commercial utilization.

Animal Husbandry

1. **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. Many new technologies have also been applied to achieve improvement in quality and productivity.

2. **To improve quality and quantity in animal husbandry are:**

- I. Management of Farms and Farm Animals**

- (i) Dairy farm management is the management of animals for milk and its products for human consumption.
 - (a) It deals with processes and systems to improve quality and quantity of milk.
 - (b) Milk yield depends mainly on the quality of breeds in the farm.
 - (c) Dairy farm management processes include:
 - Selection of good breeds having high yielding potential and resistance to the diseases.
 - Cattle 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 handler 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 is necessary.
- (ii) Poultry farm management includes the management of poultry which is the class of domesticated fowl (birds) used for food or for their eggs. It includes chicken, ducks, Turkey and geese. The poultry farm management includes following processes:
 - (a) Selection of disease-free and suitable poultry breeds
 - (b) Housing should be proper and safe.
 - (c) Proper food and water should be provided.
 - (d) Health care and hygiene of poultry birds is mandatory

- II. Bee-keeping or apiculture** is the maintenance of hives of honeybees for the large scale production of honey and beeswax. The excessive demand of honey for its nutritive value and bees wax for cosmetics, etc., led to the large scale bee-keeping practices. Bee-keeping can be practiced in any area, here there are sufficient bee pastures of wild shrubs, fruit orchards and cultivated crops. It is not labour-intensive.

There are several species of honeybees, but most common species reared by bee-keepers is *Apis indica*. 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 (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, Brinsia, apple and other, during flowering period increases pollination efficiency and improves the yield, both crop yield and honey yield.

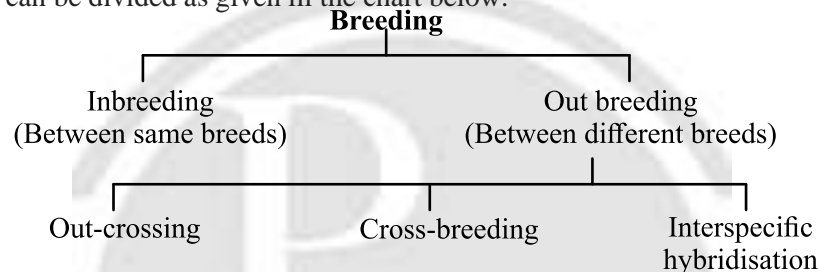


III. Fishery is an industry, which includes catching, processing or selling of fish, shellfish and other aquatic animals like prawn, crab, lobster, edible oysfegr, etc...

- (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 provides 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.
- (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.

IV. 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 iii the chart below:



- (a) Inbreeding refers to the mating between closely related individuals within the same breed for 4-6 generations.

The strategies for inbreeding are as follow:

- Identifying 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.
- 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, the undesirable genes.
- Productivity of inbred population is increased by selection at every step.
- Continued inbreeding reduces fertility and even productivity. This is called inbreeding depression.
- 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.

- (b) Outbreeding 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.
 - ✓ The offspring of such mating is called an out-cross.
 - ✓ It is done to increase milk production, growth rate in cattle's beef, etc.
 - ✓ A single out cross helps to overcome inbreeding depression.
- Cross-breeding refers to the mating of superior males of one breed with superior females of another breed.
 - ✓ It helps in accumulate desirable qualities of two breeds into progeny.
 - ✓ The progeny may be used for commercial production themselves.
 - ✓ A new sheep breed, Hisardale is 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.
 - ✓ Example of interspecific hybridisation, is a Mule obtained by crossing a male donkey with a female horse.
- (c) Artificial insemination is a method of controlled breeding. The semen from selected male parent is injected into the reproductive tract of selective female parent.

Its advantages are as follow:

- Helps to overcome problems related to normal mating.
- Semen can be stored and frozen for the later use.
- The disadvantage is its fairly low success rate.

V. Multiple Ovulation Embryo Transfer (MOET) Technology is a programme for herd improvement.

- The method includes following steps:
 - A cow is administered with hormones FSH-like activity, to induce follicular maturation and superovulation.
 - The cow produces 6-8 eggs instead of one egg, normally released per cycle.
 - A cow is now mated with an elite bull or artificially inseminated.
 - The fertilised eggs at 8-32 celled stages are recovered non-surgically and transferred to surrogate mothers.
 - The genetic mother can again be used for superovulation.
- This technology is used for cattle, sheep, rabbits, buffaloes, mares, etc.
- 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.

Microbes in Human Welfare

- ❖ Microbes are present everywhere, even in the most harsh habitats.
- ❖ Several microbes are pathogenic to plants and animals, however, many of them are useful too.
- ❖ Microbes are diverse- protozoa, bacteria, fungi and microscopic animal and plant viruses, viroids and also prions are present everywhere even at thermal vents, snow layer and highly acidic environment.
- ❖ Many bacteria and fungi are utilised by us in preparation of several household products such as: cheese, curd, dosa and idli, toddy etc.
- ❖ For industrial production of a number of products, microbes are grown in large vessel called fermenters.
 - Yeast is used to make bread and beer.
 - Yeast ferments malted cereals and fruit juices to produce ethanol and many other alcoholic products.
- ❖ Wine and beer are produced without distillation whereas whisky, brandy and rum are produced by distillation of the fermented broth.
 - Antibiotics are one of the most important products from microbes for the benefit of mankind. Penicillin was the first antibiotic discovered by Alexander Fleming.
 - Microbes also produce a range of organic acids, enzymes, bioactive molecules etc. which are utilised in medicinal and other industries.
- ❖ Wine and beer are produced without distillation whereas whisky, brandy and rum are produced by distillation of the fermented broth.



Organic acids, enzymes of molecules obtained from the microbes

Microbe	Product	Function
Lactobacillus	Curd	Increase Vit B ₁₂ content
Bacteria	Dosa and Idli	Produce dough by evolving CO ₂
Propionibacterium sharmanii	Swiss Cheese	Holes in cheese due to production of CO ₂
Fungus	Roquefort Cheese	gives flavor
Penicillium notatum	Penicillin	Antibiotic
Aspergillus niger	Citric acid	—
Acetobacter aceti	Acetic acid	—
Clostridium butylicum	Butyric acid	—
Lactobacillus	Lactic acid	—
Streptococcus vessels	Streptokinase	‘clot buster’ for removing clots from the blood
Trichoderma polysporum	Cyclosporin A	immunosuppressive agent in organ-transplant patients
Monascus purpureus	Statins	blood-cholesterol lowering agents

- ❖ Waste water is harmful because it contains pathogen containing human excreta, hence, it can not be directly released into the water bodies.
- Treatment of waste water is done by the heterotrophic microbes naturally present in the sewage.

Events in waste water treatment

	Event	Characteristic	Followed by
Primary treatment	physical removal of particles – large and small – from the sewage through filtration and sedimentation	solids that settle form the primary sludge, and the supernatant forms the effluent	Supernatant taken for biological treatment
Secondary Treatment	Aerobic treatment	growth of useful aerobic microbes into flocs, reduction of BOD	effluent sediments to form activated sludge, use as inoculum for aeration tank remaining major part of the sludge is pumped into large tanks called anaerobic sludge digesters.
	Anaerobic treatment	Anaerobic bacteria digest aerobic fungi and bacteria, produce biogas	effluent from the secondary treatment plant is generally released into natural water bodies like rivers and streams

- ❖ Methanogens are also present in the rumen of cattle, and therefore, their dung can be used to produce Gobar gas.
- ❖ Biogas produced by microbes is used as a source of energy in rural areas.
- ❖ Continuous usage of chemical fertilisers and pesticides lead to environmental pollution.
- ❖ Organic farming aims to minimise environmental pollution by using biofertilisers and biocontrol agents.
- ❖ Several insects, bacteria, fungi and viruses act as biocontrol agents.



- ❖ A number of bacteria, cyanobacteria and fungi either in free-living or symbiotic state act as biofertilisers.

Microbes as biocontrol agents and biofertilisers

Microbe	Function	Characteristic
Ladybird	Biocontrol	Against aphids
Dragonflies		Against mosquitoes
Bacillus thuringiensis		Against Insect larvae
Trichoderma		Against many root pathogens
Baculoviruses (Nucleopolyhedrovirus)		Against insects and other arthropods
Rhizobium, Azotobacter, Azospirillum	Biofertiliser	nitrogen fixation
Glomus		Forms mycorrhiza
Anabaena, Nostoc, Oscillatoria		add organic matter to the soil and increase its fertility.



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