CHAPTER – 9(UNIT-3)

STRATEGIES OF ENHANCEMENT IN FOOD PRODUCTION

A. TOPIC OF THE DAY

STRATEGIES OF ENHANCEMENT IN FOOD PRODUCTION

- Increase in population ---------- need for increase in production of quantity and quality of food.
- **Strategies of Enhancement**: Practices and techniques employed for increasing food production.

ANIMAL HUSBANDRY:

- **Livestock**: Domesticate animal mainly reared for commercial purpose or for food.
- The agricultural practice of raising and breeding livestock is called **animal husbandry**.
- Also includes **poultry farming** and **fisheries, apiculture, sericulture** etc.
- India and China – 70% livestock, productivity contribution only 25%.

Dairy farm management:

- **Dairying** ---------- management technique of raising animals for increase yield and improving quality of milk and its products.

- **Guidelines for Higher productivity**
  - Use of **improved breed** (high yield and disease resistant) - **Jersey, Brown Swiss, Sahiwal**
  - **Well housed,** presence of adequate water and maintained disease free.
  - Should feed adequate quantity and quality of fodder in scientific manner.
  - Regular visit by a veterinary doctor.
  - Stringent cleanliness and hygienic condition while milking, storage and transport of the milk and its products.

Poultry farm management:

- Poultry refers to farming practice of domesticated fowls (birds) such as chicken, duck, turkey, geese raised for meat or for their egg.
- **Measures for increasing productivity in Poultry farm**
  - Selection of **disease free** and suitable breeds.
  - E.g. **Single Comb white Leghorn** – **egg type, Polymouth rock, New Hampshire** – **meat type.**

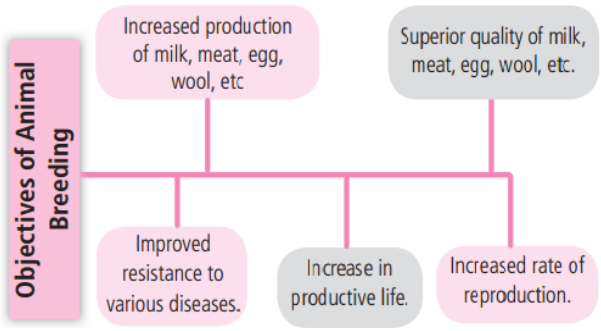
Poultry disease

- **Ranikhet disease** – *Paramyxovirus* – coughing, sneezing and droopiness
- **Bird Flu** – H_5N_1 virus, like influenza
- **Pullorum disease (white diarrhoea)** – *Salmonella pullorum*

Animal breeding:

- Breed - A group of animals related by descent and similar in most characters like general appearance, features size, configuration, etc.

- **Objectives:**



Types of Animal breeding

1. **Inbreeding -** Breeding between animals of same breed for 4-6 generations.

   Advantage:

   - Inbreeding increases homozygosity.
   - Inbreeding is necessary to create pure line in any animal.
   - Inbreeding exposes harmful recessive genes that are eliminated by selection.
   - Helpful in accumulation of superior genes and elimination of less superior genes.
   - Continuous inbreeding reduces fertility and even productivity. This is called inbreeding depression.

   Disadvantage

   - Continuous inbreeding for 4-6 generations reduces fertility and even productivity. This is called **inbreeding depression.**

- Breeding – to produce superior breed
- Continuous inbreeding causes inbreeding depression.

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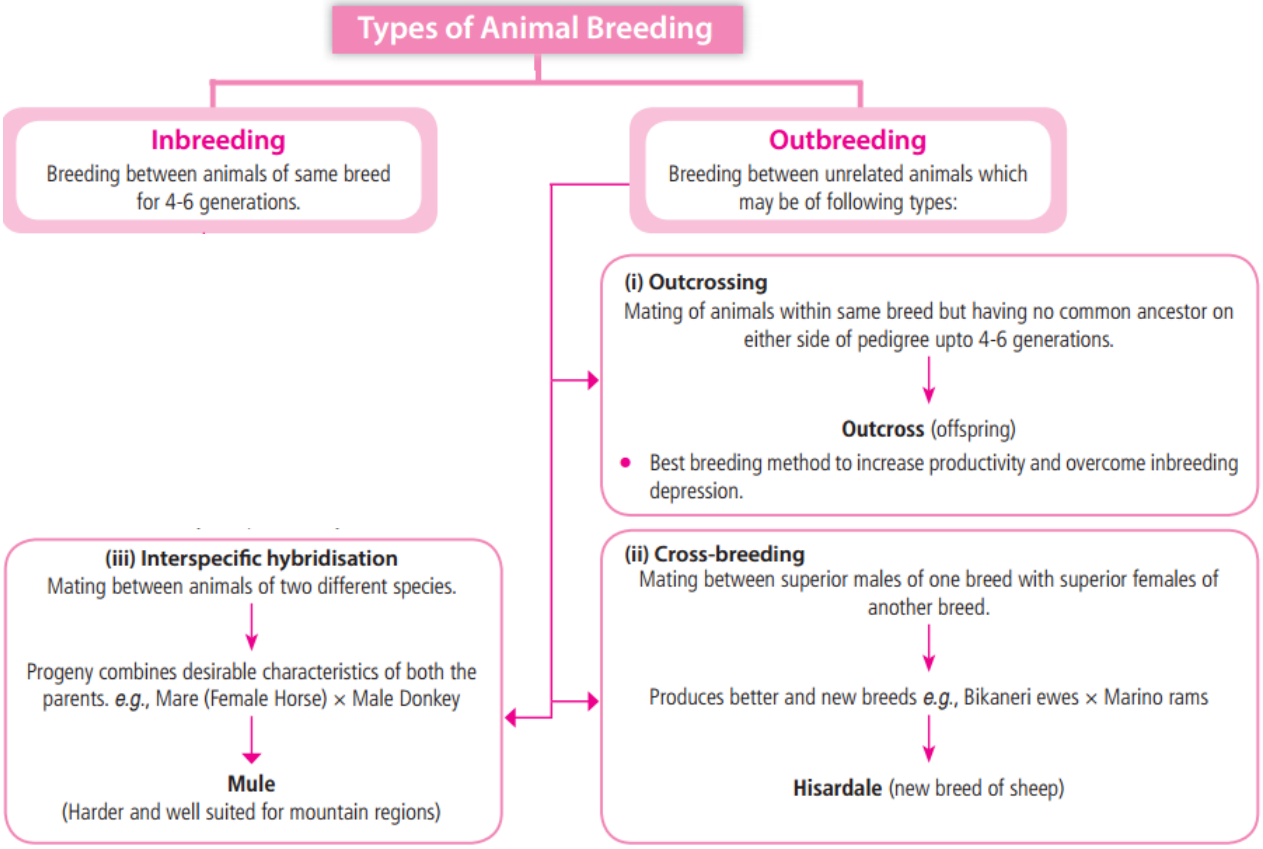
Outbreeding -types



- Outcross - the best breeding method for animals that are below average in productivity, growth rate etc.
- It also helps to overcome inbreeding depression.
- Cross breeding and interspecific hybridisation allows the desirable qualities of two different breeds to be combined.

CONTROLLED BREEDING EXPERIMENTS

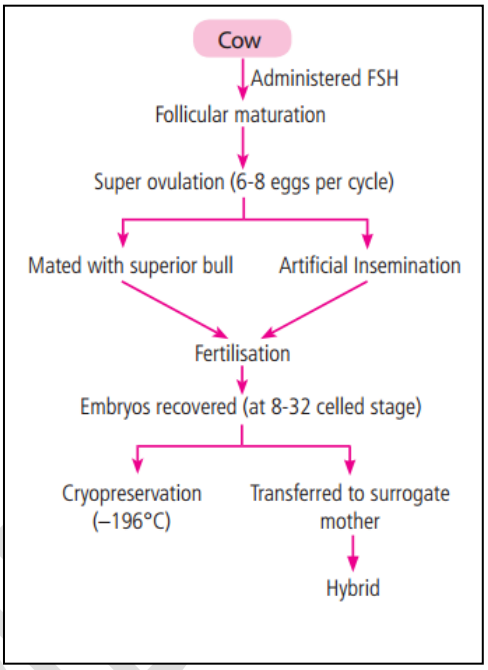
Artificial insemination:

- The semen is collected from the superior male and injected into the reproductive tract of the selected female with desirable traits by the breeder.

Advantage:

- The semen collected may be used immediately or can be frozen for later use.
- The semen from a desired breed can be transported in frozen form to distant places.
- Spread of certain disease can be controlled.

Multiple Ovulation Embryo Transfer Technology (MOET):



Procedure:

- 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.
- This technique also enhances the chances of successful production of hybrid.

Bee – keeping:

- Bee-keeping is called apiculture.
- Maintenance of honey bees and bee-hives for production of honey and bee-wax is known as apiculture.
- **Products of apiculture** –
  - **Honey** : sweet, viscous fluid, formed by conversion of nectar to thick fluid. It contains sugars, vitamins, amino acids etc. it is use as food of high nutritive values and also used as medicine.
  - **Bee-wax** : secreted by hypodermal glands of worker bee. It is is used for preparation of polishes and cosmetics and in lab microtomy.
  - **Pollinators** : Honey bees are efficient pollinators of many crop plants like mustard, sunflower, apple etc. rearing honey bees in crop fields during flowering season results in better crop yield and honey yield.

Honey Bee species

- ***Apis indica*** – indian honey bee, domesticated for honey
- ***Apis dorsata*** – Rock bee, yield max honey
- ***Apis florea*** – little bee

Fisheries:

- **Fishery or pisciculture**: industry related to catching, rearing, breeding, processing or selling of fish.
- **Aquaculture**: Rearing, trading of shellfish and other aquatic animals along with fishes.
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- Differences between Aquaculture and Pisciculture

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Aquaculture	Pisciculture
• Production of all types of aquatic organisms in water bodies	• Involves production of fishes only
• Small quantity of special feed is given from outside	• Fish feed is provided from outside
• Economically important products are obtained in addition to food	• Only food products are obtained

- **Blue revolution**: Implementation of new technologies in pisciculture and aquaculture to increase production of fish and other aquatic animals not only to feed people of our nation but also to export to other countries is called blue revolution.
- Animals cultivated under pisciculture
  - **fresh water fish:** *Catla, Rohu* and common carp.
  - **marine fishes**: Hilsa, Sardines, Mackerel and Pomfrets.
- Animals cultivated under aquaculture
  - Both freshwater and marine water fish
  - Arthropods – prawns, crabs, lobsters
  - Molluscs – Oysters (shell fish), clams

Sericulture:

- **Sericulture:** Seri = silk, culture = rearing. Rearing and management of silk producing insect for silk.
- Origin – China
- **Eri** and **Muga** culture – local origin in NE India.
- NE - Major producers due to presence of host plants of all variety in NE states naturally.
- Silk – fine, strong and soft fibre composed of two proteins – core **fibroin** and waxy outer **sericin.**
- Synthesize in silk gland and ejected through spinneret of mouth, hardened into fibre when comes in contact with air.

Types of silk worms – two groups

1. **Mulberry silk-worms : *Bombax mori,***
   - Feed on mulberry leaf.
   - It produces 'pat silk'- a bright cream coloured superior quality silk.
   - 95% of global production of silk is mulberry silk.
2. **Non – mulberry silkworms**
   a. **Muga Silkworm: *Antheraea assamensis***
      - Polyphagous - Feeds on variety of host plants – Som and Soalu
      - Produce Muga silk – golden colour with fine texture and durability.

   b. **Eri Silkworm: *Philosamia ricini***
      - Polyphagous – primary –*Castor*
      - Produced Eri Silk

   c. **Tasar Silkworm: *Antheraea paphia***
      - Feeds on Arjun, saal, ber leaves
      - Wild species

d. **Oak Tusar Silkworm - *Antheraea proyeli***

- Feeds on *Quercus* leaf
- Predominantly reared in NE – Manipur
- Outdoor rearing
- Fine quality tasar silk

PLANT BREEDING:

- **Plant breeding**: It is the purposeful manipulation genetics of plant species in order to create desired plant types that are better suited for cultivation, give better yields and are disease resistant.

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 conventional plant breeding techniques:

I. **Collection of variability:**
   - Genetic variability is the root of any breeding programme.
   - Collection and preservation of all the different wild varieties, species and relatives of the cultivated species for genetic variability is necessary.
   - The entire collection (of plants /seeds) having all the diverse alleles for all genes in a given crop is called **germplasm collection.**

II. **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 pure line is created wherever desirable and possible.

III. **Cross hybridization:**
   - Cross hybridization of two selected parent by emasculation and bagging, to produce hybrid of combined character of both parents.
   - E.g. Cross between high protein quality and disease resistance parents.

IV. **Selection of superior recombinants:**
   - Selection of plants having desirable character combination from the progenies of hybrids.
   - Usually one in few hundred to a thousand offspring shows desirable combinations.
   - 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).

V. **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 at several locations (agroclimatic zones).
- Testing is done in the farmers 'fields' at least for three generation.
- The material is compared with best available local crop cultivar.
- The approve variety is released as new variety in the form of seeds and are made available to farmers.

A. - Product of plant breeding:

- ***Green revolution***: increase in food production as a result of development of high yielding varieties and modernisation of management techniques and use of chemical fertilizers and pesticides by farmers.
- Green revolution is due to plant breeding techniques which developed high yielding variety of wheat, rice, maize etc.
- Development of new variety is initiated by **Norman E. Borlaug** (ICWMI, Mexico)
- He develop semi-dwarf variety of wheat possessing gene – **Norin 10**

Wheat and Rice:-

- Production increased many folds due to **semi-dwarf variety** during 1960-2000.
- High yielding and disease resistant varieties of wheat - *Sonalika* and *Kalyan Sona* introduced in 1963.
- Semi-dwarf variety of rice was developed from - **IR-8** at IRRI, Philippines and from **Taichung Native –I** in Taiwan. Their derivatives are introduced later in INDIA.
- ***Jaya*** and ***Ratna*****,** semi dwarf rice varieties was developed later 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 and has the ability to grow in north India.

Plant breeding for Disease Resistance:

- **Resistance:** ability of a plant to prevent the disease causing pathogen to cause disease.
- 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.
- Pathogen causing different diseases in plants:
  - **Fungi:** brown rust of wheat, red rot of sugarcane, late blight of potato.
  - **Bacteria:** black rot of crucifer, blight of rice, citrus canker
  - **Virus:** tobacco mosaic, turnip mosaic etc.

- Development of cultivars resistant to diseases is essential.
  - Enhance the production of food by reducing loss due to disease.
  - This also reduce dependence on the fungicide or insecticide.

Crop	Variety	resistance to disease
Wheat	Himgiri	Leaf and stripe rust
Brassica	Pusa Swarnim	White rust

Method of breeding for disease resistant:

i. **Hybridisation technique**

- 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 In mung bean, resistance to yellow mosaic virus and powdery mildew were induced by mutation.

Crop varieties of disease resistance

- Natural wild varieties - disease resistant but low yield.
- Hybridisation - with high yield varieties – to make disease resistant and 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:

- insect and pest infestation - major cause of large scale destruction of crop plants.
- Steps for developing insect pest resistant variety of crop are same as others.

Characters that make the plant resistance to insect pest:

- Insect resistance in host crop is due to morphological, biochemical or physiological characteristics
  - **Hairy leaves**.
  - **Solid stem** in wheat - non-preference by stem **sawfly.**
  - **Smooth leaves** and **nectar-less** cotton - do not attract **bollworms.**
  - **High aspartic acid**, **low nitrogen** and sugar content in maize - **stem borers.**

Plant breeding for Improved Food quality:

- Micronutrient, protein and vitamin deficiency - **Hidden hunger.**
- Deficiency of iron, vitamin A, iodine or zinc- increase the risk of diseases; reduce life span, reduce mental ability.

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- **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.**
- **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):

- 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 tons of protein.
- Another example is production of biomass like mushroom from straw.

TISSUE CULTURE:

- Tissue culture: development of whole plant from any part of plant or cell when grown in a test tube, under sterile condition in special nutrient medium.
- **Totipotency** : Potency or ability of a single cell/ explants to develop a whole plant, a necessity for tissue culture
- The nutrient medium provides
  - a carbon source such as sucrose.
  - Inorganic salts,
  - vitamins
  - amino acids
  - and growth regulator like auxin, cytokinin.

Types of plant tissue culture

Callus culture

- Explant is culture on a semi-solid medium to obtain an irregular, unorganised and undifferentiated mass of actively diving cells called callus.
- Requires both auxin and cytokinin growth regulators
- It is obtained within 2-3 weeks.

Suspension culture

- Single cells and small groups of cells are suspended in liquid medium.
- The medium requires auxin (2,4-D) only
- It is much faster to achieve biomass production.
- It needs to be constantly agitated at 100-250 rpm.

Meristem culture

- Involves culture of apical or axillary shoot meristems.
- Explants used are shoot tips and nodal segments.
- It is used in production of virus free plants
  - E.g. potato, Sugarcane in germplasm conservation and rapid clonal multiplication

Micropopagation

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

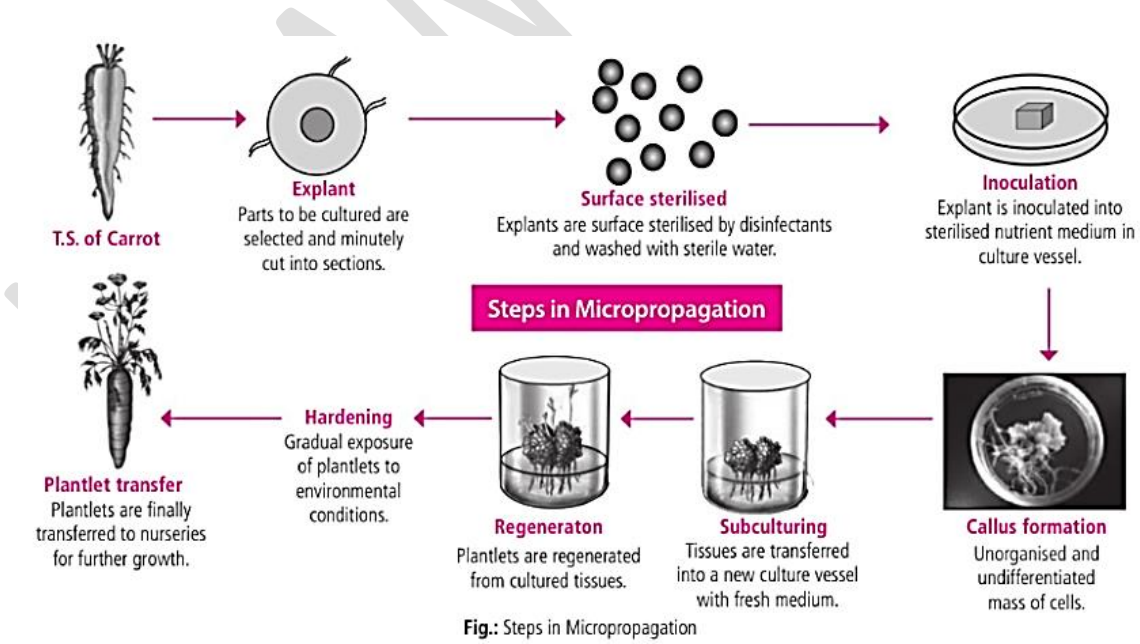

Fig.: Steps in Micropropagation

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Somatic hybridization:

- Process of formation of somatic hybrids through fusion of somatic ceels of two varieties.
- Steps

- Isolation of single cells from the plants.
- Digestion of cell wall to get protoplast of different donor cells, by use of cellulase and pectinase.
- Fusion of two protoplast by using electric field or by PEG (polyethylene glycol).
- E.g. production pomato plant from potato and tomato.
  - Advantages
- Development of hybrids of asexually reproducing plants
- Development of new crop plants
- Production of usefull polyploids.

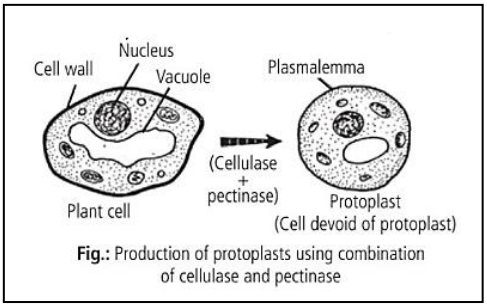

Fig.: Production of protoplasts using combination of cellulase and pectinase

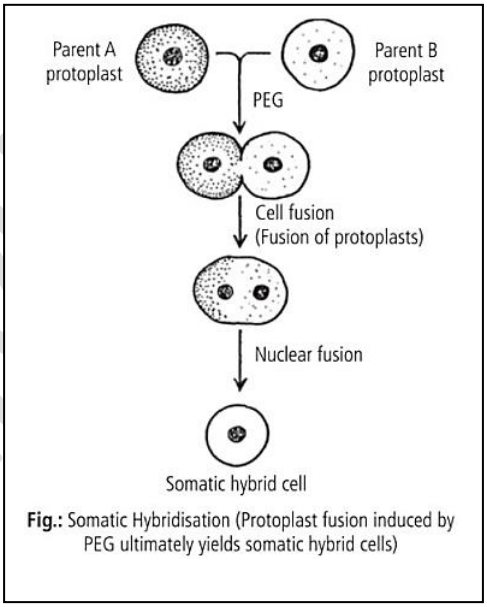

Fig.: Somatic Hybridisation (Protoplast fusion induced by PEG ultimately yields somatic hybrid cells)