Chapter-13 Strategies for Enhancement in Food Production

Very Short Answers Questions:

1. What is meant by 'hidden hunger'?

A: Because of poverty billions of people could not afford nutritious food and balanced diet. This leads to micronutrient, protein and vitamin deficiencies -

This is called 'hidden hunger'.

2. Name two semi-dwarf varieties of rice developed in India?

A: 'Jaya and Ratna'- semi-dwarf varieties of rice developed in India.

3. Give two examples of wheat varieties introduced in India, which are high yielding and disease resistant?

A: 'Sonalika and Kalyana Sona'

4. Give two examples of fungi used in SCP production?

A: *Candida utilis*

Saccharomyces cerevisiae

5. Which two species of sugarcane were crossed for better yield?

A: *Saccharum barberi* and *Saccharum officinarum*.

6. Define totipotency and explants?

A: The ability of a cell or an explants to regenerate into a complete plant is called totipotency.

Any part of a plant taken out and grown in a test tube under sterile conditions in special nutrient medium is called as an explants.

7. Define micropropagation and somaclones?

A: Production of large number of plants in a very short time and in limited space by using tissue culture technique is called micropropagation.

Plants grown through tissue culture which are genetically identical with the original (source) plant are called somaclones.

8. What is meant by germplasm collection?

A: The entire collection of plants or seeds or vegetative propagules having all the diverse alleles for all genes in a given crop is called germ plasm collection.

9. What is meant by biofortification?

A: Breeding for improved nutritional quality in the crops, like protein, oil, vitamins, micronutrients and mineral content is called biofortification.

10. Which part of the plant is best suited for making virus- free plants and why?

A: Apical and axillary meristems. In a virus infected plant, meristems are not infected and free of virus hence these are the best suited for growing virus free plants.

Short Answer Type Questions

1. Give few examples of biofortified crops. What benefits do they offer to the society?

Ans: Breeding crops for higher levels of vitamins and minerals, or higher protein and healthier fats is called as **biofortification**.

Examples:

1. **Maize** hybrids that had twice the amount of the amino acids, **lysine and tryptophan**, compared to existing maize hybrids were developed in the year 2000.

2. **Wheat** variety, ***Atlas 66***, having a high protein content, has been used as a donor for improving cultivated wheat.

3. **Iron-fortified rice** variety containing over five times as much iron as in commonly consumed varieties.

4. **Beta carotene** –containing rice variety named **Golden rice**.

5. **Vitamin A** enriched carrots, spinach, pumpkin.

6. **Vitamin C** enriched bitter gourd, *bathua*, mustard, tomato.

7. **Iron and calcium** enriched spinach and *bathua*.

8. **Protein** enriched beans – broad, lablab, French and garden peas.

Beneficial effects on society:

- It is the most practical means to improve public health.
- Help the people suffering from micronutrient, vitamin and protein deficiency (**'hidden hunger'**).
- Helps as a good source of Vitamin A, Iron, zinc at cheaper price for poor people.
- Nutrients from biofortified plants reduce the risk of disease and increase the mental abilities and life span in the population.

2. Write a short note on SCP.

Ans: Unicellular organisms used as a source of protein, as food or food supplements for the consumption of human beings or animals is referred as **Single Cell Protein or SCP**.

Examples of certain SCP organisms:

Algae: *Spirulina maxima, Chlorella pyrenoidosa, Scenedesmus acutus*

Fungi: *Candida utilis* (Torula yeast), ***Saccharomyces cerevisiae*** (Baker's yeast), ***Chaetomium cellulolyticum***.

Bacteria: *Brevibacterium ketoglutamicum, Methylophilus methylotrophus*.

Use of microorganisms as a source of protein has certain advantages and disadvantages

Advantages:

1. High rate of biomass production and growth. For example 250 Kg cow produces 200 g of protein per day. In the same period, 250g of a micro-organism like ***Methylophilus methylotrophus***, produce 25 tonnes of protein.

2. They can be grown on **cheap raw materials and wastes**. ***Spirulina*** can be grown easily on materials like waste water from potato processing plants containing starch, straw, molasses, animal manure and even sewage.

3. Such utilisation of wastes **reduces environmental pollution**.

4.Microbes can be cultures in **any environment**.

5. They can be cultured **throughout the year**.

6. They are **rich in vitamins, minerals and amino acids**. They are poor in fats.

Disadvantages:

1. Risk of contamination during production.
2. Production requires technical knowledge.
3. Presence of toxins in the product.
4. Certain proteins not suitable for human consumption.

Long Answer Type Questions

1. You are a Botanist working in the area of plant breeding. Describe the various steps that you will undertake to release a new variety.

Ans: 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 involves crossing or hybridisation of pure lines, followed by artificial selection to produce plants with desirable traits of higher yield, nutrition and resistance to diseases.

Plant breeding programmes are carried out in a systematic way.

The main steps in breeding a new genetic variety of a crop are :

1. **Collection of variability**
2. **Evaluation and selection of parents**
3. **Cross hybridisation among the selected parents**
4. **Selection and testing of superior recombinants**
5. **Testing, release and commercialisation of new cultivars.**

1. Collection of variability: Genetic variability is the root of any breeding programme. In many crops pre-existing genetic variability is available from wild relatives of the crop. Collection and preservation of all the different wild varieties, species and relatives of the cultivated species and evaluating them for their characteristics is a pre-requisite for effective exploitation of natural genes available in the populations.

The entire collection (of plants/seeds) having all the diverse alleles for all genes in a given crop is called **germplasm collection.**

2. 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 the process of hybridisation. Purelines are created wherever desirable and possible.

3. Cross hybridisation among the selected parents: The desired characters have very often to be combined from two different plants (parents), for example high protein quality of one parent may need to be combined with disease resistance from another parent. This is possible by cross hybridising the two parents to produce hybrids that genetically combine the desired characters in one plant. This is a very time-consuming and tedious process since the pollen grains from the desirable plant chosen as male parent have to be collected and placed on the stigma of the flowers selected as female

Parent. Also, it is not necessary that the hybrids do combine the desirable characters; usually only one in few hundred to a thousand crosses shows the desirable combination.

4. Selection and testing of superior recombinants*:* This step consists of selecting, among the progeny of the hybrids, those plants that have the desired character combination. The selection process is crucial to the success of the breeding objective and requires careful scientific evaluation of the progeny. This step yields plants that are

superior to both of the parents .Very often more than one superior progeny plant may become available. These are self-pollinated for several generations till they reach a state of uniformity (homozygosity), so that the characters will not segregate in the progeny.

5. Testing, release and commercialisation of new cultivars*:* The newly selected lines are evaluated for their yield and other agronomic traits of quality, disease resistance, etc. This evaluation is done by growing these in the research fields and recording their performance under ideal fertiliser application, irrigation, and other crop management practices. The evaluation in research fields is followed by testing the materials in farmers' fields, for at least three growing seasons at several locations in the country, representing all the agroclimatic zones where the crop is usually grown. The material is

evaluated in comparison to the best available local crop cultivar – a check or reference cultivar.

After evaluation the variety can be released for the farmers.

2. Describe the tissue culture technique and what are the advantages of tissue culture over conventional method of plant breeding in crop improvement programmes?

Ans: As traditional breeding techniques failed to keep pace with demand and to provide sufficiently fast and efficient systems for crop improvement, another technology called **tissue culture** got developed.

Regeneration of whole plants from **explants,** i.e., any part of a plant taken out and grown in a test tube, under sterile conditions in special nutrient media is called tissue culture. This capacity to generate a whole plant from any cell/explant is called **totipotency**.

The sequence of steps used in the tissue culture is as follows:

1. **Medium preparation**
2. **Sterilization of the medium**
3. **Explant preparation**
4. **Inoculation of explants**
5. **Incubation**

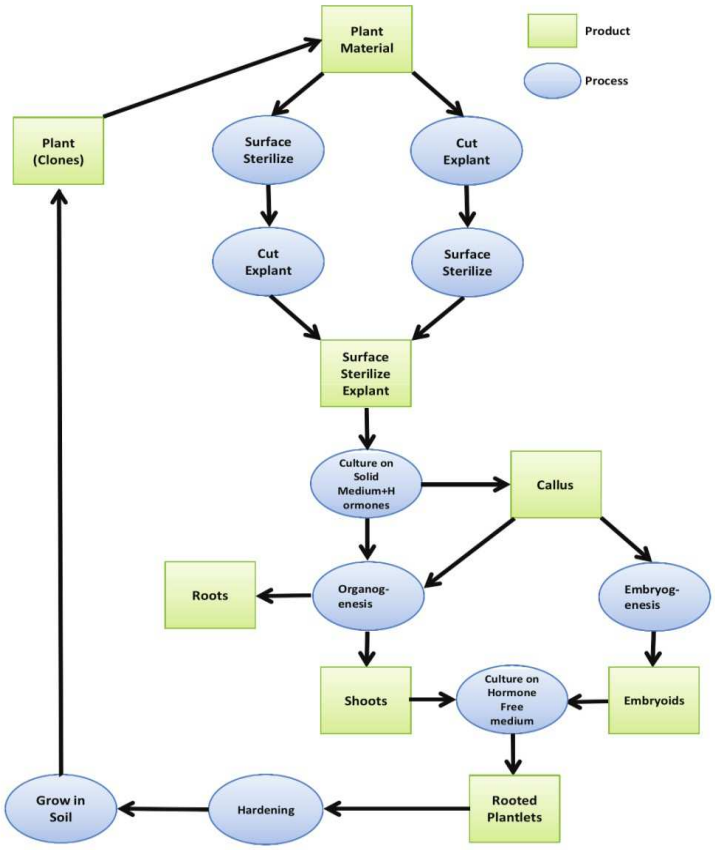
Medium Preparation: Nutrient medium must provide a **carbon source** such as sucrose and also inorganic salts, vitamins, amino acids and growth regulators like **auxins, cytokinins** etc. **Buffers** must be added to keep the medium at **suitable pH**. In preparation of the medium required amounts of carbon source, micro and macro nutrients are added to the distilled water in glass vessels ,petri dishes or test tubes.

Sterilization of the medium: Nutrient medium encourages the growth of different bacteria or fungi. The medium has to be sterilized. The liquid medium should be sterilized in the **autoclave** for **121^{0}C** foe **15 min** at **15 lb pressure.**

Explant preparation: Any living tissue from any part of the plant can be used as exlplant. It should be surface sterilized using chemicals and washing thoroughly with sterile water to remove any chemical residues.

Inoculation of Explants: The sterilized explants is introduced into the medium in **aseptic conditions** in inoculation chambers or Laminar airflows. This process is called as inoculation.

Incubation: Exposing the explants in the medium for different time period in different conditions is called incubation. In the **presence of light** the incubation will be completed in **4-5 weeks**. By manipulating the concentrations of **auxins and cytokinins** roots or shoots or entire **plantslets** can be produced.



Advantages: By application of these methods:

- It is possible to achieve propagation of a large number of plants in very short durations.
- This method of producing thousands of plants through tissue culture is called **micro-propagation**. Each of these plants will be genetically identical to the original plant from which they were grown, i.e., they are **somaclones**.
- Many important food plants like tomato, banana, apple, etc., have been produced on commercial scale using this method.
- Plants can be cultured and grown for their chemical molecules like alkaloids , antibiotics etc

- Another important application of the method is the recovery of healthy plants from diseased plants. Although the plant is infected with a virus, the **meristem** (apical and axillary) is free of virus. Hence, one can remove the meristem and grow it *in vitro* to
- obtain **virus-free plants**. Scientists have succeeded in culturing meristems of banana, sugarcane, potato, etc.
- **Artificial seeds** can be produced by encapsulating **somatic embryoides**. Somatic embryoides can be used directly in tissue culture in developing new plants.
- **Somatic hybrids**: Scientists have isolated single cells from plants and after digesting their cell walls have been able to isolate naked protoplasts (surrounded by plasma membranes). Isolated protoplasts from two different varieties of plants – each having a desirable character – can be fused to get hybrid protoplasts, which can be further grown to form a new plant. These hybrids are called **somatic hybrids** while the process is called **somatic hybridisation**.
- Tissue culture is essential in **growing GM plants**.