

# Strategies for Enhancement in Food Production

## NCERT Exemplar Solutions

### Multiple Choice Questions (MCQs)

**1. The chances of contracting bird flu from a properly cooked (above 100° C) chicken and egg are**

- (a) very high
- (b) high
- (c) moderate
- (d) None of these

Ans: (d) None of these

**2. A group of animals which are related by descent and share many similarities is referred to as**

- (a) breed
- (b) race
- (c) variety
- (d) species

Ans: (a) breed

**3. Inbreeding is carried out in animal husbandry because it**

- (a) increases vigour
- (b) improves the breed
- (c) increases heterozygosity
- (d) increases homozygosity

Ans: (d) increases homozygosity

**4. Sonalika and Kalyan Sona are varieties of**

- (a) wheat
- (b) rice
- (c) millet
- (d) tobacco

Ans: (a) wheat

**5. Which one of the following is not a fungal disease?**

- (a) Rust of wheat

- (b) Smut of bajra
- (c) Black rot of crucifers
- (d) Red rot of sugarcane

Ans: (c) Black rot of crucifers

**6. In virus-infected plants the meristematic tissues in both apical and axillary buds are free of virus because**

- (a) the dividing cells are virus resistant
- (b) meristems have antiviral compounds
- (c) the cell division of meristems are faster than the rate of viral multiplication
- (d) viruses cannot multiply within meristem cell(s)

Ans: (c) the cell division of meristems are faster than the rate of viral multiplication

**7. Several South Indian states raise 2-3 crops of rice annually. The agronomic feature that makes this possible is because of**

- (a) shorter rice plant
- (b) better irrigation facilities
- (c) early yielding rice variety
- (d) disease resistant rice variety

Ans: (c) early yielding rice variety

**8. Which one of the following combination would a sugarcane farmer look for in the sugarcane crop?**

- (a) Thick stem, long internodes, high sugar content and disease resistant
- (b) Thick stem, high sugar content and profuse flowering
- (c) Thick stem, short internodes, high sugar content, disease resistant
- (d) Thick stem, low sugar content and disease resistant

Ans: (a) Thick stem, long internodes, high sugar content and disease resistant

**9. Fungicides and antibiotics are chemicals that**

- (a) enhance yield and disease resistance
- (b) kill pathogenic fungi and bacteria, respectively
- (c) kill all pathogenic microbes
- (d) kill pathogenic bacteria and fungi respectively

Ans: (b) kill pathogenic fungi and bacteria, respectively

**10. Use of certain chemicals and radiation to change the base sequences of genes of crop plants is termed**

- (a) recombinant DNA technology
- (b) transgenic mechanism
- (c) mutation breeding
- (d) gene therapy

Ans: (c) mutation breeding

**11. The scientific process by which crop plants are enriched with certain desirable nutrients is called**

- (a) crop protection
- (b) breeding
- (c) biofortification
- (d) bioremediation

Ans: (c) Biofortification

**12. The term ‘Totipotency’ refers to the capacity of a**

- (a) cell to generate whole plant
- (b) bud to generate whole plant
- (c) seed to germinate
- (d) cell to enlarge in size

Ans: (a) cell to generate whole plant

**13. Given below are a few statements regarding somatic hybridisation. Choose the correct statements.**

- I. Protoplasts of different cells of the same plant are fused.
- II. Protoplasts from cells of different species can be fused.
- III. Treatment of cells with cellulase and pectinase is mandatory.
- IV. The hybrid protoplast contains characters of only one parental protoplast.

- (a) I and II
- (b) I and II
- (c) I and IV
- (d) IV and III

Ans: (d) IV and III

**14. An explant is**

- (a) dead plant
- (b) part of the plant
- (c) part of the plant used in tissue culture
- (d) part of the plant that expresses a specific gene

Ans: (c) part of the plant used in tissue culture

**15. The biggest constraint of plant breeding is**

- (a) availability of desirable gene in the crop and its wild relatives
- (b) infrastructure
- (c) trained manpower
- (d) transfer of genes from unrelated sources

Ans: (a) availability of desirable gene in the crop and its wild relatives

**16. Lysine and tryptophan are**

- (a) proteins
- (b) non-essential amino acids
- (c) essential amino acids
- (d) aromatic amino acids

Ans: (c) essential amino acids.

**17. Micro-propagation is**

- (a) propagation of microbes in vitro
- (b) propagation of plants in vitro
- (c) propagation of cells in vitro
- (d) growing plants on smaller scale

Ans: (b) propagation of plants in vitro

**18. Protoplast is**

- (a) another name for protoplasm
- (b) an animal cell
- (c) a plant cell without a cell wall
- (d) a plant cell

Ans: (c) a plant cell without a cell wall

**19. To isolate protoplast, one needs**

- (a) pectinase

- (b) cellulase
- (c) both pectinase and cellulase
- (d) chitinase

Ans: (c) both pectinase and cellulase

**20. Which one of the following is a marine fish?**

- (a) Rohu
- (b) Hilsa
- (c) Catla
- (d) Common carp

Ans: (b) Hilsa

**21. Which one of the following products of apiculture is used in cosmetics and polishes**

- (a) Honey
- (b) Oil
- (c) Wax
- (d) Royal jelly

Ans: (c) oil

**22. More than 70% of livestock population is in**

- (a) Denmark
- (b) India
- (c) China
- (d) India and China

Ans: (d) India and China.

**23. The agriculture sector of India employs**

- (a) 50% of the population
- (b) 70% of the population
- (c) 30% of the population
- (d) 60% of the population

Ans: (d) 60% of the population

**24. 33% of India's Gross Domestic Product comes from**

- (a) Industry

- (b) Agriculture
  - (c) Export
  - (d) Small-scale cottage industries
- Ans: (b) Agriculture

**25. A collection of all the alleles of all the genes of a crop plant is called**

- (a) germplasm collection
- (b) protoplasm collection
- (c) herbarium
- (d) somaclonal collection

Ans: (a) Germplasm collection

### Very Short Answer Type Questions

**1. Millions of chickens were killed in West Bengal, Assam, Odisha, and Maharashtra recently. What was the reason?**

**Ans:** Millions of chickens were killed or rejected in West Bengal, Assam, Odisha, and Maharashtra because they were found to be infected with the H5N1 virus, which is the causal organism of bird flu.

**2. Can gamma rays used for crop improvement programmes prove to be harmful for health? Discuss.**

**Ans:** No radiation treatment has been used to create thousands of new plant varieties. These varieties are cultivated as food and feed. Radiation is known to be much more disruptive for chromosomal structure than the manipulations used to make transgenic plants.

Such radiation treatment of crop plants has caused no documented instances of ill-health among consumers despite having been used commercially for several decades.

For rice crops alone, hundreds of different mutant varieties have been developed, mostly made by using ionising radiations, like gamma rays.

**3. In animal husbandry, if two closely related animals are mated for a few generations, it results in loss of fertility and vigour. Why is this so?**

**Ans:** The loss in fertility and vigour occurs after inbreeding because the recessive alleles tend to get together and express harmful effects in the progeny.

**4. In the area of plant breeding, it is important not only to preserve the seeds of the variety being cultivated, but also to preserve all its wild relatives. Explain with a suitable example.**

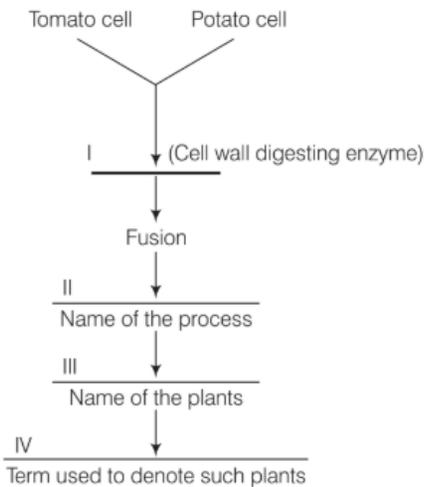
**Ans:** Collection and preservation of all the different wild varieties, species, and relatives of the cultivated species is important for effective exploitation of natural genes available in the population. e.g. Sources of resistance genes may be cultivated varieties, germplasm collections of the crop, or wild relatives.

**5. Name a man-made cereal. Trace how it was developed and where it is used.**

**Ans:** Triticale is a man-made cereal. It was developed by crossing *Triticum aestivum* (common wheat) and *Secale cereale* (European rye).

Triticale seed grain is being used in some parts of the world as a wheat substitute.

**6. Fill in the blanks.**



**Ans:**

- I. Cellulase
- II. Somatic hybridisation
- III. Pomato
- IV. Somatic Hybrid

**7. A few statements are given below followed by a set of terms in a box. Pick the correct term and write it against the appropriate statement**

<b>(a) Mating of closely related individuals within the same breed.</b>	<b>(i) Cross-breeding</b>
<b>(b) Mating of animals of same breed but having no common ancestors on either side for 4-6 generations.</b>	<b>(ii) Inter-specific hybridisation</b>
<b>(c) Mating of animals of two different species.</b>	<b>(iii) Outbreeding</b>
<b>(d) Breeding of animals belonging to different breeds.</b>	<b>(iv) Outcrossing</b>
	<b>(v) Inbreeding</b>

**Ans:**

- (a) Mating of closely related individuals within the same breed is called inbreeding.  
 (b) Mating of animals of the same breed but having no common ancestors on either side for 4-6 generations is called outbreeding.  
 (c) Mating of animals of two different species is called interspecific hybridisation.  
 (d) Breeding of animals belonging to different breeds is called cross-breeding.

**8. What is meant by ‘hidden hunger’?**

**Ans:** Consumption of food deficient in nutrients, particularly micronutrients, proteins, and vitamins, is called ‘hidden hunger’.

**9. Why are plants obtained by protoplast culture called somatic hybrids?**

**Ans:** Plants obtained by protoplast culture are called somatic hybrids because they are formed by the fusion of isolated protoplasts from two different varieties of plants, each having a desirable character, to obtain a hybrid protoplast which can be further grown to form a plant.

**10. What is protoplast fusion?**

**Ans:** The ability of protoplasts obtained from two different cells to fuse and form a hybrid protoplast is called protoplast fusion.

**11. Why is it easier to culture meristems compared to permanent tissues?**

**Ans:** Meristems have the capacity to divide continuously throughout their life. Their walls are thin and elastic to facilitate the division, hence they are suitable for tissue culture. Permanent cells lose their ability to divide, and their walls are thick. They have to differentiate to divide, hence they are not easy to culture.

**12. Why are proteins synthesised from *Spirulina* called single-cell proteins?**

**Ans:** Single-cell proteins are proteins obtained from unicellular organisms/microorganisms.

*Spirulina* is one such unicellular microbe. So, the proteins synthesised by *Spirulina* are called single-cell proteins.

**13. A person who is allergic to pulses was advised to take a capsule of *Spirulina* daily. Give the reasons for the advice.**

**Ans:** The person with allergies to pulses is advised to take *Spirulina* daily due to the following reasons

- (i) It could be a substitute for protein-rich pulses.
- (ii) *Spirulina* is rich in beta-carotene and antioxidants, besides all essential amino acids that help in improving allergic symptoms that appear due to the consumption of pulses.

**14. What is aquaculture? Give example of an animal that can be multiplied by aquaculture.**

**Ans:** When the culturing of aquatic plants and animals is done in freshwater bodies, it is called aquaculture.

Examples of animals that can be multiplied by aquaculture are  
Finfish — Tilapia, Carp, Catfish, etc.

Shellfish — Shrimps, Oysters, etc.

**15. What are the duties of a veterinary doctor in management of a poultry farm?**

**Ans:** A veterinary doctor has to ensure proper and safe farm conditions to keep the animals disease-free and treat them appropriately if diseased.

**16. Would it be wrong to call plants obtained through micropropagation as ‘clones’? Comment.**

**Ans:** No, it is not wrong to call plants obtained through micropropagation as clones because each of these plants will be genetically identical to each other and the parent plant.

### **17. How is a somatic hybrid different from a hybrid?**

**Ans:** Somatic hybrids are obtained by uniting protoplasts from two different varieties of plants and then further cultured to form a novel plant. Compatibility between two plants is not a limitation. Any two protoplasts can be united.

Whereas, hybrids are obtained by crossing two selected parent plants of opposite sex. Many times, compatibility is a limitation for breeding.

### **18. What is emasculation? Why and when is it done?**

**Ans:** Removal of stamens from the bisexual flower that is used as a female parent in plant hybridisation is called emasculation. This is done to avoid unwanted self-pollination. This has to be done at bud condition before the anthers dehisce.

### **19. Discuss the two main limitations of plant hybridisation programme.**

**Ans:** The limitations of the plant hybridisation programme include

- (i) Availability of a limited number of identified disease-resistant genes that are present in various crop varieties or wild relatives.
- (ii) Compatibility of parents.
- (iii) Time-consuming and tedious process.

### **20. Interspecific crosses are rare in nature, and intergeneric crosses almost unknown. Why?**

**Ans:** In interspecific crosses, male and female animals of two different related species are mated. In some cases, the progeny may combine desirable features of both the parents and may be of considerable economic value, e.g., the mule.

An interspecific hybrid's fertility varies. Many of Panthera (ligers, tigers, leopards, etc.) hybrid males are infertile, while the female counterparts can breed with the species they contain (female ligers can breed with a lion or a tiger to produce li-ligers or ti-tigers). These are rare in nature.

Intergeneric hybridisation is the crossing of two different animals/plants of different genera. It is almost unknown in nature. Intergeneric hybrids more or less never form complete zygotes/embryos. These are sterile/infertile.

### **21. Differentiate between pisciculture and aquaculture.**

**Ans:** Fish farming in isolated water bodies is called pisciculture. Similarly, when the culturing of aquatic plants and animals is done in freshwater bodies, it is called aquaculture.

### **22. Give two important contributions of Dr. MS Swaminathan.**

**Ans:** Contributions of Dr. MS Swaminathan are as follows

- (i) Introduction of short, high-yielding varieties of wheat in India.
- (ii) Development of short-duration, high-yielding varieties of rice.

### **23. The term ‘desirable trait’ can mean different things for different plants.**

**Justify the statement with suitable examples.**

**Ans:** The desirable trait can be different for different plants. The breeders have tried to incorporate these into crop plants. The list may be as follows

- (i) Increased tolerance to environmental stress (salinity, extreme temperature, drought). e.g., hybrid maize, jowar, and bajra, which are resistant to water stress.
- (ii) Resistance to pathogens (viruses, fungi, and bacteria,) e.g., moong bean (resistance to yellow mosaic virus and powdery mildew).
- (iii) Increased tolerance to insect pests. e.g., a new variety of Brassica (rapeseed mustard) is resistant to aphids.
- (iv) High-yielding and improved quality of crop plant. e.g., Atlas 66 used as a donor for developing wheat varieties with improved protein content.

## **Short Answer Type Questions**

### **1. You are planning to set up a dairy farm. Describe the various aspects you would consider before you start the venture.**

**Ans:** The following aspects are required to be considered

- (i) Good breeds with high-yielding potential should be kept.
- (ii) Cattle should be fed scientifically with good quality and quantity of fodder.
- (iii) Animal shed should be kept clean, away from dirt and pollution.
- (iv) Cattle and handlers should be kept in a hygienic condition.
- (v) Regular visit by veterinary doctors with proper records is needed.
- (vi) Cattle should be housed well with adequate water, and conditions should be disease-free.

**2. It is said that diseases are spreading faster due to globalisation and increased movement of people. Justify the statement taking the example of the H<sub>5</sub>N<sub>1</sub> virus.**

**Ans:** The avian flu (also known as bird flu) is a current and significant issue affecting the global environment as well as the health of millions of people worldwide.

- The H<sub>5</sub>N<sub>1</sub> virus (influenza-A) occurs mainly in birds, is highly contagious among them, and can be deadly.
- The major global environmental issue that plays a large role in the advancement of the H<sub>5</sub>N<sub>1</sub> avian influenza virus is globalization. i.e., increasing integration of countries.
- Through globalisation, the progression of the H<sub>5</sub>N<sub>1</sub> avian influenza virus occurs around the world at a pace faster than scientists can anticipate, and also, technology and research cannot possibly keep up.
- Globalisation will allow the H<sub>5</sub>N<sub>1</sub> avian influenza virus to travel to various parts of the world without impediment.
- Once it has developed the ability to spread easily from human to human, the major concern becomes the travel of individuals around the world, particularly air travel.
- Through air travel, an infected individual could infect dozens of people during their movement; those newly infected individuals would, in turn, infect dozens more, and so on and so forth.

**3. Explain the concept of the blue revolution.**

**Ans:** The term 'Blue Revolution' refers to the remarkable emergence of aquaculture as an important and highly productive agricultural activity.

Aquaculture refers to all forms of active culturing of aquatic animals (including fish) and plants, occurring in marine, brackish or freshwater.

**4. A farmer was facing the problem of low yield from his farm. He was advised to keep a beehive in the vicinity. Why? How would the beehive help in enhancing yield?**

**Ans:** Beekeeping or apiculture is an important enterprise of agriculture concerned with the maintenance of hives of honeybees for the commercial production of honey and wax. Beekeeping is a low-investment, less problematic, and highly profitable cottage industry.

The beehives, when kept in the fields of sunflowers, Brassica, apples, and pears,

increase the pollination efficiency of flowering plants and improve the yields.

**5. Lifestyle diseases are increasing alarmingly in India. We are also dealing with large-scale malnutrition in the population. Is there any method by which we can address both of these problems together?**

**Ans:** To address both these problems, biofortification can be done. This area focuses on improving food quality with respect to protein, oil, vitamins, micronutrients, and mineral content. The oils need to be rich in omega-3 fatty acids, which are good for the heart.

Similarly, proteins should have more lysine and tryptophan (essential amino acids). Many varieties of maize, carrots, and spinach have been released that fulfill the above criteria.

**6. How can we improve the success rate of fertilisation during artificial insemination in animal husbandry programmes?**

**Ans:** To improve the chances of successful production of hybrids, many means are used. One such programme is called MOET or Multiple Ovulation Embryo Transfer. During this procedure, a cow is given hormonal treatment so that more than one ovule (6-8 eggs) is produced per cycle.

After mating or artificial insemination, the embryos in an 8 to 32-celled state are transferred to different surrogate mothers. The method has been successfully used for cattle, sheep, buffalo, etc.

**7. What is meant by germplasm collection? What are its benefits?**

**Ans:** The collection of all the diverse alleles of all the genes of a crop plant is called a germplasm collection. It is of great benefit in plant breeding programmes as it offers, to the breeders, the entire set of genes and alleles and the characteristics which a plant expresses.

The breeder selects the most favourable characters of a particular gene, manipulates it, and transfers it to a desirable parent.

**8. Name the improved characteristics of wheat that helped India to achieve green revolution.**

**Ans:** The Improved characteristics of wheat that helped India achieve the green revolution are

- (i) Semi-dwarf nature

- (ii) Quick yielding feature
- (iii) High-yielding feature
- (iv) Disease resistance

**9. Suggest some of the features of plants that will prevent insect and pest infestation.**

**Ans:** Features of plants that will prevent insect and pest infestation are

- (i) Increasing hair growth on aerial parts of plants.
- (ii) Rendering the flowers nectarless.
- (iii) Enabling plants to secrete insect-killing chemicals (toxins).

**10. It is easier to culture plant cells in vitro as compared to animal cells. Why?**

**Ans:** It is easier to culture the plant cells in vitro as compared to animal cells because the plant cells have the property to grow into a new plant. This property of a plant cell is termed totipotency. This ability is limited in animal cells.

**11. The culture medium (nutrient medium) can be referred to as a ‘highly enriched laboratory soil’. Justify the statement.**

**Ans:** Culture medium is a highly enriched laboratory soil as it provides all the requirements, e.g., carbon source such as sucrose and inorganic salts, vitamins, amino acids, and growth regulators like auxins and cytokinins, etc., to the growing plant.

**12. Is there any relationship between dedifferentiation and the higher degree of success achieved in plant tissue culture experiments?**

**Ans:** Yes, when a cell dedifferentiates once, it gets regressed to its embryonic stage and then can again differentiate into any form of tissue. So, the plant tissue culture can be more successful as any kind of tissue can be produced even from differentiated cells.

**13. Give me a living cell of any plant and I will give you a thousand plants of the same type”. Is this only a slogan, or is it scientifically possible? Write your comments and justify them.**

**Ans:** It is scientifically possible to grow thousands of plants from a living cell of any plant, and this process is called micropropagation. The property of plant cells that helps them to grow into a new plant is totipotency.

Micropropagation is the use of plant cell culture to regenerate a large number of plants.

This results in genetically identical plants and is also called clonal propagation. Hence, the desirable characters are kept constant for many generations. Micropropagation is widely used in forestry and in floriculture. Plants can be obtained throughout the year under controlled conditions.

**14. What is the difference between a breed and a species? Give an example for each category.**

**Ans:** A breed is a specific group of animals or plants having a homogenous appearance, behaviour and other characteristics that distinguish it from other animals or plants of the same species, e.g., Afghan shepherd, American bulldog are breeds of dog.

Species is one of the basic units of biological classification and a taxonomic rank. It can be defined as the largest group of organisms capable of interbreeding and producing fertile offspring. e.g., lion, cow, dog are species.

**15. Plants raised through tissue cultures are clones of the ‘parent’ plant. Discuss the utility of these plants.**

**Ans:** Plants raised through tissue culture are very useful because they are an identical copy of the parent plant. This is of great use when desirable traits of the parent plant have to be maintained.

**16. Discuss the importance of testing of new plant varieties in a geographically vast country like India.**

**Ans:** Before the new plants are generated through plant breeding programs, they need to be evaluated for their yield and other agronomic traits of quality, disease resistance, etc. The testing is done on the farmers’ field for at least three growing seasons, at different 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, known as a check or reference cultivar.

**17. Define the term ‘stress’ for plants. Discuss briefly the two types of stress encountered by plants.**

**Ans:** Stress for plants can be defined as any external factor that negatively influences plant growth, productivity, reproductive capacity, or survival. This includes a wide range of factors which can be broadly divided into abiotic or environmental stress factors like salinity, extreme temperatures, drought, etc., and biotic or biological stress

factors.

**18. Discuss natural selection and artificial selection. What are the implications of the latter on the process of evolution?**

**Ans:** Natural selection is a gradual, non-random process by which biological traits become either more or less common in a population as a function of differential reproduction of their bearers. It is a key mechanism of evolution.

In natural selection, the environment acts as a sieve through which only certain variations can pass.

Artificial selection is a process in which animals and plants with desirable traits are considered by human breeders and favoured for reproduction. It is an artificial mechanism by which evolution can occur.

It is also called selective breeding as it promotes traits that suit human preferences. In contrast to natural selection, here the evolution is intentional or guided.

**19. Discuss briefly how pure lines are created in animal husbandry.**

**Ans:** When breeding is between animals of the same breed, it is called inbreeding. If we want to evolve a pure line in any animal, inbreeding (for 4-6 generations) is necessary. It also helps in the accumulation of superior genes and the elimination of less desirable genes by increasing homozygosity.

**20. What are the physical barriers of a cell in the protoplast fusion experiment? How are the barriers overcome?**

**Ans:** The Cell wall is the most important physical barrier in protoplast fusion experiments. This can be overcome by treatment with enzymes like cellulase and pectinase, which can digest the cell wall and liberate the naked protoplast surrounded only by the cell membrane.

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

**Ans:** Maize, wheat, rice, bathua, spinach, and pulses have biofortified varieties. Maize hybrids have twice the amount of amino acids, a fortified wheat variety has high protein content, fortified rice variety has high quantities of iron.

Consumption of such biofortified foods will enrich the nutritive value of our common foods and will vastly improve public health.

Instead of consuming different food items for obtaining different nutrients, if 2 or 3

nutrients can be incorporated into a single crop, it would offer enormous benefits to human beings and may even help to overcome several nutrient deficiency disorders latent in our country.

## 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 programmes are carried out systematically worldwide in government institutions and commercial companies.

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

(i) 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 (followed by their evaluation for their characteristics) is a prerequisite for effective exploitation of natural genes available in the populations.

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

(ii) Evaluation and Selection of Parents The germplasm is evaluated to identify plants with a desirable combination of characters. The selected plants are multiplied and used in the process of hybridisation. Purelines are created wherever desirable and possible.

(iii) Cross Hybridisation Among the Selected Parents. The desired characters have to be combined from two different plants (parents), e.g., the 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 the male parent have to be collected and placed on the stigma of the flowers selected as the female parent.

Also, the hybrids don't need to combine the desirable characters; usually, only one in a few hundred to a thousand crosses shows the desirable combination.

(iv) 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.

(v) 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. After evaluation, the variety can be released for the farmers.

**2. (a) The shift from grain to meat diets creates more demands for cereals. Why?**

**(b) A 250 kg cow produces 200 g of protein per day, but 250 g of *Methylophilus methylotrophus* can produce 25 tonnes of protein. Name this emerging area of research. Explain its benefits.**

**Ans:** (a) The shift from grain to meat diets creates more demand for cereals, as it takes 3-10 kg of grain to produce 1 kg of meat by animal farming.

(b) This research is related to single-cell protein.

Microbes are being grown on an industrial scale as a source of good protein. Microbes like *Spirulina* can be grown easily on materials like wastewater from potato processing plants (containing starch), straw, molasses, animal manure, and even sewage, to produce large quantities, and can serve as food rich in protein, minerals, fats, carbohydrates, and vitamins. Such utilisation also reduces environmental pollution.

**3. What are the advantages of tissue culture methods over conventional method of plant breeding in crop improvement programmes?**

**Ans:** As traditional (conventional) breeding methods failed to keep pace with demand and to provide fast and efficient systems for crop improvement, another technology called tissue culture emerged. The advantages of tissue culture over conventional breeding are as follows

- (i) It can be used to produce a large number of plantlets within a short period by micropropagation.
- (ii) All cells in the culture are derived from a single explant by mitotic division; therefore, all have a similar genotype and constitute a clone.
- (iii) Tolerance to stress can be obtained by providing pollutants, toxins, salts, etc., in the culture medium in increasing dosage. The surviving healthy cells are selected for raising resistant plants.
- (iv) Virus-free plantlets can be obtained by meristem culture.
- (v) Embryos that do not survive inside seeds can be grown by tissue culture to form new plants.

**4. ‘Modern methods of breeding animals and plants can alleviate the global food shortage’. Comment on the statement and give suitable examples.**

**Ans:** With the ever-increasing population of the world, the enhancement of food production is a major necessity. Modern biological principles, as applied to animal husbandry and plant breeding, have a major role in our efforts to increase food production. These modern techniques include embryo transfer technology and tissue culture techniques.

Multiple Ovulation Embryo Transfer Technology (MOET) is a programme for herd improvement in animals like cattle, sheep, rabbits, buffaloes, mares, etc.

High milk-yielding breeds of females are bred with high-quality meat-yielding (meat with less lipid) bulls to increase herd size. It ensures a good quality of progeny. It is also an economic and time-saving process to obtain the desirable progeny.

The procedure for MOET is as follows

- (i) A cow is administered hormones with FSH-like activity to induce follicular maturation and super-ovulation.
- (ii) The cow produces 6-8 eggs instead of one egg produced normally.
- (iii) It is now either mated with an elite bull or artificial insemination is carried out.
- (iv) When the fertilised eggs attain the 8-32 cell stage, they are non-surgically removed and transferred to a surrogate mother.
- (v) The genetic mother can now be superovulated.

Modern methods in plant breeding involve following

- (i) Tissue culture is an in vitro technique of regeneration of a whole plant from any part of a plant (explant) by growing it on culture medium under aseptic conditions.

- (ii) Biofortification is the method for developing crops with higher levels of vitamins, minerals, proteins, and healthier fats to improve public health.
- (iii) Single-cell protein is an alternative protein source for animal and human nutrition from certain beneficial microorganisms like Spirulina.

**5. Does apiculture offer multiple advantages to farmers? List its advantages if it is located near a place of commercial flower cultivation.**

**Ans:** Yes, apiculture offers many advantages to farmers, such as

- (i) Honey produced by honeybees is a food of high nutritive value.
- (ii) It is used in the indigenous system of medicine.
- (iii) Honeybee also produces beeswax, which is used in the preparation of cosmetics and polishes of various kinds.

If apiculture is done near a place of commercial flower cultivation, it offers several advantages. Bees are the pollinators of many crop species such as sunflowers, Brassica, apple, and pear. Keeping beehives in crop fields during the flowering period

- (i) Increases pollination efficiency.
- (ii) Improves the yield, which is beneficial both from the point of view of crop yield and honey yield.

**6. (a) Mutations are beneficial for plant breeding. Taking an example, justify the statement.**

**(b) Discuss briefly the technology that made us self-sufficient in food production.**

**Ans:** (a) It is possible to induce mutations artificially in plants through use of chemicals or radiation (like gamma radiation), and then selecting and using those plants that have the desirable character as a source in breeding.

This process is called mutation breeding. In the mung bean, resistance to yellow mosaic virus and powdery mildew was induced by mutations.

(b) Traditional farming can only yield a limited biomass, as food for humans and animals.

Better management practices and an increase in agricultural land area can increase yield, but only to a limited extent. Plant breeding as a technology has helped increase production to a very large extent.

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

This technology has given support to the green revolution, which was responsible for

not merely meeting the national requirements in food production, but also helped us to export it.

### **7. Discuss how the property of plant cell totipotency has been utilised for plant propagation and improvement.**

**Ans:** Plant cell totipotency can be utilised for plant propagation and improvement

- (i) By application of these methods, it is possible to achieve propagation of a large number of plants in a very short time. Plants like tomato, banana, apple, etc., have been produced on a commercial scale.
- (ii) Healthy plants can be recovered from diseased plants (by micropropagation). This is done by removing the meristem, which is disease—free, and growing it in vitro. This has been done in banana, sugar cane, potato, etc.

### **8. What are three options to increase food production? Discuss each, giving the salient features, merits, and demerits.**

**Ans:** Traditional farming can only yield a limited biomass as food for humans and animals. Better management practices and increased agricultural land can increase yield, but only to a limited extent. The following are the three options to increase food production

**(a) Single Cell Protein:** The biomass obtained from microorganisms can be treated or processed in industry to be used as food and is called single-cell protein.

- **Merits of Single-Cell Proteins**
  - (i) Its production reduces pollution as it uses organic wastes and industrial effluents.
  - (ii) It provides a protein-rich diet.
  - (iii) It fulfills the demand for protein in the human diet and takes off the pressure on the agricultural system.
- **Demerits of Single-Cell Protein**
  - (i) Sometimes, the microbial biomass, when taken as a dietary supplement, may lead to allergic reactions.
  - (ii) Many types of microorganisms produce substances that are toxic to humans and also to animals.

**(b) Biofortification:** It is the method for developing crops with higher levels of vitamins, minerals proteins and healthier fats to improve public health.

- **Merits of Biofortification**

- (i) It can increase yields grown on the same or less acreage.
- (ii) It can potentially improve nutritional value or other health benefits.

- **Demerits of Biofortification**

- (i) Its successful implementation into society requires safe delivery systems, stable policies, and appropriate social infrastructures.
- (ii) It continued with financial support also.

(c) Tissue-Culture: It is an in vitro technique for the regeneration of a whole plant from any part of a plant by growing it on culture medium under aseptic conditions.

- **Merits of Tissue Culture**

- (i) A large number of plants can be grown in a short time.
- (ii) Disease-free plants can be multiplied.
- (iii) Seedless plants can be multiplied
- (iv) The plants where sexual reproduction is absent may undergo somatic hybridisation.

- **Demerits of Tissue Culture**

- (i) It requires a great expense because it needs the latest techniques in the laboratory.
- (ii) It requires acclimatisation of plants grown by tissue culture to the external environment.
- (iii) It requires special expertise.

BioSmartNotes