Improvement in Food Resources

Methods of Crop Variety Improvement

Food Resources

Food is one of the basic necessities to survive in this world. It can be defined as any substance from which a living organism obtains nutrients. Nutrients are chemical compounds like proteins, carbohydrates, vitamins, fats and minerals, which are required for the overall growth and development of an organism. Hence, food plays a major role in the survival of organisms.

What are the different sources of food?

Food can be any substance from which nutrients are obtained. In general, these include **agricultural** and **animal husbandry**

products. A wide range of agricultural food is commercially available. These include rice, wheat, vegetables and fruits. Similarly, animal husbandry also provides a variety of substances as food. These include meat, fish, egg and milk. All such food items are rich in nutrients such as proteins, carbohydrates, fats and vitamins.

- The practice of growing plants at a place is known as **agriculture**.
- Plants grown on a large-scale for food are known as **crops**.

Nutrient	Plant source	Animal source
Carbohydrates	Cereals such as wheat, rice, maize, millets, sorghum, etc.	Milk (contain significant amount of carbohydrate)
Proteins	Pulses such as soya bean, gram (*chana*), black gram, green gram (*moong*) peas, pigeon pea (a*rhar*), lentil (*masoor)*, etc.	Egg white, fish, meat, etc.
Fats or lipids	Ground nuts, sesame, castor, mustard, sunflower, etc.	Animal fat, egg yolk, etc.
Vitamins and minerals	Vegetables, spices, fruits	-

Apart from these food crops, there are certain crops that are raised as fodder for **livestock**

. These include *berseem*, oats and *sudan* grass.

Seasonal Crops

You must have observed that different crops are grown in different seasons. **Do you know why?**

This is because each crop requires a different climatic condition, temperature range and **photoperiod**

for its growth and to carry out its life cycle. So, some crops are grown in the rainy season while others are grown during winters. Let us study how crops are classified on the basis of the seasons in which they are grown.

- **Kharif crops:** These crops are sown in the rainy season (or *kharif* season) and harvested during autumn. The term 'kharif' means 'autumn' in Arabic. They are cultivated between June and October. These crops are dependent on the southwest monsoon. Examples of *kharif* crops include paddy, soya bean, pigeon pea, maize, cotton, green gram and black gram.
- **Rabi crops:** These crops are sown in the winter season (or rabi season) and harvested during spring or summer. The term 'rabi' means 'spring' in Arabic. They are cultivated between November and April. They are not dependent on monsoon. They get water from percolated underground water. Examples of *rabi* crops include wheat, pea, mustard and linseed. Some rabi crops like pea are harvested early as they get ready early.
- **Zaid crops** are grown in the short duration between the rabi and kharif crop seasons, mainly between March and June. These crops are grown on irrigated lands so they do not have to wait for the monsoon rains. Zaid crops include seasonal fruits and vegetables like bitter gourd and watermelon.

Improvement of Food Resources

Why do we need to improve the production of food resources?

India's population is increasing alarmingly. The current population of India has crossed one billion and is still growing. To meet the ever-increasing demand for food, we need more than a quarter of a billion tonnes of grain every year. This can be achieved by farming more lands and through systematic and proper management of production and distribution of food. However, in India, the agricultural land has already been cultivated intensively and there is no fresh land available for agricultural purposes. Therefore, it is necessary to increase the yielding efficiency of both crops and livestock.

An increase in food production techniques does not mean that we should use our natural resources extensively. Doing so would destroy the balance of natural resources. So, it is important to keep in mind that food production should be increased without disturbing environmental balance.

The yielding efficiency of crops can be improved:

- By choosing appropriate seeds for planting

- By undertaking different cropping patterns and seasonal cultivation of crops to assure a maximum **yield**
- By nurturing crop plants through manipulation of soil conditions and management of water requirement
- By protecting growing crops and minimizing loss of harvested plants

Thus, the major group of activities for obtaining a good crop yield can be classified as follows:

- Improvement of crop variety
- Improvement of production efficiency
- Management of crop protection

Know More

Let us read about some of the measures that have been taken to increase the quantity and the quality of food resources.

- **Green revolution**:It contributed to increasing food-grain production from the same area of land through various efforts. It was aimed at meeting the food demands of the ever-increasing population. It involved various plant hybridization experiments to produce high-yielding varieties of seeds. It also involved the introduction of various new technologies, e.g., use of fertilizers, irrigation, etc.
- **White revolution**:It contributed to the growth of milk production in India.
- **Blue revolution**:It is contributed to increase the production of both marine and freshwater resources. It was started in 1973 in India. It involved the management of water resources to achieve drinking-water and crop-irrigation security. This resulted in the emergence of fish culture as a highly productive agricultural activity.
- **Silver revolution**:It was aimed at increasing egg production with the help of medical science and more protein-rich food for hens.

Know Your Scientist

'Father of the Green Revolution'

Norman Borlaug (1914- 2009) was an American agronomist. He was instrumental in the introduction of high-yielding varieties of seeds in combination with modern agricultural production techniques in Mexico, Pakistan and India. He is credited with saving over a billion people worldwide from starvation.

'Father of the Indian Green Revolution'

M. S. Swaminathan (born 1925) is an Indian geneticist. He is known for his leading role in the green revolution of India.

Criteria for Improved Crop Varieties

For new varieties of crops to be accepted, it is necessary that the varieties produce high yields under the different conditions found in different areas. Cultivation practices and crop yield are related to weather, soil quality and availability of water. India has a wide geographical diversity. Certain regions are very fertile, while others are dry and experience very little rainfall. Drought-like weather conditions and flood situations are unpredictable. So, only those crop varieties are useful which can be grown in these diverse conditions.

Farmers need to be provided with good quality seeds of a particular variety, i.e., the seeds should all be of the same variety and germinate under the same conditions. Otherwise, when seeds are grown in a particular condition, only some of them will germinate and the remaining will not.

Now, you must have got some idea about why there is a need for improving crop yield. Let us now learn about the desired **agronomic**

characters for which the existing crop varieties need to be improved.

Characteristics of a Good Crop Variety

A good crop variety should possess the following characteristics.

- **Disease resistance**: The crop should be resistant to most diseases. This improves the net yield of the crop annually.
- **Response to fertilizers**: The crop should respond to fertilizers. Fertilizers serve as a source of nutrients to plants. They induce a healthy plant development, thereby increasing crop productivity.
- **High-yielding capacity**: Another desirable agronomic character is the high-yielding capacity of a crop variety. Poor yield lowers the annual crop production.

- **Insecticide tolerable**: Crop plants are treated with various insecticides to prevent the harmful effects of insects and pests. Intolerance to such insecticides destroys the plants. As a result, the net production comes down.
- **Improved quality**: The quality of one crop differs from that of another. For example, protein quality is important in pulses, oil quality in oilseeds, etc.
- **Drought resistance**: Another important agronomic character is drought resistance. Unavailability of water can destroy crops. Drought-resistant crops can survive even when water availability is low.
- **Biotic and abiotic resistance**: A variety of biotic factors such as pests, nematodes and abiotic factors such as drought, water salinity and temperature, can also reduce the net crop production. Resistance to such factors increases crop productivity.
- **Wider adaptability**: The crop should have wider adaptability so that it can be grown under different climatic conditions.
- **Change in duration of maturity**:The crop should have a shorter duration of maturity. This makes the harvesting process easier and also reduces the loss that occurs during harvesting. The economical value of the crop rises in consequence.

Improvement of Crop Variety

It is natural that a single variety of crop does not possess all the desirable characteristics. Thus, it is necessary to improve the crop variety. Two fundamental approaches are adopted to get the desirable characteristics in a single variety. These are:

- Hybridization or plant breeding
- Genetic engineering

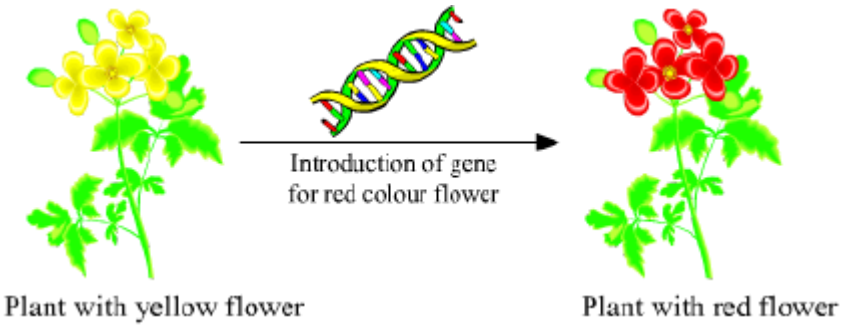
Hybridization

Hybridization is the process in which two genetically dissimilar individuals (varieties) are purposely crossed to get a hybrid variety. In this way, characteristics from both the parent varieties can be obtained in the hybrid variety. This process is also known as **plant breeding**. Hybridization can be:

- Inter-specific, i.e., between two different **species** of a plant Inter-generic, i.e., between two **genera**

- Inter-varietal, i.e., between different plant varieties

Genetic engineering



Genetic engineering is the process in which the gene for a particular character is introduced inside the chromosome of a plant cell (or individual). The introduction of this gene in the individual leads to the production of a **transgenic plant**.Such a transgenic plant exhibits the character of the newly introduced gene.

Nutrient Management

Crop Production Management

Poorly cultivated crops give a low yield. For a higher yield, the proper management of crops is essential. This management of crop production includes activities such as adopting appropriate cropping patterns and providing proper nutrients and water to the growing crops.

Crop production management varies from farmer to farmer. Rich farmers having access to more money, land, the latest technology, etc., can adopt various measures during the cycle of crop production to increase their yield. This, however, is not the case with poor farmers.

Crop production management includes:

- Nutrient management
- Manures and fertilizers
- Organic farming
- Biofertilizer
- Irrigation
- Rivers
- Canals
- Sprinkler system
- Drip irrigation, etc.
- Cropping patterns
- Mixed cropping
- Inter cropping
- Crop rotation

Nutrient Management

You have learned previously how nutrients are essential for the growth and development of our body. In the same way, nutrients are required for the proper growth and functioning of plants. The net yield can be greatly enhanced by making better nutrients available to crop plants.

Nutrients that are required in relatively large quantities for the growth and development of plants are called **macronutrients**. These nutrients are six in number. There are certain other nutrients that plants require in relatively low quantities. These are called **micronutrients** and are seven in number.The given table lists the various nutrients required by plants.

Sources	**Nutrients**	
Air	Carbon and oxygen	
Water	Hydrogen and oxygen	
Soil	**Macronutrients**	**Micronutrients**
	Nitrogen, potassium, phosphorus, calcium, magnesium and sulphur	Iron, manganese, boron, zinc, copper, molybdenum and chlorine

Note: In addition to the sixteen essential elements named above, there are certain other beneficial elements such as sodium, silicon, cobalt and selenium. These are required by higher plants.

Solved Examples

Example 1: **How can we know that a particular nutrient is essential for a plant?**

Solution: The following requirements need to be fulfilled for an element to qualify as an essential plant nutrient.

• The plant cannot complete its life cycle in the absence of the element.

• The deficiency of the element can be prevented or corrected only by supplying the element to the plant.

• The element has a direct influence on the nutrition and metabolism of the plant.

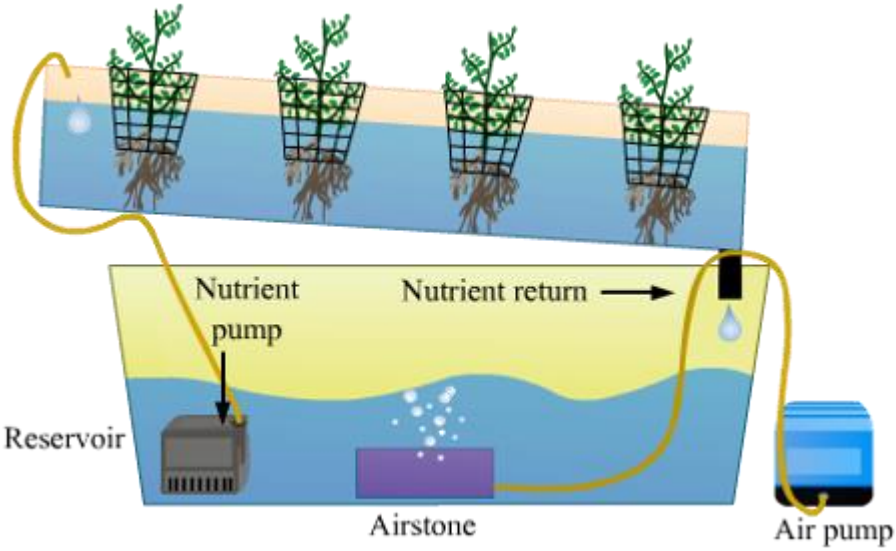
Hard

Example 2: **What are the primary elements? How does their deficiency affect plants?**

Solution: Plants need three macronutrients in the greatest amounts. These are nitrogen, potassium and phosphorus (NPK). These three elements are known as the primary elements.

The deficiency of the primary elements can adversely affect some important plant life processes such as reproduction. Their deficiency can also make plants more susceptible to diseases. Consequently, the production capacity of the plants gets reduced.

Know More



Hydroponics

Hydroponics refers to the process of growing plants in the absence of soil, with their roots immersed in a nutrient solution.

Advantages

This technique helps in determining the role of each macronutrient and micronutrient in the growth of plants, the amount in which each nutrient is required and the diseases caused due to the excess or deficiency of these nutrients.

Disadvantages

Large volume of nutrient solution is required for this process. Great attention needs to the paid to the plants being grown in this way. A little carelessness can alter the pH and nutrient concentration, thereby affecting the growth of the plants.

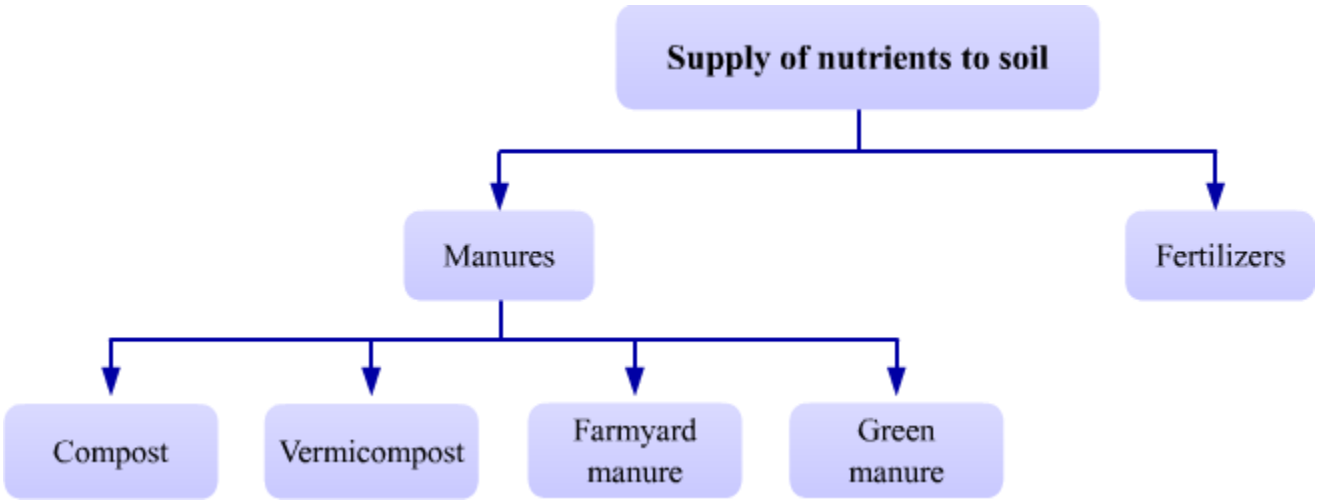
Manures and Fertilizers

The three macronutrients namely, nitrogen, potassium, and phosphorus (NPK) are required by plants in greater amounts. These are known as primary elements. Deficiency of these nutrients can affect some important life processes such as reproduction. It can also

make plants more susceptible to diseases. Hence, the crop production capacity will be reduced. Availability of nutrients can be improved by providing nutrients to the soil.

- Manure
- Fertilisers

Thus, soil can be replenished and the lost nutrients can be retrieved by adding **manures and fertilizers**.



Manures

Manures are decomposed animal and plant wastes. Manures are known to have a large quantity of organic materials and a little amount of plant nutrients.

Composition

Manures are composed of a large quantity of organic matter. Ammonia, nitrate, organic substances, etc., are the predominant organic matter found in manures. Manures contain variety of nutrients such as nitrogen, phosphorus, potassium.

Advantages

- Manures increase the water-holding capacity of soil.
- These mixtures are rich in organic matter. Their addition to soil makes it fertile, thereby promoting the growth of plants.
- Generally, biological wastes are used as manures. These wastes are environment friendly unlike chemical fertilizers.

Disadvantages

- Since manures contain only a small quantity of nutrients, they are needed in large amounts.
- Manures are bulky and, hence, inconvenient to store and transport.

Manure Types

Based on the kind of biological material present, manures can be classified as **compost, vermicompost, green manure and farmyard manure**.

- **Compost and vermicompost**:Composting is the process in which farm waste materials such as **livestock**

excreta (e.g., cow dung), vegetable waste, domestic waste and **sewage**

waste are decomposed in pits to release the organic matter and nutrients. When composting is done using earthworms to fasten decomposition, the process is called vermicomposting.

- **Green manure**: It refers to certain plants (such as sun hemp or *guar*) that are grown for a specific period of time and then incorporated into soil by **ploughing**

. This process is carried out before sowing the crop seeds. The green manure (also known as 'cover crop') enriches soil by increasing the percentage of organic matter in soil. It mainly adds nitrogen and phosphorus to soil.

- **Farmyard manure**:It is the decomposed mixture of cattle excreta and urine, litter and leftover organic matter such as fodder. It is highly rich in nutrients.

Fertilizers

Fertilizers are plant nutrients used for increasing soil fertility. They are manufactured commercially from chemicals and are marketed in a concentrated form. They can be organic or inorganic in nature. Fertilizers ensure healthy growth and development of plants by providing them with essential nutrients such as nitrogen, phosphorus and potassium. Different guidelines (such as dosage, time and post-addition precautions) need to be followed while adding fertilizers to soil.

Types

Fertilizers are divided into groups based upon the nutrients they supply.

- **Nitrogenous fertilizers**: These fertilizers supply nitrogen. Examples include urea and ammonium nitrate.

- **Potassic fertilizers**: These fertilizers supply potassium. Examples include potassium chloride and potassium sulphate.

- **Complex fertilizers**: These fertilizers supply at least two or more nutrients. Examples include nitrophosphate, ammonium phosphate and NPK (nitrogen, phosphorus and potassium).

Fertilizers: Advantages and Disadvantages

Advantages and disadvantages of using fertilizers in relation to using manures.

Advantages

- Fertilizers are mostly inorganic compounds that can readily dissolve in water. So, their constituent nutrients can be quickly absorbed by plants.
- They are good sources of nitrogen, phosphorus and potassium. They contain much higher quantities of nutrients in comparison to manures and are therefore required in very small amounts. However, they are good only for short-term use.
- They are easy to use, store and transport.

Disadvantages

- Fertilizers get washed away along with irrigation water, which then flows into nearby water bodies to cause water pollution.
- Their continuous use harms useful or **symbiotic**soil microorganisms.
- Their excessive use may reduce soil fertility and increase soil acidity.
- They cannot **replenish** the organic matter of soil.To get an **optimum** yield, it is necessary to use a balanced combination of manures and fertilizers. Manures are better in the long run because they contain organic materials and do not harm any life.

Solved Examples

Example 1: **Differentiate between manures and fertilizers.**

Solution:

Manures	Fertilizers
Manures are natural substances formed by the decomposition of organic (animal and plant) wastes.	Fertilizers are man-made substances. They can be organic or inorganic in nature.

They contain essential nutrients such as nitrogen, phosphorus and potassium only in small amounts.	They are very rich in essential plant nutrients.
They add a great amount of organic matter in the form of humus to soil. This improves soil fertility and increases the water-holding capacity of soil.	They do not add humus to soil.
They are not nutrient-specific. They remove the general deficiencies of soil.	They are nutrient-specific (e.g., potassic fertilizers).
Since they contain nutrients in small quantities, they are needed in large amounts.	They contain large quantities of nutrients, so they are needed in very small amounts.
They are bulky and, hence, inconvenient to store and transport.	They are compact and concentrated, so can be easily used, stored and transported.
They are cheap and prepared in rural homes or fields	They are expensive and prepared in factories.
They do not cause any harm because they are organic in nature.	They get washed away with irrigation water, which then flows into nearby water bodies to cause water pollution. Their continuous use harms useful or symbiotic soil microorganisms.

Organic Farming

Organic farming is the form of farming that involves minimal or zero use of environmental pollutants such as chemicals (fertilizers, pesticides, herbicides) and genetically-modified organisms.

Organic manures, farm wastes (such as excreta), healthy cropping systems (mixed cropping, intercropping and crop rotation) and bio-pesticides (such as *neem* and turmeric) are utilized in this method of farming. Organic farming also involves the use of **bio-agents**

(such as a **culture**
of blue-green algae) in the preparation of bio-fertilizers.

Organic farming aims at providing nutrition to plants, managing pests and producing a good yield without using anything that can harm the environment. The food items produced in this type of farming are called **organic food**.

Bio-fertilizers

Bio-fertilizers are the organisms that increase soil fertility. These are introduced to seeds, roots or soil to mobilize the availability of nutrients by their biological activity. Unlike chemical fertilizers, bio-fertilizers are extremely beneficial in enriching soil with organic nutrients. Thus, these are good supplements to the conventional fertilizers. *Rhizobium*, *Azotobacter* and blue-green algae are some common examples of organisms used as bio-fertilizers. Bio-fertilizers are cost-effective and eco-friendly.

Crop Production Management through the System of Irrigation

Irrigation

Irrigation is the process whereby the water requirement for agricultural and other activities is met from sources other than rainwater, for example, canals, wells and reservoirs.

Why do plants require water?

- Plants require water for carrying out the process of germination. In the absence of water, germination is affected.
- Water is also required for transporting nutrients (in a dissolved state) from one plant part to the others.
- Water is essential for plants to perform photosynthesis.
- Water protects crop plants from frost and hot currents.

Sources of water for irrigation

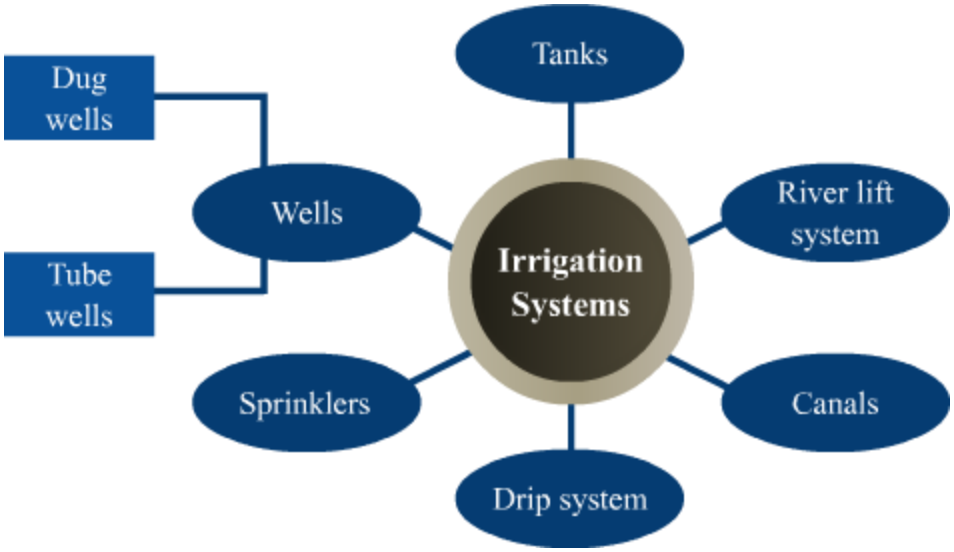
- River (most commonly used)
- Ground water
- Canals
- well/ Tubewell

Factors determining the choice of irrigation system

- Nature of crop plants (Irrigation based on this factor is called crop-based irrigation.)
- Nature of soil (Irrigation based on this factor is called soil-based irrigation.)
- Availability of water and the amount of rainfall received (For example, a region receiving scanty rains will be devoid of groundwater. So, tube wells and dug wells cannot be chosen as systems of irrigation in this region. A canal system of irrigation will be opted for instead.)

Types of Irrigation System

Several irrigation systems have been adopted to supply water in agricultural lands. These are as follows:



Concept Builder

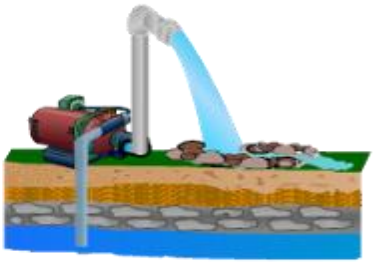
Watershed Management

Watershed management refers to the sustainable distribution and use of water resources and their minimal wastage. It helps recover sources of water and enables water to be distributed according to need. It involves implementation of plans, projects and programs to enhance and sustain a watershed and its functions. Thus, watershed management facilitates proper distribution of water resources so that farmers have adequate quantity of water for irrigating their lands.

Irrigation Systems

Wells: Dug wells and tube wells are used for supplying water to fields for irrigation. A dug well comprises a hole dug in the ground, which reaches up to the water table. The water is lifted with the help of a pulley. A tube well consists of a long wide tube driven deep down the water table to pump up the ground water and to release it in fields as per the requirement.

Dug well



Tube well

Canals: These are man-made water channel systems used for delivering adequate water to fields for irrigation. Canals are connected with water reservoirs or rivers. The main canal is divided into many branches that supply water.

Irrigation Systems

Sprinkler system: This system is useful in watering land that is uneven and does not have sufficient supply of water. It consists of a series of perpendicular pipes with rotating nozzles on top. These pipes are joined to the main pipeline at regular intervals. Water flows through the pipes at a high pressure and gets sprinkled onto the land. This method is useful in irrigating sandy soil.

Drip system: In this system, water is supplied to plant roots drop by drop. Water is supplied to the plants directly with the aid of small pipes with holes. This is the best technique to water plants as it prevents wastage of water.

Solved Examples

Example 1: **If there is low rainfall throughout the year in an area, what measures will you suggest to the farmers in the area for better cropping?**

Solution: In case of scanty rainfall, farmers can resort to systems of irrigation that best suit their needs and location. Farming lands situated on the outskirts of cities can be irrigated by the sprinkler and drip irrigation methods. Canals can be used for irrigating fields that are situated near a river. If the farming lands are in villages, then they can be irrigated by dug wells and tube wells.

River Lift System

In this system, river water is drawn directly from the source and is supplied to fields located close by. This system is followed in regions where canals are irregular and insufficient because of low water levels in the source river.

The river lift system makes use of a simple water-powered pump. The running force of the river is used for moving the waterwheel, which in turn induces movement in the attached system of gears. This rotates the chains of containers that collect water from the river and pour it on the aqueduct situated above the river. The system can work twenty-four hours a day and no fuel is needed for its functioning.

Advantages of Irrigation

Some advantages of irrigation are:

- Increases crop productivity
- Ensures continuous supply of water to fields
- Maintains the fertility of land
- Increases agricultural practice in regions with low rainfall
- Improve ground water storage

Harmful effects of excess water:

- Excess water reduces the supply of air in soil spaces. Plant roots die due to this lack of oxygen.

- Sometimes crops get damaged because of natural calamities like untimely rains and hailstorms. Hailstorms can result in the fall of mature crop plants (at grain maturation stage, as in the case of wheat). This fall of mature crops is called lodging.

- Water logging is a condition when the water supplied to a field is not properly drained. Excess water accumulates in the area around roots and, thus, damages the crop plants.

Cropping

Production Management

The cropping systems of a region are decided by a number of soil and climatic parameters. These determine the type of crop or set of crops for cultivation. Nevertheless, at the farmers' level, potential productivity and monetary benefits act as guiding principles while opting for a particular crop or cropping system.

Have you noticed different crops growing together in the same field? Do you know the reason for this?

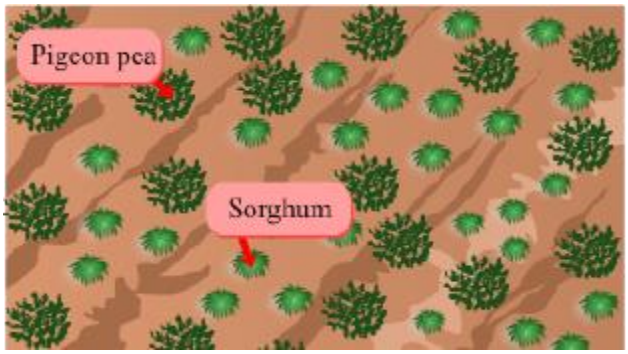
Farmers may grow different crops together without any definite pattern. On the other hand, they may also follow definite patterns while growing different crops (like, for example, growing alternating rows of two crops in the same field). These methods increase crop yield.

The commonly practised cropping patterns are as follows:

- Mixed cropping
- Intercropping
- Crop rotation

Mixed Cropping

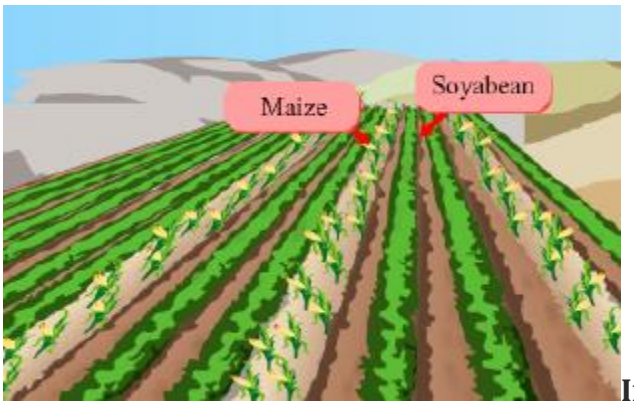
Mixed cropping is the technique wherein two or more crops are sown simultaneously on the same land, without any definite pattern. This system minimizes the risk of crop failure. Crop combinations grown in this manner include wheat and gram, wheat and mustard, and groundnut and sunflower.



The crops selected to be grown together are such that their products and waste materials benefit one another. For example, if wheat is grown along with a leguminous crop such as gram, then the uptake of nitrogen from the soil by the wheat crop is compensated through the addition of nitrogen to the soil by the leguminous crop.

Mixed cropping not only increases soil fertility but also improves crop productivity.

Intercropping and Crop Rotation



Intercropping is the process wherein two or more crops are grown simultaneously in the same field in a definite pattern. In this process, a few rows of one crop alternate with a few rows of another crop. Crop combinations grown in this way include cauliflower and spinach, soya bean and maize, and *bajra* and *lobia*.

The crops grown together are such that their nutrient requirements are different. This ensures that the crops do not compete for the same nutrients, which in turn allows maximum utilization of the applied nutrients by each individual crop.

Intercropping helps prevent the spread of pests and diseases throughout the field. It also reduces soil erosion.

Crop rotation is the practice of growing two or more varieties of crops in the same field in sequential seasons. The duration of crop rotation determines the crops to be sown. For example:

- For one-year rotation: maize and mustard or wheat and rice are sown in succession.
- For two-year rotation: maize, mustard, sugarcane and *methi* are sown in succession.

Crop rotation helps prevent the growth of pathogens and pests. It improves soil fertility and reduces the need for fertilizers. In this method, several crops can be grown with only one soil preparation (ploughing).

Keeping the land unused

Sometimes, farmers replenish nutrient content of the soil by ploughing and tilting the land and leaving it uncultivated for one or two seasons. The sheep and goats are allowed to graze and sit over the land whose dropping enrich the nutrient content of the soil. This process helps to get increased crop yield in the next growing season.

Some farmers clear a forest by cutting down trees and burning them for agriculture. The ash is then mixed with the soil to make it fertile. The land is suitable for cultivation only for few years. Then farmers have to move to other areas with forests to repeat the process for cultivation of crops.

Solved Examples

Example 1: How does the growing of different crops in a field in a definite pattern help?

Solution: Intercropping helps increase the productivity per unit area by ensuring maximum utilization of resources by each individual crop. In intercropping, the selected crops are such that their nutrient requirements are different. This prevents them from competing for the same nutrients. Growing of the different crops in an alternating pattern also prevents pests and diseases from spreading to all the plants belonging to one particular crop in a field.

Example 2: **How does the growing of different crops in a crop rotation pattern help?**

Solution: Crop rotation involves growing those crops in succession which support one another. A crop that leaches or makes the soil deficient in a particular nutrient is followed in the next season by a dissimilar plant that helps in returning the lost nutrient to the soil. Also, this plant draws a different ratio of nutrients. Thus, crop rotation helps in replenishing the lost fertility of soil.

Example 3:**Differentiate between mixed cropping and intercropping.**

Solution:

Mixed cropping	**Intercropping**

It is the practice of growing two or more crops in an indefinite pattern.	It is the practice of growing two or more crops in a definite pattern.
Mixed cropping helps minimize risk of crop failure due to abnormal conditions such as harsh climate and attack of pathogens.	Intercropping helps increase the productivity per unit area by ensuring maximum utilization of resources by each individual crop.
The selected crops are such that they require nutrients in differing amounts. They also support one another.	The selected crops are such that their nutrient requirements are different. This ensures proper utilization of the applied nutrients by each individual crop.
The seeds of the crops are mixed before sowing.	The seeds of the crops are sown separately in alternating rows.
It is difficult to spray pesticides on and apply fertilizers to an individual crop in this cropping system.	It is quite easy to spray pesticides on and apply fertilizers to each individual crop in this cropping system.
It is not possible to harvest and thresh the crops separately.	The crops can be easily harvested and threshed separately.
Only a mixed produce of the crops can be marketed and consumed.	The produce of each crop can be marketed and consumed separately.

Methods and Importance of Crop Protection

Importance of Crop Protection

You have studied previously how pathogens such as bacteria, viruses and fungi affect the health of human beings. In the same way, plants are also affected by various pathogens. Pests can invade and inhabit the crops in fields, thereby bringing down productivity. Crop productivity is also affected by the uncontrolled growth of weeds.

The following are some examples of common pests affecting crop plants:

Crop protection method includes:

- Use of herbicides, insecticides and fungicides
- Natural crop protection method

- Biotechnology based methods/ techniques
- Cultural practices like, crop rotation, water management, etc.
- Physical measures like insect traps, etc.

Importance of crop protection method

Crop protection method plays an important role in safeguarding crop plants from various organisms like pests, pathogens, viruses, etc.

Factors Affecting Crops

Different **biotic** and **abiotic** factors can affect crop growth and the quality and quantity of stored grains. The former are the living components of environment, e.g., insect pests, weeds, bacteria and fungi; the latter are the non-living components of environment, e.g., temperature and moisture.

Biotic factors

- **Weeds** are unwanted plants that grow in cultivated fields along with crop plants.
- They compete with crop plants for nutrients, light and space. As a result, the crop plants get lesser nutrients, light and space. This reduces crop productivity.
- Examples; *Xanthium* (gokhroo), *Parthenium* (gajar ghas), *Cyperinus rotundus* (motha), wild *Sorghum* and wild oat.
- **Pests** are generally insects that destroy crops in the following ways.
- They suck the **cell sap**

from various plant parts with the help of their piercing and sucking mouth parts. Examples; **aphids**

and leafhoppers.

- They cut and chew roots, stems and leaves with the help of their chewing mouth parts. Examples; Grasshoppers and locusts.
- They bore into stems and fruits and feed on plant tissues. Example; Sugarcane borers.
- **Microorganisms or pathogens** cause diseases in crop plants. They are generally transmitted through soil, water, air and seeds.

Microorganisms or pathogens	**Diseases caused in plants**
Bacteria	Bacterial blight in beans, cankers in blueberries
Fungi	Late blight of potatoes, club root of cabbage

Viruses	Yellow vein-banding symptoms on grapevine, rose mosaic
Nematodes	Cysts in the roots of tobacco

Protection of Crops

Crops can be protected from weeds, pathogens, etc. through mechanical, biological and chemical means.

- **Mechanical control** involves protecting crops from infectious agents by removing the agents via uprooting, hand hoeing, ploughing and flooding.
- **Biological control** involves using insects or other organisms that consume and destroy weeds and pests. For example:
  - The prickly-pear cacti (*Opuntia*) are controlled by cochineal insects.
  - Aquatic weeds are controlled by the fish known as grass carp.
  - Ladybirds and dragonflies are useful in getting rid of aphids and mosquitoes.
- **Chemical control** involves using chemicals to destroy insect pests, weeds and infectious microbes. **Pesticides** are chemicals intended for preventing, destroying, repelling or mitigating pests. They can be used against insect pests, plant pathogens, weeds, molluscs and microbes. Insecticides, herbicides and fungicides are examples of pesticides. They are spread through fumigation or dusting.

- **Insecticides** are pesticides used against insects. They include ovicides and larvicides, which are used against insect eggs and larvae respectively. They are used in fields as well as in homes. chlorpyrifos and malathion are examples of insecticides.
- **Herbicides** are used for eradicating weeds. Atrazine and isoproturon are examples of herbicides.
- **Fungicides** are used for destroying fungi. Mancozeb and Captan are examples of fungicides

- **Nematicides** are used for killing nematodes. Methyl bromide and Aldicarb are examples of nematicides.
- **Rodenticides** are used for killing rodents. Warfarin and Bromadiolone are examples of rodenticides.

Protection of Crops

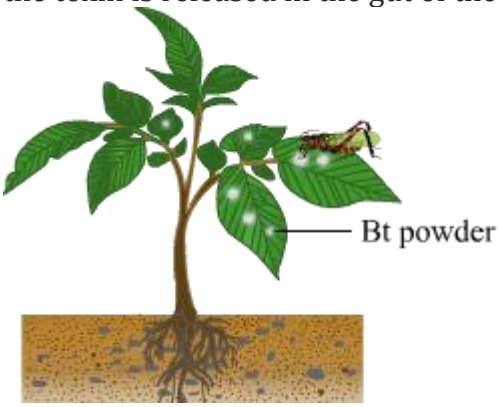
In order to keep harmful agents away from fields, farmers should take some basic preventive measures. These include:

- Proper soil and seed preparation
- Timely sowing of crops, intercropping and crop rotation
- **Summer ploughing**, which involves deep ploughing to destroy weeds and pests
- Use of disease-resistant variety of crops, i.e., crops which can resist the attack of pathogens

Note: Chemicals should be used in limited amounts. An excessive use of chemicals can lead to several environmental problems. Moreover, these chemicals are poisonous for plants and animals.

Bt Crops

Bacillus thuringiensis (Bt) is an insect pathogen used as a bio-pesticide. It kills a wide range of insect larvae. It is an example of a microbial bio-control agent. Bt is available in sachets as dried spores. These are mixed with water and sprayed on vulnerable plants such as *Brassica* and fruit trees. The insect larvae consume the sprayed substance. Consequently, the toxin is released in the gut of the larvae, which then kills the larvae.



Bt plants are the resistant variety of plants that have been genetically modified by inserting the gene for Bt toxin. Thus, they are protected from the attack of insects.

Solved Examples

Example 1: Name two pesticides.

Solution: Atrazine and chlorpyrifos are two pesticides.

Protection of Stored Grains

The biotic and abiotic factors we have studied about in this lesson affect the quality and quantity of stored grains. The following effects are brought about under the influence of these factors.

- Weight loss
- Poor seed quality
- Poor germination rate
- Discolouration of grains

Such effects reduce the market value of grains and consequently, the profits realised by farmers. Therefore, proper management of stored grains is important.

Here are some important measures that should be taken to protect stored grains.

- Floors should be cleaned before storing grains.
- Frequent chemical fumigation (to kill pests etc.) should be carried out.
- There should be proper aeration and ventilation to control moisture and temperature levels.

Animal Husbandry

Do you know what animal husbandry is?

- **Animal husbandry** is the science of managing **livestock**. It involves feeding, breeding and controlling diseases in farm animals.
- Animal husbandry involves rearing animals like cattle, poultry, fishes and bees to obtain the desired products from them. So, animal husbandry deals with cattle farming, poultry farming, fish farming and bee farming.

What is the need for animal husbandry?

Animals are sources of food such as milk, eggs and meat. Increase in human population increases the demand for these foods. Animals also act as beasts of burden, doing a lot of heavy work for humans. Thus, there is the need for animal husbandry or rearing of livestock for specific purposes.

Livestock wealth is an index to the prosperity of a country. So, improving livestock with the help of various tools and techniques is important with respect to the growth of a country. The objectives of the various tools and techniques of livestock improvement are to increase:

- milk production
- meat production
- egg production
- the outputs of other products and services obtained from animals

Types of animal husbandry:

- Cattle farming
- Bee farming
- Poultry farming
- Fish farming/ Pisciculture

Cattle Management

An important part of cattle management is **the feeding of cattle**. **C**attle should be given healthy and nutritious food. Their food requirements can be classified into the following two types.

- **Food for general maintenance**: It comprises food items required to keep cattle healthy and strong.
- **Food for milk-production:** It includes the food given during lactation period.

Cattle should be provided a well-balanced diet containing all essential nutrients in proportionate amounts.The types of food comprising such a diet are as follows:

- **Roughage**: It largely consists of fibre and provides low nutrition. Examples include green fodder, hay, silage and legumes.
- **Concentrates**: These are high in proteins and other nutrients, but low in fibre. Examples include cottonseeds and oilcakes.
- **Feed additives**: These contain micronutrients that promote the health and milk output of dairy animals.

Diseases of Cattle

A variety of diseases affect cattle. The diseases adversely affect the production of milk and, in some cases, even cause death. **Parasites**

are the common causes of cattle diseases. The parasites present on the body surface of an animal cause skin diseases. Such **external parasites** include lice, ticks, mites and fleas. Apart from these, there are disease-causing parasites that are found inside the body of an animal. Such **internal parasites** include worms (found in the stomach and the intestine) and flukes (found in the liver).

C**attle are also infected by viruses, bacteria and fungi.**

Viral diseases

1. Cows, buffaloes, sheep, goats and fowls are infected with smallpox.
2. Viral skin infection can be seen in sheep and goats.

Bacterial and fungal diseases

1. Diarrhoea is common among cattle.
2. Necrosis disease affects the hoofs and tail.
3. Pinkeye, a bacterial eye infection, is also common among cattle.

4. Other bacterial diseases of cattle include anthrax and haemorrhagic septicaemia.

Prevention of diseases in cattle

- Proper cleanliness should be maintained.
- The animals should be provided with nutritive food and clean drinking water.
- **Vaccination** helps prevent viral and bacterial diseases.

Know More

Mad cow disease is a fatal disease. It is caused by the build up of abnormal proteins called **prions** inside the brain. Mad cow disease is a major epidemic in cattle in Britain. As per an estimate, over 160000 cattle had died due to the disease in UK by the end of January 1997. Human beings can also be infected with the same disease if the infected meat is consumed.

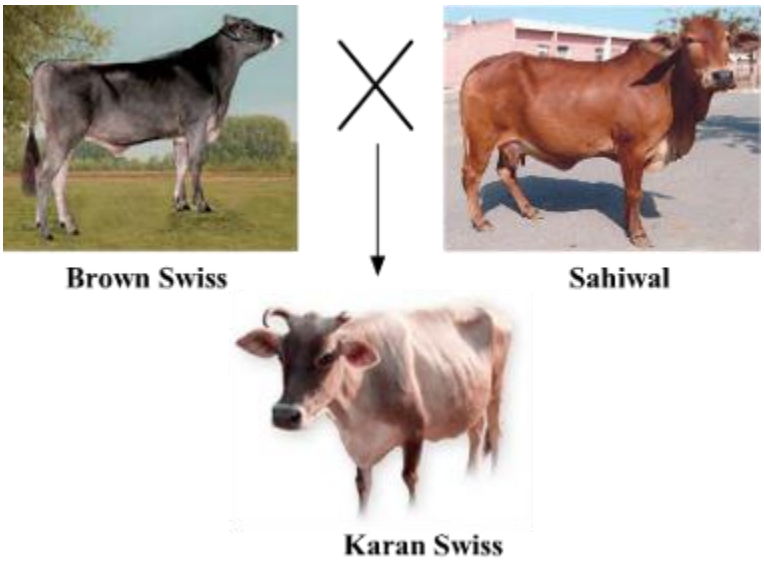
Breeding Cattle

Choosing an improved cattle breed is another element of cattle management. **Hybrid cattle breeds** are produced via **hybridization or crossbreeding** for improving productivity. Hybridisation is the process in which two genetically dissimilar individuals (varieties) are purposely crossed to get a hybrid variety. In this way, characteristics from both the parent

varieties can be obtained in the hybrid offspring. A hybrid cattle breed is produced by crossing two cattle breeds having the required qualities.

Cattle breeds

Exotic or foreign breeds such as Jersey and Brown Swiss are selected for their **high milk production**. Local breeds such as Red Sindhi and Sahiwal are selected for their **high resistance to diseases.** The breed selected for its milk-production is crossed with the breed selected for its resistance to diseases. The produced hybrid breed contains the characteristics of the parent breeds. Therefore, the offspring not only produces more milk, but is also more resistant to diseases.



Know More National Dairy Research Institute (NDRI) in Karnal, Haryana has developed improved breeds of cows such as Karan Swiss, Karan Fries and Frieswal by crossing exotic and indigenous breeds.

- Karan Swiss is a hybrid variety produced by crossing Brown Swiss and Sahiwal.
- Karan Fries is a hybrid variety produced by crossing Holstein-Friesian and Tharparkar.

These hybrid breeds can yield two to three times more milk than our indigenous cows.

Solved Examples

Example 1: Name two exotic breeds of cow.

Solution: Jersey and Brown Swiss are two exotic breeds of cow.

Example 2: What is humane farming?

Solution: The word 'humane' means 'having or showing compassion or benevolence'. Humane farming refers to the practice of farming in which the care and needs of livestock are not neglected. They are raised outdoors in a healthy environment where they are able to express their natural behaviour and have access to basic amenities like fresh clean water and food. Under humane farming, farm animals are protected from cruelty and abuse. Further, the public and the environment are protected from the adverse impacts of industrialized animal factories.

Poultry Farming

Poultry farming involves large-scale rearing of poultry birds.

Why is poultry farming required?

Poultry farming is undertaken to meet the demand for eggs and meat**. It deals with the management of domestic fowl to improve the quality and production of eggs and meat.**

Meat Eggs

Poultry birds

- **Meat-giving fowls are called broilers. They are chickens of either gender that are slaughtered for meat** when about 5 to 8 months old.
- **Layers** are hens that are used for egg production until they are about 18 to 24 months old.Broilers have different housing, nutritional and environmental requirements for their fast growth and low **mortality**

.Broilers are fed with protein- and vitamin-rich supplements (mainly vitamins A and K), with adequate amounts of fat. This helps in maintaining their feather and **carcass**

quality. It also reduces their mortality rate.

- Food supplemented with respective nutritional needs is provided to poultry.

- For good production of poultry, proper management techniques should be followed. Regular cleaning of the farm is of utmost importance. Maintenance of temperature is also required.

Diseases of Poultry

Poultry birds suffer from a variety of diseases caused by bacteria, viruses, fungi and parasites. They also suffer from nutritional deficiencies. Diseases in poultry can result in economic losses.

- Bacterial diseases of poultry include cholera, tuberculosis and diarrhoea.
- Fowl pox is a viral disease of poultry.
- Aspergillosis is a fungal disease of poultry.

Preventing diseases in poultry

- Poultry should be provided a clean housing area, with regular sanitation and spraying of disinfectants.
- Vaccination prevents the spread of infectious diseases.

Breeds of Poultry

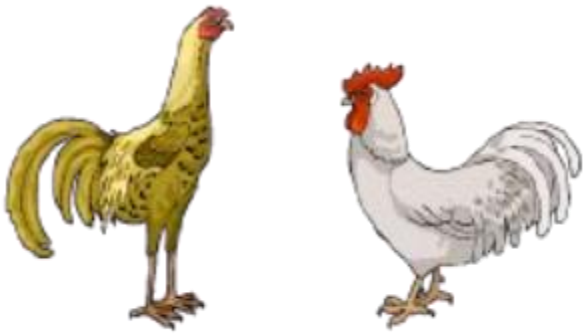
Indigenous breeds such as **Aseel** provide high yield of meat. Aseel has four popular varieties—Peela, Yakub, Nurie and Kajal.

The exotic breeds used popularly in our country are as follows:

- **White Leghorn**: It is popular for its small body size which means that it requires less feed for its maintenance. It produces long white eggs.
- **Rhode Island Red**: It is a dual type of breed as it is both a good layer and broiler.

Hybridization

Improvement in poultry variety is achieved through hybridization or crossbreeding.



Aseel White Leghorn

An indigenous breed like *Aseel* is crossed with an exotic breed like the *Leghorn* to produce an improved hybrid variety with the desired traits.

Some desirable traits of hybrid poultry are as follows:

- Good quality and large size of eggs
- Low maintenance requirement
- High resistance to diseases
- Tolerance to high temperature
- Good quality and quantity of chicks
- Ability to utilize cheaper diets produced from agricultural wastes

Fish Farming

You now know about poultry farms and dairy farms, but **have you ever heard about fish farms? What do you think is done in a fish farm?** Let us find out.

Fishing is an occupation for some and a diversion or sport for certain others. You would see different varieties of fishes if you were to visit a fish market. All of these are good and cheap sources of animal proteins. That is why fish is an important part of human diet.

Fish farming or **pisciculture** is the practice of raising fish population commercially. It involves the production of aquatic animals that are of high economic value. These can be true fishes as well as shell fishes such as prawns, lobsters, crabs, shrimps, mussels and oysters.

Fish Farming

Need of Fish Farming

The capturing of fishes to meet the demand of an ever-increasing population depletes the natural fish stocks. So, to restore the balance and to continue meeting the demand for fishes, fish farms or culture fisheries become necessary.

Thus, there are two ways of obtaining fishes.

- **Capturing of fishes:** It is the process of obtaining fishes from natural resources**.**
- **Culturing of fishes:** It is the practice of raising fishes in fish farms.

The capturing and culturing of fishes can be done in both freshwater (such as rivers and ponds) and marine ecosystems.

Categorisation of Fishes on the Basis of Water Resources

Marine fisheries

In India, marine fishery is carried out along the 7500 km coastline and in the deep seas beyond. Fishing is done using fishing nets and boats. The amount of caught fish can be increased by locating schools of fishes using satellites or echo sounders. Some examples of marine fishes include mackerel, tuna, sardine, pomfret and Bombay duck. Some varieties of marine fishes are of high economic value. Finned fishes (such as pearl spot, *bhetki and* mullet) and shelled fishes (such as prawn, mussel and oyster) fall in this category. The cultivation of marine organisms for commercial purpose is known as **mariculture.**

Inland fisheries

Canals, ponds and rivers are some freshwater resources. Brackish-water resources are generally found where seawater and freshwater occur together. It includes estuaries and lagoons. Freshwater and brackish-water fisheries are called **inland fisheries**.

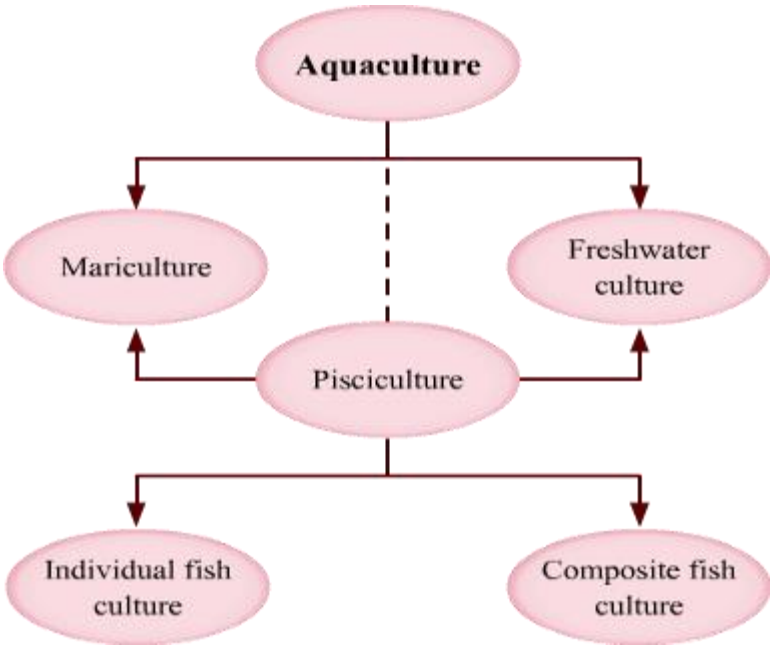
Culture Fisheries

Aquaculture is the farming of aquatic plants or animals (marine or freshwater) for food or commercial purpose.

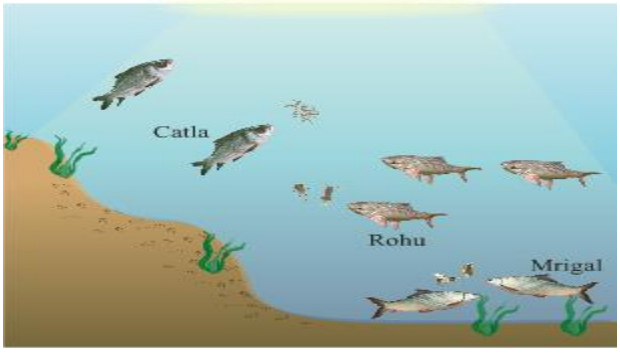
Freshwater culture is a type of aquaculture. It involves cultivation of freshwater organisms for commercial purpose.

Mariculture is another type of aquaculture. It involves cultivation of marine organisms for commercial purpose.

Pisciculture or fish farming is also a type of aquaculture. It can be done in marine water or freshwater. Fish culture can be practised either separately for different fishes or as a composite fish-culture system.



Culture Fisheries



Composite Fish Culture

An intensive way of farming fishes is the **composite fish-culture system**. In such a system, five or six different species of fishes are grown together in a single fishpond. Fishes with different food habits are chosen so that they do not compete for food amongst themselves. For example, *catla* feeds on the surface of water; *rohu* is a middle-zone feeder; *mrigal* and the *common carp* are bottom feeders; and the grass carp feeds on weeds. This ensures complete utilization of food resources in the pond. Such a system increases fish yield. A composite fish-culture system is shown in the given figure.

A major **problem** with this system is that many of these fishes breed only during the monsoon. So, the rate of fish production slows down at other times of the year. However, the use of hormonal stimulations has provided a solution to this problem.

Solved Examples

Example 1: Why are the fishes obtained from culture fisheries more useful commercially?

Solution: The fishes obtained from fisheries are larger as they receive proper food and nutrition, and have a healthy environment for their growth. Thus, they are more useful commercially.

Did You Know?

- **A person who studies fishes is called an ichthyologist.**
- **The largest fish is the whale shark. It can grow up to the length of 12 m or more.**
- **The smallest fish is the freshwater goby. It is less than 1 cm in length. It is found in the Philippine Islands.**

Meat Providing Livestock

Besides poultry and fish, meat is also obtained from goat, sheep and pig.

Goats
Goats are commonly reared in India, not only for their meat, but also for their milk which is very nutritious in nature. They need a dry and safe shelter to protect them from excessive heat and cold. They normally feed on the leaves of a variety of plants. Some important breeds of goats are *Gaddi, Kashmiri, Pashmina,* etc.

Sheeps
Sheeps are reared for their mutton, wool and skin. They do not require any well structured shelter. They normally feed on green grass, weeds and other farm wastes. However, when they are reared for their mutton, more nutritive feed is provided that includes gram chaff, oil cakes and mineral mixtures. Important breeds of sheep are *Nali*, *Deccani*, etc.

Pigs

Pigs are reared for their meat (pork) and animal fat (lard). Pork is a rich source of proteins and is also cheaper in cost. Lard is used as a cooking medium and is also used in manufacturing soaps, lubricants, grease, and candles. The stiff body hairs of pigs are used for making painting brushes.

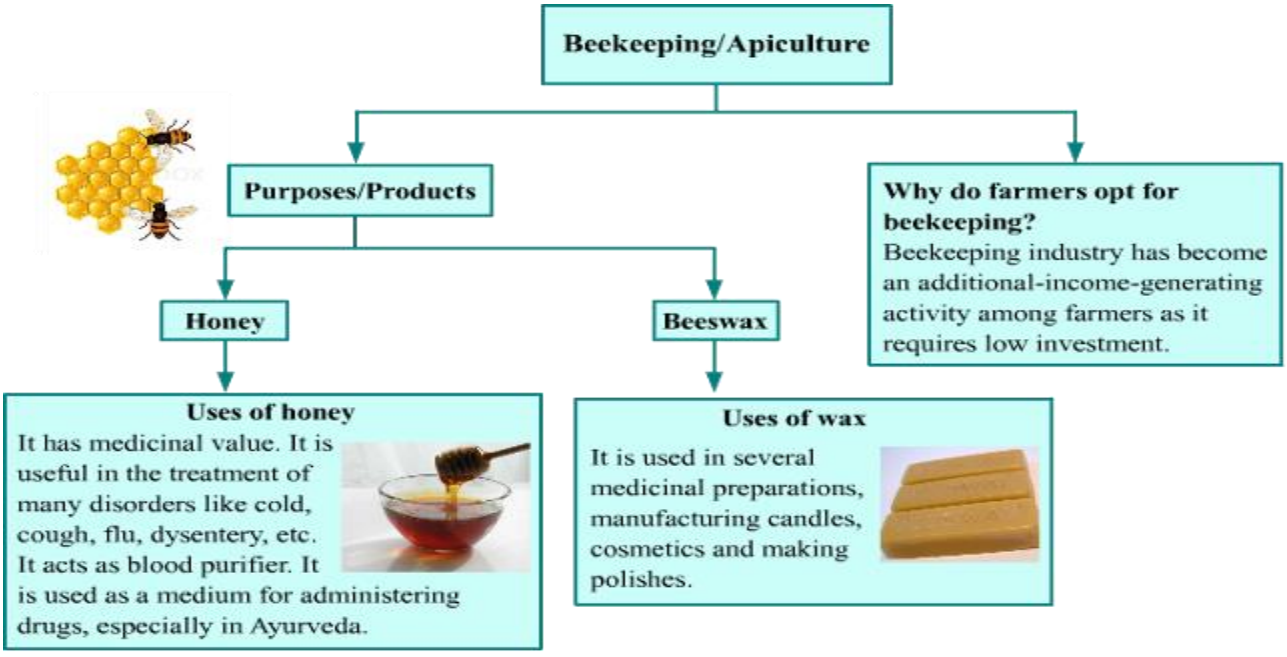
Pigs can feed on any possible food source, such as kitchen wastes, vegetables, or even garbage. The domesticated pigs are usually fed on grains. The commonly reared indigenous breeds of pigs are Desi and Ghori. Some exotic breeds include Berkshire, Yorkshire, etc.

Apiculture

We use honey for different purposes in daily life. We know that this honey is produced by bees, but how is it obtained commercially? Are there any bee farms just like there are cattle, poultry and fish farms?

Yes, bees are also reared like fishes, poultry and cattle for their products such as honey and beeswax. Beekeeping is practised all over the world due to the extensive demand for honey. The practice of beekeeping is known as **apiculture** and the bee farms are known as **apiaries.**

Apiculture is the rearing, care and management of honeybees for obtaining honey, beeswax and other products such as propolis, bee venom and royal jelly.



Know More

Honeybees are social insects. They live in colonies, in nests or **beehives**. A colony of honeybees has three types of castes—worker bees, drones and the queen bee. **The worker bees collect pollen and nectar from flowers to make honey inside their gut and, thus, also help in cross-pollination.**

Honey is a sweet food made by bees using nectar. It is composed of sugars, minerals that are known to purify, heal and soothe the skin. It also contain several compounds such as chrysin, catalase, pinocebrin which function as antioxidants (i.e., they protect the healthy cells from damage caused by free radicals). It is also a rich source of vitamins B1, B2, B3, B5, B6 and C and minerals such as copper, iodine and zinc.

Bee Farms

Let us take a look inside a bee farm.

Honeybees require proper feed and good shelters for apiculture. Apiaries are rectangular containers having wooden frames inside them. They are set near good pasturage

to form good honey. **Honeybees make their hives in these apiaries. Compartments of hives are called honeycombs.**

Apiaries

Factors affecting the quality of honey produced

- The quality of honey produced is greatly affected by both the quantity and quality of the available flowers (pasturage) from which bees collect nectar and pollen.

Did You Know?

Bees communicate with one another about food sources by dancing in a particular manner.

Sericulture

You must have seen your mother wearing rich silk *sarees*. But do you know that the silk used to make these *sarees* is actually obtained from an insect?
The silk is obtained from the cocoon (pupa stage) of an insect commonly known as silkworm. The artificial rearing of silkworm and obtaining silk from them is known as **sericulture**.

These silkworms feed on the leaves of mulberry tree. While entering the pupa stage, they develop a cocoon around them by secreting a fibre from the silk glands found in their mouth. It is from this cocoon from where the silk fibre is obtained. To obtain the silk, cocoons are first treated with boiling water to kill the living pupa inside them. The silk thread is then obtained from the killed cocoons through a process called reeling. The silk fibre thus obtained is then treated and used for commercial purposes.