

9th Improvement in Food Resources-I



All green plants synthesize their own food from carbon dioxide and water in the presence of sunlight. The energy needed for this comes from the sun. Green plants are called autotrophs because they synthesize their own food. Those organisms (nongreen plants and all animals) which cannot synthesize their own food are called heterotrophs.

Indian scientists have been able to increase foodgrain production. They have introduced improved varieties of crops. Crops are plants grown in large quantities for food or other needs. The introduction of improved varieties crops, better agricultural methods and irrigation facilities resulted in an increase in the production of foodgrains. This was through a country-wide programme called Green Revolution in the late 1960s.

Green Revolution	Programme
Fish	Blue Revolution
Milk	White Revolution
Oil	Yellow Revolution
Pulses	Golden Revolution

Sustainable agriculture: With the increase in human needs, there is a need to increase food production without upsetting the balance in nature. The practice of cultivating land using such methods that yield sufficient crops, but do not harm the environment is called sustainable agriculture.

Crop Production: Cereal crops are those food crops that give foodgrains which can be eaten or used to make flour, e.g., wheat, rice, maize, millet, etc. Pulses are seeds of crops that can be eaten, e.g., peas, grams, lentils, etc. The seeds of some plants (oilseed crops) are used to make oils for cooking. All these types of crops contain different nutrients.

Crops	Nutrients	Use in the body
Cereals, e.g., wheat, rice, maize, millet, sorghum and oats	Carbohydrates	Give energy
Pulses, e.g., gram (<i>chana</i>), pea (<i>matar</i>), black gram (<i>urad</i>), green gram (<i>moong</i>), pigeon pea (<i>arhar</i>) and lentil (<i>masoor</i>)	Proteins	Help in growth and repair
Oilseed crops, e.g., soya bean, groundnut, mustard, sunflower and linseed	Fats	Give energy and warmth
Vegetables and fruit, e.g., beans, cabbage, apples and papaya	Vitamins and minerals	Regulate body functions

Crop Seasons: Crops require suitable climatic conditions, optimum temperature ranges and particular durations of daylight (photoperiod) for their proper growth and flowering. Depending on the seasonal conditions and the time of growth there are three main crop seasons in India: kharif, rabi and summer crops.

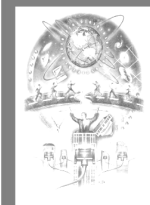
Kharif (rainy) crops: Rice, *jowar*, *bajra*, maize, cotton, sugar cane, soya bean, groundnut and *arhar* are kharif crops. They are sown in the rainy season (around June—July) and harvested around October.

Rabi (winter) crops: Wheat, barley, grams, linseed, oilseed rape, potato, mustard and peas are rabi crops. They are sown in the winter season (around October) and harvested around March.

Summer crops: Pulses like *urad* and *moong* are grown in the summer months (March to June). Rice, maize, potato and groundnut are also grown as summer crops in areas which are well irrigated.

Improvement in Crop Yield: The yield from crops can be improved by adopting some scientific approaches. These approaches are:

1. Management of crop production
2. Crop improvement through genetic manipulation



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3. Management of crop protection

Management of Crop Production: Measures have to be taken for increasing crop yield. For example, measures are taken to provide manure and fertilizers, proper irrigation, better farming methods and modern farming implements to the farmers. **Management of nutrients:**

Some plant nutrients are nitrogen, phosphorus, chlorine, potassium, calcium, magnesium, sulphur, iron and manganese. They are essential for plants as they support normal growth, reproduction and may be involved in cellular reactions. These nutrients are grouped into macronutrients and micronutrients. **Macronutrients:** The nutrients needed by plants in large amounts are called macronutrients. These are carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, calcium, magnesium and sulphur. Among the nine macronutrients, nitrogen, phosphorus and potassium are needed in greater amounts than the others. These three are called primary nutrients. **Micronutrients** The nutrients required by plants in very small amounts are called micronutrients. These are iron, manganese, copper, zinc, boron, molybdenum and chlorine.

Sources of nutrients: Plants obtain carbon from the carbon dioxide present in the air, hydrogen from water and oxygen from air and water. They get the remaining nutrients from the soil. Soil is, therefore, the most important source of various plant nutrients.

Deficiency: When any macro- or micronutrient is absent or its concentration is less than the required amount, such a condition leads to a deficiency of that nutrient. The deficiency of nutrients leads to stunted growth, yellowing of leaves (due to less chlorophyll), reduced crop yield and even the death of plants. Manure and fertilizers are added to the soil to supply more nutrients.

Manure and Fertilizers: Manure and fertilizers are added to the soil to make up for the loss of nutrients and increase soil fertility. **Manure** is organic matter obtained from the decomposition (breakdown) of animal wastes, dead plants and animals by the action of decomposers like bacteria and fungi. Since ages farmers have been using cowdung as a manure to improve the fertility of the soil for a long time. Manure contains a mixture of various nutrients suitable for plant growth. It restores soil texture which increases the retention of water and aeration. It increases the ability to retain water in sandy soil. It improves drainage and prevents waterlogging in clayey soil. It is not very rich in nutrients like nitrogen, phosphorus and potassium. Therefore, it is necessary to add chemical fertilizers to provide these specific nutrients. **Types of manure:** On the basis of the biological materials used, manures are of different types:

1. **Farmyard manure:** It is the decomposed mixture of cattle excreta (dung), litter (bedding material for animals) and leftover organic matter (roughage or fodder). It can be prepared by storing these wastes in a pit for decomposition for 1—2 months.
2. **Compost:** It is prepared from straw, sewage waste, vegetable and animal refuse, weeds, etc. This is made to decay in pits. The process of preparing compost is known as composting. Compost is rich in organic matter and nutrients. It is added to the soil to increase crop productivity.
3. **Vermicompost:** When compost is prepared with the help of earthworms, it is called vermicompost. Vermicomposting is a process by which biodegradable kitchen waste is turned into black, nutrient-rich manure with the help of earthworms and microbes.
4. **Green manure:** the practice of ploughing green legume-bearing plants into the soil for improving its fertility is called green manuring. Crops like sunhemp, guar, etc., are commonly grown for this purpose. These crops are grown and mulched (covered on the surface of land) by ploughing before flowering.



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Fertilizers are inorganic chemicals manufactured in industries. They contain essential plant nutrients like nitrogen, phosphorus, and potassium [NPK]. They are prepared in a concentrated form, so it is easy to transport them. Fertilizers are available in the form of granules, water-soluble powders or solutions. **Types of fertilizers:** three main types of chemical fertilizers are:

1. Nitrogenous fertilizers: contain nitrogen, e.g., urea, ammonium nitrate.
2. Phosphatic fertilizers: contains phosphorus e.g. superphosphate, ammonium phosphate, etc.
3. Potassium fertilizers: contains potassium e.g. potassium nitrate.

These fertilizers are used for enhancing the vegetative and reproductive growth of the plants. For example, leguminous crops such as pulses, groundnut, redgram, etc., do not need nitrogenous fertilizers. This is because the roots of such crops have nitrogen-fixing bacteria (*Rhizobium*), which can convert nitrogen of air into nitrogen compounds. **Application of fertilizers:** Different fertilizers are used at different times and in different ways. The application of fertilizers may be done before sowing, during irrigation and by spraying them.

Judicious use of fertilizers: Fertilizers should be used only when they are required. An excessive use of fertilizers degrades the soil and harms water bodies.

	Fertilizers	Manure
1	Fertilizers are man- made inorganic salts or organic compounds.	Manure is a natural substance obtained by the decay of animal wastes and plant residues
2	Fertilizers are nutrient- specific. They can provide specific nutrients to the soil.	Manure is not nutrient- specific.
3	Fertilizers are very rich in inorganic nutrients like nitrogen, phosphorus and potassium.	Manure is not very rich in inorganic nutrients.
4	Fertilizers are readily absorbed by plants because they are soluble in water.	Manure is not very soluble in water.
5	Fertilizers do not provide any humus to the soil.	Manure provides humus to the soil.
6	Fertilizers are prepared in factories.	Manure is prepared in fields or rural homes.
7	Fertilizers are easy to store, transport and use because they are compact and concentrated.	Manure is not easy to store, transport and use because it is bulky.

Disadvantages of fertilizers: The excessive use of chemical fertilizers can change the nature of the soil—making it either too acidic or too alkaline. These fertilizers finally reach the aquatic systems during the rainy season, making the water unfit for human consumption. Many forms of aquatic life including fish may die as a result of water pollution.

Organic farming: Here, chemical fertilizers and pesticides are not used. Instead, organic materials such as animal manure, mulches, sewage sludge, compost, grasses, straw and other crop residues are used to provide nutrients to the soil. These methods include diversified farming, crop rotation and the planting of pest-resistant species. The disadvantage of organic farming is that farmers do not have much control over the nutrients that they are adding to the soil and hence the crop yield may suffer.

Irrigation: Man depends on water for the production of food (agriculture or aquaculture), disposal of domestic and industrial wastes, generation of energy, transportation, industrial

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production and recreation. Since water resources are being increasingly overexploited due to urbanization and industrialization, its management and proper utilization of this resource has become a challenging. In India, groundwater gets replenished by rainfall. In spite of all this, 58 per cent of our cropped area does not have a proper irrigation facility and depends on rainfall. Irrigation is essential at various stages of plant growth. The various sources of irrigation used in our country are wells, rivers, canals, reservoirs, lakes, ponds and tube wells.

Mixed Cropping: The practice of growing two or more crops at the same time in a field is called mixed cropping. It has been practised by our farmers to avoid total crop failure when there is little or no rainfall.

1. Wheat and chickpea or wheat and mustard
2. Maize and *urad* bean
3. Soya bean and pigeonpea (red gram, *arhar*)
4. Barley and chickpea
5. Sorghum (*jowar*) and pigeonpea

Importance of mixed cropping:

1. Growing crops with different requirements minimizes the risk of crop failure.
2. Usually a cereal crop is grown with a leguminous crop like beans, peas and grams. The nitrogen-fixing bacteria in the roots of leguminous plants improve the fertility of the soil by converting atmospheric nitrogen into nitrogenous nutrients which benefit the crop plants. This increases the crop yield.
3. Mixed cropping also discourages infestation by pests. This is because the presence of one crop discourages the growth of the pests of the other crop.
4. Mixed cropping is economically beneficial too. The farmer produces more than one crop. It also helps him earn more.

Intercropping: Intercropping is just a modification of mixed cropping. In mixed cropping, different types of crops are not planted in any definite pattern. In intercropping one row of a cereal crop may be followed by one or two rows of a leguminous crop, and so on. As intercropping is more systematic, it makes better use of land than mixed cropping. It aims to increase productivity. Advantages are:

1. Since the seeds of the two crops are planted in definite rows (in mixed cropping they are mixed together), it is easier to use fertilizers and pesticides required by each crop.



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2. Intercropping also makes it possible to harvest and thresh the two crops separately. In mixed cropping the yield is a mixture of the two crops which cannot be separated.

Crop Rotation: Crop rotation is the practice of growing different crops in succession in the same field or soil. The basic aim is to increase productivity, but it also helps to maintain the fertility and moisture content of the soil. **Benefits of crop rotation:**

1. A particular crop (or a particular group of crops) requires certain nutrients. If it is grown on the same soil year after year, the soil becomes deficient in these nutrients. Crop rotation takes care of this problem. Usually a pulse (leguminous) crop is grown in the interval between two cereal crops. Cereal crops take away nitrogenous compounds from the soil. The nitrogen-fixing bacteria in the roots of pulse crops restore these compounds.
2. Crop rotation helps control pests and diseases too. When the same crop is grown in the same field over and over again, the pests specific to the crop get the right conditions to multiply more and more rapidly. When another crop is grown in between, their growth slows down because they do not find favourable conditions.
3. The fact that crop rotation helps maintain soil fertility, and control pests and diseases, means that the farmer has to spend less on fertilizers and pesticides. It helps to conserve the environment too because accumulation of chemical fertilizers and pesticides in the soil and water bodies is harmful.

Variation means difference between individuals of the same species. The basic idea is to choose or select two varieties of crops, each of which has at least one desirable quality, such as high yield or resistance to disease. And then cross-breed them to produce a hybrid variety which has the good qualities of both varieties. This process of cross-breeding between genetically dissimilar individuals is called hybridization. Hybridization may be of the following three types.

1. Intervarietal: between two different varieties of the same species
2. Interspecific: between two different species of the same genus
3. Intergeneric: between two different genera.

Generally, intervarietal cross-breeding is used to produce high-yielding plants.

Plant Breeding: The science of improving crop varieties for better and higher yield is called plant breeding. The various approaches used are:

1. Introduction of a crop from another area: Superior varieties of crop plants are obtained from other areas. They are allowed to acclimatize (get used to) to the local environment. Then a study of their growth pattern.
2. Selection of plants with desired traits: The plants with desirable characters are selected. Selection is done in two ways. One way is to select the seeds of many plants with desirable external characteristics. These characteristics may include the size of fruit, and the number and size of seeds. This method is called mass selection. The other way is to select the seeds of plants with some desired characters and sow them in separate plots. This method is called pure-line selection.
3. hybridization, or cross-breeding

Plant Breeding in India: Plant breeding to improve crop varieties has been successfully carried out in India. Indian agricultural scientists at the Pusa Institute, started cross-breeding some Indian varieties of wheat with some high-yielding Mexican varieties during late 1960s. The resulting hybrid varieties were pest-resistant, high-yielding and better suited to our climate. This was the beginning of the Green Revolution in India. Prof Swaminathan is thus considered the architect of the Green Revolution in India.

Advantages of high-yielding varieties:

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1. **High yield:** As compared to the traditional varieties, the hybrid varieties of crops have greater yield per plant. This increases productivity.
2. **Early maturation:** Hybrid varieties require less time for maturation. This makes it possible for the farmer to raise more than one crop in a year. Hybrid varieties also mature uniformly.
3. **Better response to fertilizers:** HYVs respond better to fertilizers. This increases crop yield.
4. **Desirable agronomic traits:** Hybridization makes it possible to develop varieties with desirable agronomic traits. For example, tall crop plants cannot resist strong winds. Hybridization has made it possible to develop dwarf varieties which are able to better withstand strong winds.
5. **Wider adaptability:** The aim of plant breeding is to produce varieties which are stronger and can tolerate wider fluctuations of environmental conditions. This will make them more adaptable and make it possible to grow them in very different environments.
6. **Better quality:** Varietal improvement makes it possible to produce better-quality crops.

Disadvantages of high-yielding varieties:

1. **Produce less fodder:** The plant parts that are left over after the grain harvest are used as fodder. Hybrid varieties yield less fodder than traditional varieties because they are shorter.
2. **Higher inputs:** HYVs require more water and fertilizers. They also need pesticides at every stage of growth and more frequent weeding.

Management of Crop Protection: Crop fields may have a large number of undesirable plants (weeds), insect pests and diseases. Various methods are:

Control of Weeds: Many undesirable plants grow along with cultivated crops. These unwanted plants are called weeds. The growth of weeds in the field is very harmful as they compete with the useful plants for minerals, water, light and space. They thus decrease the crop yield and lower the quality of foodgrains. Another disadvantage is that weeds spread crop pests and diseases by acting as alternative hosts to insects and microorganisms. Weeds sometimes produce poisonous substances which may affect crop growth or may poison crop produce. It is, therefore, essential to remove these weeds from time to time. **Common weeds are:** *Amaranthus (chaulai)*, *Chenopodium (bathua)*, *Convolvulus (khuri)*, doob grass.

Methods of weed control: The process of removing weeds from a crop field is called weeding. Mechanical, biological and chemical means are adopted to control weeds.

Mechanical method: Weeds are removed manually by hand or with the help of a harrow (*khurpi*), hoe or rake. It is a costly affair and takes a lot of time. Weeds are also removed by tilling, mowing (cutting with a machine), burning and flooding.

Biological method: some insects or organisms are deliberately put into the crop field to destroy the weeds but do not harm the crop.

Chemical control: Chemicals used to kill weeds are called weedicides. The use of weedicides is easy, cheap and less time-consuming. Weedicides may be used as sprays or powders. Since weedicides are poisonous substances, the grains must be washed before use. Weedicides are also called herbicides.

Crop Diseases: Crops are infected by many disease-causing organisms like bacteria, fungi, viruses and insects. Collectively they are called pathogens. The disease may be localized or widespread. Crop diseases are of the following three types:

1. **Seed-borne:** Diseases which are transferred through seeds are called seed-borne diseases. Ergot of *bajra* and leaf spot of paddy are examples of seed-borne diseases. Both these diseases are caused by fungi.
2. **Soil-borne:** Diseases which spread through the soil are called soil-borne diseases. Examples of soil-borne diseases are smut of *bajra* and tikka of groundnut. Both these diseases are caused by fungi.





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Name of Crop	Name of disease	Symptoms
Wheat	Rust	Brown or black elongated spots on the leaves.
	Smut	Black powdery masses in the grains.
Rice	Blast	Brown spots on the margins of leaves
Groundnut	Tikka	Dark spots surrounded by yellow rings in all aerial parts.
Mustard	White rust	Shiny white pustules on leaves and stem
Sugar cane	Smut	Appearance of long whiplike black shoot.
	Red rot	Red spots on the midribs of leaves.

Effect of pests and crop diseases:

1. Insects cause a great deal of damage to crop plants. Besides destroying crops, they also transmit numerous disease-causing microorganisms. Insect pests attack plants in three ways.
2. Locusts, dragonflies and grasshoppers cause severe damage to crops and trees by eating their leaves and stems.
3. Bugs and beetles eat the leaves and tender shoots.
4. Termites and white ants cause extensive damage to the roots of plants.

Methods of pest control:

1. Chemical and biological methods; some birds, insects or other organisms are deliberately put into the field to kill the pests selectively.
 2. The introduction of disease-resistant varieties of crops for controlling pests and crop diseases.
 3. Crop rotation also removes pests and diseases.
 4. Treatment of seeds, like soaking in fungicide solution, also helps in removing diseases.
- Pesticides may be of many types such as insecticides, fungicides, rodenticides, weedicides and nematocides. Nematocides kill nematodes, weedicides kill weeds, rodenticides kill rodents, fungicides kill fungi, and insecticides kill insects. Insect-resistant varieties do not allow the pests to grow and damage them.
5. The chemicals used to kill insects are sprayed either by simple hand-operated machines or by power sprayers.

Harmful effects of pesticides: pesticides are not biodegradable, they remain in the field, causing environmental pollution. Contact with pesticides - may cause skin problems and respiratory diseases. Besides, nonbiodegradable pesticides mix with the soil and water. Crop plants absorb these, and when animals and human beings eat the grains, vegetables or fruits, the pesticides present in them enter their bodies and accumulate in tissues, causing illnesses. Hence, pesticides should be used with great care.

Fruit, vegetables and grains should be washed thoroughly to wash off pesticides. Since the pesticides ultimately cause environmental pollution, we should adopt preventive measures like the use of resistant varieties, optimum time of sowing the crops and crop rotation.

Scientific storage of Grain: Need for Safe Storage: Storage of food is an enormous task. It involves a whole range of activities and precautions. The storage system should be reasonably safe to prevent damage during storage.

Damage during Storage: A scientific method of food storage has to consider all those factors which cause food to perish (spoil), and to apply measures to stem the damage. Over 10% of the foodgrains produced in our country (amounting to about 15 million tonnes of foodgrains) are lost due to improper storage. Factors responsible for the spoilage of food are:



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Abiotic factors: Abiotic factors include moisture, temperature, the composition of the storage container and oxidation in certain foods. **Moisture content:** The moisture content of stored grain should be sufficiently low, i.e., around 14% by weight. This does not mean that the grain should not have any moisture at all. Grains lose their germinating power if the moisture content is reduced beyond a certain limit. **Temperature:** The temperature at which foodgrains are stored is an important factor because a certain temperature range is ideal for the growth of insects and microorganisms. While insects find 30° to 32°C optimum for their growth. If the storage compartment is kept cool and dry, much of the damage to the foodgrains can be averted.

Biotic factors: Biotic factors include living organisms such as rodents, birds, insects and microorganisms which damage stored foodgrains. Food also gets spoilt by the action of the enzymes present in them.

Preventive and Control Measures: In order to protect grains from any kind of loss during storage, the following preventive and control measures can be adopted.

1. Dry or nonperishable food such as cereals, pulses, flour, sugar, spices and nuts can be stored at room temperature in suitable containers or bags after proper drying in the sun followed by drying in shade. This mode of storage is called dry storage.

2. Perishable food, i.e., those that are likely to be spoiled at room temperature very soon, should be stored at a low temperature. This method of storage is called cold storage. Fruit, vegetables, fish, meat, eggs and milk are some perishable food materials that need to be stored at a low temperature.

3. The place of storage such as godowns, stores, etc., should be clean, dry and free from foreign matter and infestation of insects, rodents and spiders. There should not be any cracks and holes in the wall, floor or ceiling of the store house.

4. Pesticides can be used to control pests. These can be used in two ways: spraying and fumigation.

Spraying: Pesticides can be sprayed in the storage structure before storing foodgrain. This kills the pests before the arrival of stocks and also eliminates chances of contamination of foodgrain with pesticides.

Fumigation: It is a method by which insect pests are exposed to fumes or vapours of chemicals, without contaminating the stored foodgrain.

