Agriculture-7

(For Seventh Class)

Punjab School Education Board

Sahibjada Ajit Singh Nagar

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FOREWORD

Punjab School Education Board since its inception has been constantly putting its efforts for re-designing lessons and preparing books according to the needs of national educational view point and occupational requirements of the state.

The present textbook has been prepared in the light of National Curriculum Framework 2005 and Punjab Curriculum Framework 2013. Accordingly, it has been felt that more emphasis should be laid on vocational courses. India is mainly an agrarian economy and Punjab is considered as food Bowl of the country. This book contains information about agricultural economic development of the country, some common tips about agriculture and information about agriculture based supplementary enterprises and industrial occupations so that students can be made aware to adopt it.

This book prepared by experts of Punjab Agricultural University, Ludhiana will prove helpful for students and teachers.

Suggestions from field are welcome for making the book better.

Chairperson

Punjab School Education Board

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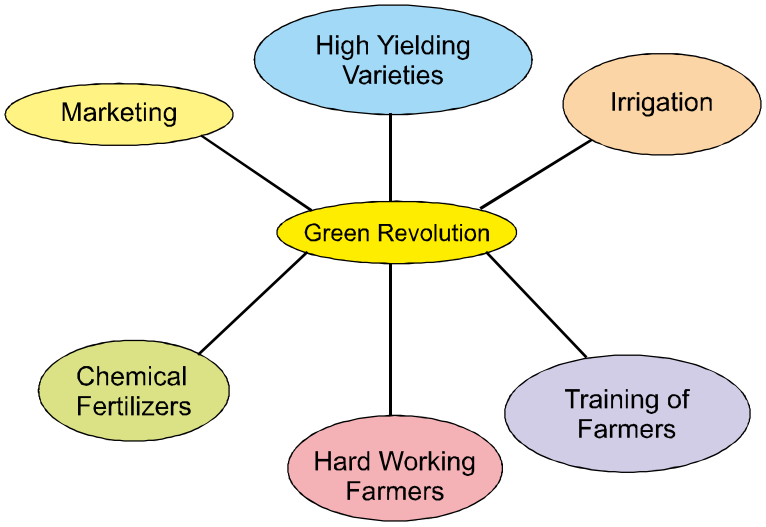
Chapter-1

GREEN REVOLUTION

Green revolution refer to the rapid growth in food grain productivity happened during 1960s in India and other countries of the world. The term Green Revolution was coined by Dr William S. Gaud. Punjab was the pioneer among other states of India in bringing the green revolution in agriculture production. Punjab being the agricultural state, Green revolution played an important role in economic prosperity of the state. There was three times increase in food grain production in this decade. The food grain production of Punjab increased from 34 lakh ton in1965-66 to 119 lakh ton in 1971-72. This was mainly due to the increase in productivity and area of wheat and paddy crops. There were various factors contributing to Green Revolution in the state as depicted below



Factors contributing towards Green Revolution

High Yielding Varieties

Initially the seeds of HYV were introduced from the other countries into Punjab. Punjab Agricultural University was established at Ludhiana for boosting agricultural research and development in the state. Scientists of Punjab Agricultural University, Ludhiana developed the high yielding varieties of wheat

and rice in collaboration with the scientists from different countries. Kalyan Sona, Sonalika and PV-18 varieties of wheat became popular among Punjab farmers due to their high yield. Seeds of these improved varieties increased the productivity of these crops. New varieties of wheat were dwarf and high yielding. Although paddy was not grown traditionally in the state, but due to availability of high yielding varieties like IR-8 and Jaya, area under this crop also increased.

Irrigation Infrastructure

Irrigation is an important factor in agricultural production. The new varieties require more water and at specified time. Major irrigation projects were initiated to expand the canal irrigation network in the state. Farmers also installed the tube wells at their fields for irrigation purposes. This made agriculture less dependent on monsoon or rains and helped to provide assured irrigation for the crops. This resulted in increased area under cultivation and more food grain production.

Chemical Fertilizers

Use of chemical fertilizers started for the cultivation of high yielding varieties. Punjab became the highest consumer of chemical fertilizers in 1971-72. Chemical fertilizers were used to meet the nitrogen and phosphorus requirement of the crops. This has also resulted in increasing the productivity of food grains in the state.

Hard Working Farmers

Innovative and hard working nature of the farmers supplemented the efforts of scientists in achieving the Green Revolution in the state. Punjab farmers adopted these high yielding varieties and other technologies at their farms at very fast rate. Rural artisans comprising blacksmiths, masons, carpenters etc also supported the farmers by developing farm implements at village level.

Marketing

Due to surplus food grain production, Punjab started contributing to the central pool of food grains. Regular markets and purchase centers were established for proper marketing of agricultural produce. The minimum support price (MSP) was introduced to ensure marketing of wheat and paddy. Food Corporation of India (FCI), central and state warehousing corporations was formed for storage

and distribution of purchased food grains. This helped the farmers to get remunerative prices.

Training

PAU played an important role in transfer of latest agricultural technology to the farmers. PAU Scientists organized various training courses to educate extension workers and farmers about new cultivation practices.PAU is organizing *kisan melas* twice a year to display all agricultural related technology. All India radio and television also helped the agricultural scientists to dissemination of new technology to the farmers. Extension functionaries of Department of Agriculture and other allied departments also educated the farmers about new technologies.

Other factors

The new high yielding varieties were more prone to insect-pest and disease incidences. The new plant protection techniques were developed and chemical control measures were also suggested to the farmers. National Seed Corporation and Punjab State Seed Corporations were established to provide good quality seed to the farmers. Besides, agro machinery, electricity, land reforms, provision of soil and water testing laboratories contributed towards the development of agriculture and realizing the green revolution in the state.

Beyond Green Revalution

Green Revolution brought many economic, social and cultural changes among the people of the state. With the increase in agricultural production, the income of the farmers also increased. This results in improved living conditions of the farmers. Paddy and wheat became the main crops of the state and the biodiversity got affected. Natural resources like soil and water get contaminated with the use of pesticides and chemical fertilizers. The widespread use of these chemicals put adverse effects on human health and environment.

As the food grain production is increasing in other states of the country, there is less demand for food grains produced in the Punjab. Thus to reduce area under paddy-wheat crops, cultivation of alternative crops like maize, cotton, pulses, oilseeds, fruits and vegetables are being encouraged in the state. New crop varieties are being developed using latest techniques such as biotechnology,

tissue culture and nanotechnology etc. Techniques of natural resource conservation are being popularized in the state to check the depletion of underground water table, air, soil and water pollution. Farmers are being educated through soil-water testing campaigns and other extension activities. Institutional credit through banks is being made available to the farmers at lesser rate of interest to encourage the use of latest farm technologies at their farms. Agricultural processing and value addition is promoted through the establishment of agro processing industries. Small and marginal farmers are being advised to adopt subsidiary occupations to increase their farm income. Farm enterprises such as beekeeping, mushroom cultivation, seed production, vegetable cultivation can be adopted by them with small capital investment. There are many other such initiatives taken to attain the goal of the ecologically sustainable growth in agriculture and to make the state and the agricultural population economically prosperous.

Exercise

a) Answer in one-two words:

1. In which decade the Green Revolution was witnessed in Punjab?
2. Who has coined the term Green Revolution?
3. What kind of change came in the height of wheat crop period of Green Revolution?
4. Which type of fertilizers farmers started using in the period of Green Revolution?
5. Name any wheat variety which became popular in the period of Green Revolution.
6. Productivity of which crops increased significantly during Green Revolution.
7. Is paddy a traditional crop of Punjab?
8. Which state of our country contributes highest food grains to the central pool?
9. Whether diversification in agriculture has increased/decreased with Green Revolution.
10. Name the central organization established for procurement of food grains?

b) Answer in two-three sentences:

1. List down the factors responsible for Green Revolution.
2. What type of seeds was developed by the scientists in the period of Green Revolution?
3. How the irrigation system of the state was changed in the period of Green Revolution.
4. Why farmers have to use chemical fertilizers in the period of Green Revolution.
5. What type of marketing system was developed by the Govt.?
6. Write the various extension programmes initiated for farmers' training in the state.
7. What is the role of PAU in bringing Green Revolution in Punjab?
8. How water resources of the state get affected with continuous paddy-wheat crop rotation.
9. In present scenario, why it is important to reduce area under rice-wheat crops in Punjab.
10. Name the different farm enterprises which can be started with small investment?

c) Answer in five to six sentences:

1. What do you understand by Green Revolution? Explain.
2. Write a short note on high yielding varieties.
3. What type of economic and environmental changes occurred due to Green Revolution?
4. Name the different subsidiary occupations and why it is important to be adopted by the farmers.
5. What efforts have been initiated in the direction of Evergreen Revolution?

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Chapter-2

SOIL AND WATER TESTING FOR CROP PRODUCTION

Soil testing is important to know the fertility status of soil and to get optimum crop yield. In this chapter we will learn about importance of soil and water testing, techniques of testing and interpretation of the results.

SOIL TESTING:

Soil testing is an important tool for balanced use of fertilizers in soils. Excessive use of fertilizers not only deteriorates the soil environment but also decreases the profit level. Soil testing determines the fertility status of soil, its organic carbon content, pH of the soil and the amount of available nutrients present in the soil. Soil testing can be done for any of the following purposes:

a) To know the quantity of fertilizers required for crop production.

b) For reclamation of *Kallar* soils.

c) For orchard Plantation

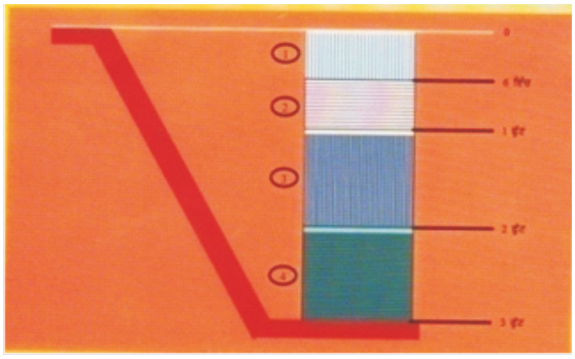
The sampling of soil is an important part of soil testing. If soil sampling is not done in a correct way, accurate results cannot be obtained. The different procedures for collection of soil samples are given below:

1. Soil sampling for knowing the quantity of fertilizers for crop production:

Scrap away surface litter and make a V-shaped cut with a spade or a *khurpa* to a depth of 6 inches. Remove about 1" thick uniform slice of soil from one side of the cut. Put this sample in a clean cloth or bucket. Similarly, take samples from 7 to 8 random spots in a zigzag pattern in the field . Put the samples in a clean bucket, tray or cloth and mix it thoroughly. Take approximately half kg soil, air dry the sample under shade and put it in a cloth bag. Label the cloth bag with information such as field number, name of the farmer, address, date of sampling etc. The soil samples are usually collected from fallow fields after the harvest of crops. However, if the crop has been planted, take the samples between rows. Do not take sample from unusual spots such as recently fertilized area, old bunds, compost piles etc.

Procedure for soil sampling

2. Soil sampling for *kallar* soils : Soils containing excessive soluble salts in the surface layer, which affect the crop growth adversely, are called *kallar* soils. Soil samples can be taken from *kallar* soils by digging three feet deep pit with one side vertically straight and the other slanting. From the vertically straight side, remove with the help of *khurpa* about 1" thick soil layer to collect about half kg soil from 0-6, 6-12, 12-24 and 24-36 inch depth. Cut uniform slices of soil separately from each layer. Put the soil samples collected from each depth in a separate clean cloth bag and label with the information such as field number, depth of sample, name of the farmer, address, date of sampling etc.

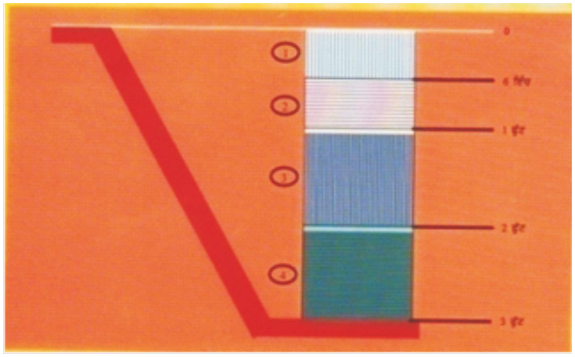


Soil sampling procedure for *kallar* soils

3. Soil sampling for orchard plantation :

Soil samples for orchard plantation can be taken by digging a 6 feet deep pit in the centre of the field in which orchard has to be planted. Keep the one side of the pit vertically straight and the other slanting. From the vertically straight

side, remove with the help of khurpa about 1" thick soil layer to collect about half kg soil from 0-6, 6-12, 12-24, 24-36, 36-48, 48-60 and 60-72 inch depth. Collect and process samples from different depths as described above for kallar reclamation. If there is any concretion layer, sample it separately and note down its depth and width.



Soil sampling Procedure for orchard plantation

WATER TESTING FOR IRRIGATION

The underground water in our state is not equally suitable at all places for irrigation of crops. For example, the underground water in most parts of south-western districts of Punjab is saline or sodic in nature. It is not suitable for irrigation, if this water is used for irrigating the fields continuously, it will make the soils *kallar* and also results in decrease of soil fertility. Therefore, it is important that tube well water should be tested to know its suitability for irrigation.

Sampling of tube well water:

Run the tube well for half an hour. Take a clean bottle, rinse it with tube well water for two to three times and fill it. Do not wash the bottle with soap or any detergent. Put the stopper on the bottle and write the name of the farmer, address and depth of tube well on it.

SOIL AND WATER TESTING LABORATORIES

Soil and water samples should be sent to nearby soil and water testing laboratories. Soil and water samples are tested at Punjab Agricultural University (PAU), Ludhiana. The soil and water samples are also tested at Regional Research

Centers of the PAU at Gurdaspur and Bathinda. The Department of Agriculture, Punjab and some other government agencies have also established soil and water testing laboratories where farmers can get their soil and water samples tested.

RESULTS OF SOIL AND WATER TESTING

Soil testing gives the information regarding the type of soil, pH, electrical conductivity, organic carbon, macronutrients like available phosphorus & available potassium and micronutrients (zinc, iron, manganese and copper) in the soil. Similarly, from water testing we get to know about pH of water, its electrical conductivity, residual sodium bicarbonate and amount of chlorine present in it.

As we get examined our self from doctor from time to time, similarly a farmer should get the soil of his field tested after every three years.

Exercise

a) Answer in one-two words:

1. At what depth, soil samples should be taken for knowing the quantity of fertilizers can be taken.
2. How much quantity of soil sample should be taken for soil testing?
3. How deep the pit should be dug for taking soil samples from a *kallar* soil?
4. For orchard plantation, up to which depth soil samples should be taken.
5. How much time a tube well should be run before taking sample for water testing?
6. After how much time, the soil and water testing should be repeated in the same field.
7. Name any two micronutrients about which soil testing can provide the information.
8. Name any two macronutrients about which soil testing can provide the information.

9. Can we wash the bottle to be used for water sampling with detergent or soap?
10. Name any one result about which the water testing provides the information.

b) Answer in one or two sentences.

1. When is the right time to take the soil samples?
2. How to take soil samples from a standing crop.
3. Why it is important to take soil and water samples in a correct way for their testing.
4. What is the problem of underground water of south-western districts of Punjab?
5. What information should be written on the cloth bag containing soil sample.
6. If we get a concretion layer while sampling for orchard plantation. What should we do?
7. Write the three purposes for which the soil can be tested.
8. How continuous irrigation with saline/sodic water affects the soil.
9. How many samples should be taken while soil sampling for an orchard plantation.
10. At what depth, soil samples should be taken for *kallar* soils.

c) Answer in five to six sentences.

1. Write down the importance of soil and water testing.
2. Write in detail about soil sampling procedure for an orchard plantation.
3. Describe the procedure of taking water sample from a tube well.
4. From where the soil and water samples can be got tested.
5. What type of results can be obtained from soil and water testing?

Activities

- Practice the soil sampling procedure for fertility evaluation at farmers' fields.
- Visit your nearby soil and water testing laboratory and collect the information about soil and water testing reports.

Chapter-3

ESSENTIAL NUTRIENTS FOR CROPS

In addition to air, water, light and temperature, plants require seventeen essential nutrients for their growth. In the absence of these nutrients, plants can not complete their life cycle. In plants, the deficiency of a particular essential nutrient can be corrected only by application of that nutrient. The essential nutrients are directly involved in internal metabolic activities of plants. Depending upon the requirement of essential nutrients for plants, these are divided into two categories:

1. **Macronutrients:** Carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, calcium, magnesium and sulphur
2. **Micronutrients:** Zinc, Iron, manganese, copper, boron, chlorine, molybdenum and cobalt

Plants take up carbon and oxygen from air and hydrogen from water whereas other essential nutrients are taken up from soil. Leguminous crops can fix atmospheric nitrogen from air for their growth and development.

Functions, deficiency and remedy of essential nutrients in plants:

a) NITROGEN: Its major functions in plants are as under:

1. Nitrogen is part of chlorophyll and proteins present in plants
2. Nitrogen helps in increased growth of plants
3. Nitrogen helps in metabolism of carbohydrates in plants
4. Nitrogen helps in the use of phosphorus, potash and other nutrients

Deficiency symptoms of Nitrogen : Deficiency of nitrogen first appears on older lower leaves of plants. Yellowing of older leaves also starts from leaf tip and increases towards base of leaf. Upper leaves start yellowing in the absence of remedy. Tillering and branching is reduced. Internodes become short and crop yield is reduced.

Nitrogen deficiency symptoms in crop

Remedial measures: Application of nitrogenous fertilizers (urea, CAN, ammonium chloride etc.) immediately after observing deficiency symptoms eliminate the deficiency of this nutrient. Application of these recommended nitrogen fertilizers in right amount by right method and at right time to the crop, saves it from losses due to deficiency of this nutrient.

Effect of Nitrogen application in crop

a) **PHOSPHORUS:** Major functions of this nutrient in plants are:-

1) It helps in formation of new cells in plants
2) It helps in flowering, fruiting and seed formation.
3) Helps in the development of roots.
4) Provide strength to straw and thus prevents the crop from lodging.
5) Provide resistance to diseases.

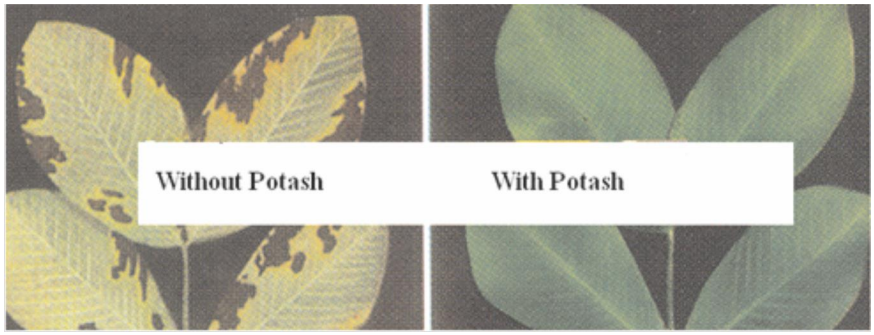
Deficiency symptoms of Phosphorus: Deficiency symptoms of phosphorus appear on older leaves like nitrogen. The plant foliage turns dark green and growth becomes stunted under deficiency. After some time older leaves become reddish-purple in colour and this coloration increases from top to base of leaves. With time whole foliage turns purple or bluish purple. Leaves and stem start drying. Crop maturity is delayed

Remedial measures: Phosphorus is immobile in soil. So to save the crop from deficiency of this nutrient, drill recommended dose of phosphorus containing fertilizers like Diammonium phosphate (DAP) or super phosphate at the time of sowing. Phosphorus containing mixed fertilizers (NPK) can also be used. Rabi crops respond more to phosphatic fertilizers. So phosphorus use should be preferred to *Rabi* crops.

b) POTASSIUM: Major functions of this nutrient in plants are:-

1) It is required for formation and translocation of starch in plants.
2) It improves quality of produce.
3) It is essential for photosynthesis.
4) It helps in formation of proteins.
5) It strengthens the roots and straw to reduce lodging
6) Increases crop resistance to diseases.

Deficiency symptoms of Potassium : Its deficiency symptoms first appear on older leaves. Interveinal yellowing of leaves occurs and leaf margins also become yellow.



Potassium deficiency symptoms

Afterwards yellow area becomes brown in colour and dries. Plant growth remains stunted and leaves are most affected. Straw becomes weak and yield is reduced.

Remedial measures: Potassium is also immobile in soil like phosphorus. So, on the basis of soil testing, drill the recommended quantity of potash fertilizer (muriate of potash) at the time of sowing.

c) **SULPHUR:** Major functions of this nutrient in plants are:-

1) It is a part of protein and enzymes.
2) It is involved in the formation of chlorophyll.
3) It stimulates seed formation.
4) It promotes the nodule formation in leguminous crops to fix atmospheric nitrogen.

Deficiency symptoms of Sulphur:

Deficiency of sulphur appears on young new leaves. Young leaves become light coloured and turn pale yellow. In case of severe deficiency, all leaves become yellow. Plant growth remains stunted.

Sulphur deficiency symptoms in crop

Nodulation in leguminous crops is reduced and fixation of atmospheric nitrogen is reduced.

Remedial measures: When the deficiency is noticed in field, apply gypsum followed by light irrigation. Prefer use of super phosphate among phosphatic fertilizers, as it prevents its deficiency.

d) ZINC: Zinc is part of most of enzymes which are helpful for increased growth, starch and hormone formation.

Deficiency symptoms of Zinc: Deficiency of zinc has been observed in those soils which are high in phosphorus and carbonates. Deficiency symptoms are variable in different crops and those of paddy and wheat are illustrated here:

Paddy

1) Deficiency symptoms first appear on older leaves.
2) Small scattered light yellow to brown spots appear on older leaves.
3) Brown spots later enlarge and turn deep brown like rusting of iron.
4) Leaves remain small and plants become stunted and bushy.
5) Leaves fall after drying.
6) Maturity of crop is delayed and yield is reduced.

Deficiency symptoms of zinc in crop

Wheat

1) Third or fourth leaf from top of plant develops a band of white or yellow tissue.
2) Yellow spots on interveinal area of leaves and middle part of leaf becomes brownish.
3) These spots are enlarged and mixed with each other. Ultimately leaf is broken from middle.
4) Bushy appearance of plants.
5) Earing and maturity is also delayed.

Remedial measures: To ameliorate deficiency of zinc, Apply zinc sulphate to soil. In case of severe deficiency, zinc sulphate solution can be sprayed on standing crop.

F) IRON: Major functions of this nutrient in plants are:-

1) Iron takes part in the synthesis of chlorophyll.
2) It has a catalytic role in the activities of several enzymes.
3) It is essential for the synthesis of proteins.

Deficiency symptoms of iron:

1) The typical symptoms of iron deficiency in all crops are alike. The symptoms first appear on younger leaves.
2) Initially interveinal chlorosis appears. Later, veins also turn yellow.
3) In severe cases, the new emerging leaves become bleached and turn white.

Remedial measures: When yellowing of leaves is observed, apply heavy irrigation immediately to crop.

Deficiency symptoms of iron

Spray the crop with one percent ferrous sulphate solution (one kg ferrous sulphate in 100 liters of water) at weekly intervals. Iron deficiency can be corrected with 2-3 such sprays. Ferrous sulphate should not be applied to soil as it is not much effective.

G) MANGANESE: Major functions of this nutrient in plants are:-

1) It helps in the synthesis of chlorophyll.

2) It is a part of many enzymes necessary for metabolic activities.

Deficiency symptoms: Deficiency symptoms of manganese vary in different crops. Deficiency symptoms in wheat and berseem crops are as under:-

Wheat: Severe deficiency of manganese appears on wheat sown in sandy soils.

1) The symptoms appear on middle and lower leaves.
2) The basal part of the leaf exhibits interveinal chlorosis which extends towards the tip.
3) The symptoms remain confined largely to the lower 2/3 part of the leaf.
4) Under severe deficiency, the chlorosis enlarges and streaks of pinkish brown colour appear in between the veins.
5) The veins remain green.
6) Ears emerge with difficulty and appear sickle shaped.

Berseem:

The middle stem leaves of berseem show deficiency symptoms of manganese i.e. grey to yellow mottling, leaving small area around the margins tip and about 1/3 area from the base. These spots later spread over the entire leaf and turn pinkish to brown in colour.

Manganese deficiency in berseem crop

Remedial measures:

Spray the crop with 0.5% manganese sulphate solution (1 kg manganese sulphate in 200 liters of water/acre) 3-4 times at weekly interval. In case of wheat one foliar spray should be done 2-3 days before first irrigation and 2-3 sprays afterwards at weekly intervals.

Exercise

a) Answer in two-three words:

1. Name two essential macronutrients for crops.
2. Name two essential micronutrients for crops.
3. What is the colour of leaves during nitrogen deficiency?
4. Name the essential nutrient required for disease resistance in plants.
5. What is the colour of plants due to deficiency of potash?

6. Name the nutrient required for cell formation in plants.
7. Name two nitrogenous fertilizers used for remediation of nitrogen deficiency.
8. Which fertilizer can be used for remediation of phosphorus deficiency in plants?
9. Which crop is affected most by manganese deficiency in sandy soil?
10. Which fertilizer is used during sulphur deficiency?

b) Answer in one-two sentences.

1. What are essential macro and micronutrients for crops?
2. What are the functions of zinc in plants?
3. What are functions of manganese in plants?
4. Give deficiency symptoms of phosphorus.
5. What are the deficiency symptoms of zinc observed in rice crop?
6. What are the causes of iron deficiency?
7. What are the deficiency symptoms of manganese observed in wheat?
8. What are the remedial measures for manganese deficiency in wheat?
9. Name major crops affected by potassium deficiency.
10. What are the remedial measures for iron deficiency?

c) Answer in five-six sentences.

1. What are the functions of nitrogen in plants?
2. What are the deficiency symptoms of nitrogen in plants?
3. What are the remedial measures for phosphorus deficiency?
4. Name the soils in which deficiency of zinc occur mostly?
5. What are the deficiency symptoms of iron in plants and give its remedial measures?

Activity

Maintain a record file of leaves showing deficiency symptoms of different essential nutrients in field crops.

Chapter-4

Efficient Utilization of Water in Agriculture

Agricultural sector is largest consumer of water. The Punjab state which is predominantly agricultural state is having 41.58 lakh hectares area under cultivation in the state out of which 98 per cent is irrigated. The area irrigated by groundwater through tubewells is 75 per cent whereas remaining area is irrigated by canal water. The numbers of tubewells are increasing continuously and amount of water withdrawal is more than recharge, this result in declining rate of water table. Groundwater is declining rapidly in almost entire state for last three decades. Farmers have to shift from centrifugal pumps to submersible pumps for water table depth more than 10 m. This leads to water as well as electricity crises as more energy is required to extract water from higher depths. Therefore judicious use of water is very important in agriculture especially in the state like Punjab.

Methods of irrigation: The average irrigation efficiency of water is only 35 to 40 per cent in agricultural sector. But this can be increased substantially by adopting various modern irrigation techniques. The various methods for irrigation are:

* Flood irrigation in the field through borders or basins
* Drip irrigation
* Sprinkler irrigation
* Furrow irrigation
* Irrigation through bed planting

Flood irrigation in the field through borders or basins is most popular in Punjab. Generally water is applied in field through single out let. The crop yield can be increased by making small borders even with lesser water. The size of border depends upon soil type, slope of field and delivery size of tube well pipe. For 3 to 4" delivery pipe of tube well, farmer should make 17-18, 10-11, and 6-7 borders for light, medium and heavy soils. In case of less water availability, smaller borders should be made for higher crop yield. Rice and wheat can be irrigated by basin/border irrigation.

Drip irrigation is modern technique of irrigation. This technique is well accepted in areas having water scarcity and poor quality problem. In this method,

water is conveyed through PVC pipes and applied through nozzles near plants. This method is quite useful for orchard crops like mango, pomegranate, lemon, kinnow, ber, papya , guava and for vegetable crops like tomato, cauliflower, cucumber, brinjal, chilly, capsicum etc.

Sprinkler method of irrigation is very efficient in sandy soil and undulating land where land leveling very expensive. Drip and sprinkler irrigation not only increase the yield of the crop but also improves the quality of crop. This technique is more popular in orchards and cash crops due to its high initial investment

Drip Irrigation

Sprinkler Irrigation

Furrow irrigation method is economical and is an efficient technique for the crops having wider plant to plant spacing like cotton, sunflower and maize etc. Wheat sowing with **bed planting** can result in 18-25 percent water saving. For efficient utilization of water, different methods should be adopted for different crops.

Furrow Irrigation

Bed Planting Method

Saving and conservation of irrigation water:

Demand and supply should match each other for optimum management of water resources. The deficiency in water resources can be managed by water saving and conservation techniques e.g recharging excess runoff from agricultural field, selection of appropriate method depending upon crop and soil type, less water consuming crops and adopting drip/sprinkler irrigation etc.

Crop diversification: Rice and Wheat are major kharif and rabi crops of Punjab. Both of these crop require large amount of water for irrigation. There are many crops which can be cultivated in Punjab those consume less water e.g, basmati, maize, cotton, oilseed and pulses etc, .Wheat can be replaced by barley and oil seed crops as these crops require comparatively lesser water.

Modern agricultural machinery: Computerized laser leveler can be used for land leveling in precise manner. By adopting this technique 25-30 percent water can be saved and yield can also be improved by 15-20 percent. Sowing of wheat can be done by using zero till drill to save pre sowing irrigation.

Use of tensiometer in paddy: After transplanting paddy, water should be kept standing in the field during first 15 days. Afterward irrigation can be applied at two days interval, this results in saving of water. The irrigation scheduling in paddy can also be done by using tensiometer. By using this instrument, up to 20 per cent water can be saved. Tensiometer is an instrument formed by glass tube

Tensiometer

and inserted in the field. Irrigation is applied when water level touches from green layer to yellow layer.

Mulching: In crops like maize and sugarcane, mulching can be done by using crop residue which results in reduction of evapotranspiration losses and ultimately results in water saving. Besides, mulching can be done by using polythene sheet so that water can be saved. Mulching is quite useful for capsicum and chilly.

Water saving through mulching

Conservation through rainwater harvesting: Rainwater harvesting is very important. We should renovate our village ponds. The pond water if fit can be used for irrigation and natural recharge. Abandoned hand pumps and wells can also be used for recharging purposes.

Groundwater recharge through abondoned well

Lining of canal and channels: Water (10 to 20 percent) can be saved by lining canal or field channel or by adopting underground pipe line system.

Exercise

(a) Answer in one-two words.

1. How much area of Punjab is under agriculture?
2. How many plots per acre should be there in medium soils to save water?
3. For how many days, paddy field should remain in flooded condition after transplanting?
4. Name the drill which helps in saving pre sowing irrigation water in wheat crop?
5. How much yield is increased by using laser leveler?
6. How much irrigation efficiency is measured generally on agricultural fields?
7. What are major crops of Punjab?
8. Which instrument is used for scheduling irrigation in paddy?
9. Name any two crops which consume less water?
10. What is the effect of mulching on evapotranspiration?

(b) Answer in two-three sentences.

1. Write the purpose of using tensiometer?
2. What are the advantages of zero till drill?
3. What are the advantages of laser leveler?
4. What type of crops should be furrow irrigated?
5. What are the advantages of sprinkler and drip irrigations?
6. What do you mean by 'Mulching'?
7. Write the name of different methods of irrigation?

8. Name the various factors influencing the plot size for irrigation?
9. How rain water can be harvested?
10. How water can be saved by crop diversification?

(c) Answer in five-six sentences.

1. How water can be saved in paddy transplanting?
2. Discuss the five techniques used for water saving in agriculture?
3. Explain the different methods of irrigation?
4. What are the various methods for conserving rain water?
5. Write a note on 'Water saving by crop diversification'.

Activity

- Visit the nearby farmers' field and note down the different water saving techniques used by them.

Chapter-5

WEED MANAGEMENT IN FIELD CROPS

Undesirable and unwanted plants which grow out of their proper place and harmful to the crops are called as weeds.

Harmful effects of weeds:

Adoption of improved technology helps in enhancing the productivity of crops but it has also increased the problem of weeds. Intensive cropping, more use of fertilizers and irrigation, creates the favourable conditions for the growth of weeds. Weeds compete with crops for growth factors like nutrients, water, sunlight etc. which ultimately results in yield reduction. Different crops are infested with different types of weeds. These not only reduce the yield of the crop but also deteriorate the quality of produce and also set seeds for the next season. So it is important to control weeds at the right time.

Classification of Weeds: According to their leaf morphology weeds are classified as:

a. **Grass weeds:** Leaves are long, narrow with parallel veins

b. **Broadleaf weeds:** Leaves are broad with a network of veins.

According to season, weeds are also classified as *kharif* and *rabi* weeds.

a. ***Kharif* weeds:** Kharif season starts from May-June to October month. The weeds appearing in this season are known as *kharif* weeds. Weeds pose serious threat to the field crops in *kharif* season due to availability of more water due to rainfall. Weeds reduce the crop yield by 20-50 percent in this season. Weeds like *Swank, swanki, kanki, motha, ghrilla, sanni* etc. emerge in transplanted paddy during *kharif* season. In other *kharif* crops, grasses and broadleaf weeds are also present in large numbers like *takri gha, kutta gha, makra, madhana, acrachne gha, chiraian da dana, khabbal gha, kaon makki, tandla, chulai, bhakra, makru vel, salara, baru, dila* etc.

b. ***Rabi* weeds:** The *rabi* season starts from November to March-April. The weeds appearing in this season are known as *rabi* weeds.Wheat is the most important crop of this season. *Gulli danda/sitti is* a very serious weed of wheat, particularly in paddy-wheat cropping system and jaundhar/ *jangli javin* in wheat is a problem of non-paddy-wheat rotation. Besides this, the wheat crop is also infested with broad leaf weeds like *maina, maini, jangli senji, jangli palak, kandiali palak, pit papra, jangli mattar, billi booti, takla, jangli halon, button booti* etc. but the major loss is caused by *gulli danda*.

Weed Management approaches: Type and density of different weeds depends upon crop rotation, texture of soil, rate of fertilizer, source of irrigation etc. Weeds can be controlled by following three main approaches:

1. **Hoeing:** Weeds can be controlled by giving hoeing or tillage. Hoeing can be done manually with *khurpa*/kasolla/ wheel hoe, *triphali* or tractor drawn cultivator. Hoeing for the control of weeds is only beneficial if it is given at right time and in a proper way. However, crop suffers a heavy set back when timely labour is not available or there is frequent rainfall when the crop is due for hoeing.
2. **Cultural control:** Weeds can also be controlled with the adoption of cultural methods. Some weeds have the same ecological requirement as that of a crop. So by changing crop rotation, life cycle of particular weed can be broken for example wheat can be rotated with another *rabi* season crop for the control of *gulli danda*. Selection of quick growing wheat varieties and optimum sowing time helps in checking weed growth. Placement of fertilizers instead of broadcasting, bi-directional sowing, and reducing row to row spacing also helps in management of weeds.
3. **Herbicides:** The chemicals which kill the weeds are called herbicides. Weeds can be controlled effectively by use of herbicides. When controlled by herbicides during germination these weeds will not compete with the crop for nutrients, moisture, space, light etc. and does not cause yield

reduction of the crop. Different herbicides are recommended in field crops for the control of different types of weeds. The recommended herbicides by Punjab Agricultural University, Ludhiana should be applied at the right time with optimum dose and should be used judiciously when required. Do not use the same group of herbicides year after year in field instead use different group of recommended herbicides in rotation should be used. The continuous use of a single group of herbicides year after year promotes new weeds in the field.

Time of application of herbicides: It can be classified into three categories:

1. **Pre-plant:** Application of herbicide after seed bed preparation but before the crop is sown eg Treflan.
2. **Pre-emergence:** Application of herbicide before the germination (emergence) of crop and weed eg Stomp
3. **Post-emergence:** Application of herbicide on the emerged crop and weeds eg Topik

Some herbicides are applied only on weeds growing in between crop rows as a directed spray with protected hood so that herbicide does not fall on crop leaves eg. Round up

Precautions in application of herbicides:

1. Always use flat fan or flood jet nozzles for herbicide spray.
2. Keep the herbicides beyond the reach of children.
3. Wear hand gloves during preparation and at the time of spray.
4. Receipt must be obtained from the shopkeeper at the time of purchase of herbicide.
5. Always spray on clear days.
6. Prepare the spray fluid before each filling.
7. Uniform spray should be done to cover all area.

Exercise

a) Answer in one-two words:

1. Name any one major weed of paddy-wheat rotation.
2. Name the broadleaf weed of wheat.
3. Name the weed of paddy.
4. Name the herbicide used as pre-emergence.
5. Name the herbicide used as post-emergence
6. Which herbicide is sprayed by using protected hood?
7. Name the farm implements used for hoeing.
8. Name any one cultural practice for the control of weeds.
9. Name the nozzle used for the spray of herbicides.
10. Should farmer use the same herbicide year after year?

b) Answer in one-two sentences.

1. Define weed.
2. How to identify grass weeds?
3. How to identify broadleaf weeds?
4. On what factors, type and density of weeds depends?
5. What are the problems in hoeing?
6. Why *kharif* weeds pose serious problem?
7. Under which weather conditions herbicide should be sprayed?
8. How to control *gulli danda* in wheat by cultural methods?
9. Name the weeds of *rabi* season crops.
10. Name the various growth factors for which weeds compete with the crops?

c) Answer in five-six sentences.

1. Why is it necessary to control weeds in crops?
2. How to control weeds by cultural methods?
3. What are herbicides and its uses?
4. Classify herbicides according to time of application.
5. What precautions should be followed while applying herbicides?

Activity

- Collect different specimen of *kharif* and *rabi* weeds and prepare a record file.

Chapter-6

INSECT PESTS AND DISEASES OF CROPS

A tremendous growth in agriculture has been witnessed due to introduction of improved varieties and new methods of crop protection and production. Crop protection from insect pest and diseases plays a significant role in increasing crop yields. Despite a sound crop protection technology, about 1/3rd crop yield is reduced by insect pest and diseases every year. Sometimes, a famine like situation arises due to failure of plant protection technology. The brown spot disease of paddy caused famine in Bengal during 1943 and American bollworm of cotton almost destroyed the crop completely in Punjab during 1996-2002. This chapter will explain the insect pest and diseases of field crops.

A. INSECT PESTS OF CROPS:

The insect pest species are numerous than any other kind of life existing on this earth. The body structures, pattern of growth and development, ability to consume different kind of food, swiftness are the main characteristics by which insect pests adapt themselves to all types of environments. Mainly four kinds of insect pests attack our food crops.

1. Sucking insect pests: These insect pests suck sap from leaves and result in loss of chlorophyll and other vital nutrients from plants. Consequently the plants become pale, stunted and photosynthesis process is affected. The common examples of sucking pests are aphids, jassids whitefly and mealy bug.

Table: Sucking insect pests of major crops:

S.No.	Insect Pests	Crops
1	Jassids	Cotton, Okra, Maize, Rice, Mango etc.
2	Aphids	Wheat, oilseeds, peach and Cole crops
3	White fly	Cotton, pulses, tomato, papaya etc.
4	Mealy bug	Cotton, mango, papaya and citrus crops

Sucking pests of crops

2. Fruit and shoot borers: These insect-pests enter and feed within different plant parts. The detailed information of these insects is as under:

a) **Shoot borers:** These insect-pests make holes in shoot/stem of plant and make dead hearts by which plant dries up and dies. e.g. rice and sugarcane stem borers, pink stem borer and maize shoot fly etc.

Attack of stem borer

b) Fruit borers: They destroy maturing fruits, vegetables and bolls of plants by feeding inside them. The symptoms of damage can be identified from the excreta of plants. e.g. Cotton bollworms, Brinjal fruit and shoot borer etc.

Attack of bollworm on cotton crop

3. **Leaf feeders**: These insect reduce the photosynthesis process of plant by feeding on leaves. Generally they feed on the leaves in following two ways:

a) **Leaf cutting insect**: These insects start feeding from the margins of leaves and moves towards the midrib of leaves e. g. Armyworm, Grey weevil, Red pumpkin beetle etc.

Leaf cutting grey weevil

b) **Leaf mining insect**: These insects feed on the green matter between the upper and lower epidermis of the leaf. e.g. Hadda beetle, Cabbage butterfly etc.

4. Root feeding insect pests: These insects feed on the underground plant parts such as roots, lower portion of stem and kill them. e.g. termites, white grub etc. They feed on a number of crops.

B. CROP DISEASES:

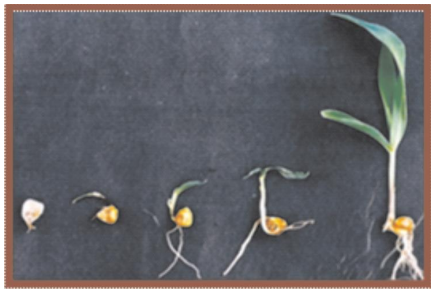
The crops suffer from various kinds of fungal, bacterial and viral diseases at different stage of crop growth. The diseases of crop spread from one place to other by seed, soil, air and heavy rains.

1. Fungal diseases of crops: Generally, you must have seen cottony fungal growth on stale bread at your home. The fungus produces different kinds of poison and enzymes within the plant by entering through different plant parts. Fungus is of different kinds and these effects the plants in different ways. Various kinds of fungal diseases are as under given in the Table:

Table: Fungal diseases of different crops

S. No.	Disease	Symptoms of damage	Crop
1.	Blight	Water soaked spots are seen on leaves and stem. White fungus can be seen on under surface of leaves	Rice, potatoes, moong and cruciferous crops

2.	Seed rot	The seed rots within the soil	Maize, rice and different vegetables
3.	Smut	The seeds get turned into black powder	Wheat, rice etc.
4.	White rust	White powder like growth appears on different plant parts	Ber, peas etc



Seed rot disease

2. Bacterial diseases of crops: Like human bacterial disease viz. Tuberculosis, typhoid, Plants also suffer from different bacterial diseases. The bacteria damage the plants by entering through natural openings or cut plant parts. The main bacterial diseases are as under:

a) Blight: The disease occurs on rice, the major *Kharif* crop of Punjab. Yellow green stripes appear on the margins of leaves in this disease.

b) Stem rot and leaf spot diseases: The water soaked spots appears on plant parts in this disease.

3. Viral diseases of crops: In human being, viruses cause dangerous diseases like AIDS. Insect pest spread different viral diseases of plants e.g. white fly spread leaf curl disease. These diseases are more dangerous than other diseases due to difficulty in their management. Symptoms of these diseases are given below in the table and figures.

Table: Viral diseases of plants and their symptoms.

S. No.	Disease	Symptoms	Crop
1.	Leaf curl disease	The leaves bend inwards from corners of leaves.	Cotton, papaya, chili and tomatoes etc.

2.	Mosaic disease	Irregular yellow and green bands appear on the leaves.	Moong, okra, papaya and potato etc.

Leaf Curl disease of cotton

Yellow vein mosaic disease in moong crop

Integrated management of insect-pests and diseases:

The major plant protection practices includes use of chemical insecticides, resistant varieties, natural enemies, cultural control such as changes in time of sowing and irrigation and mechanical control. The environment friendly, pesticide free, socially and economically beneficial production of food requires integrated use these techniques. Integrated pest management can be divided into two parts.

1) Preventative measure:

- Selection of crop variety resistant to attack of insect-pests and diseases.
- Seed treatment with insecticides and fungicides.
- Judicious and need based use of fertilizer, insecticides and irrigation
- Some insect-pests and diseases can be controlled by exposing the fields to sunlight
- Incidence of some insect-pests and diseases can be reduced by removing weeds from fields, bunds and nearby areas

2) Curative measures:

- First and most important aspect of pest management is the correct identification of insect pest and disease to identify the pest management techniques accordingly.
- Some insect-pests can be controlled by uprooting and destroying the infected plant in initial stages of crop damage

- Use the recommended dose of insecticides/ fungicides.
- The insecticide should be selected according to the nature of insect, symptoms of damage and cause of disease.
- Timely and judicious application of insecticides/pesticides should be practiced
- Natural enemies and other micro-organism can also be used for control of insect pest

Transgenic are the most recent method of pest management. BT cotton is a transgenic crop and has played an important role in the management of insect-pests of cotton. In this method, the required genes are transferred from different organism to crops for insect pest management.

SAFE USE OF INSECTICIDES AND POISONS

Insecticides are harmful to human being, so these should be kept away from the reach of children and proper care should be taken at the time of use of pesticides. In the event of poisoning, the doctor should be consulted at the earliest. Before the arrival of doctor, following first aid can lower the effect of insecticide poisoning:

a) In case of insecticide poisoning:

1. Give saline water to induce vomiting
2. Give lukewarm water if a person goes in comma
3. If a person is in comma, don't go for vomiting

b) In case of inhalation of pesticides

1. Patient should be taken to open air
2. Loosen the clothes of patient
3. Give artificial inhalation and put minimum pressure on chest
4. Keep the patient warm by covering him in blanket
5. No intoxicant should be given to patient
6. Patient should remain calm

c) In case of pesticide enters eyes

1. Keep eyes open
2. Slowly rinse the eyes with fresh water
3. Keep on washing eyes until the doctor arrives

Exercise

a) Answer in one-two words:

1. Which disease of rice has caused famine in Bengal?
2. Name the most harmful insect pest of cotton in Punjab during 1996-2002?
3. Name the crop in which gene has been introduced from other organism?
4. Are insecticides harmful to human beings?
5. Write name of any bacterial disease?
6. Write name of any viral disease?
7. Write name of any two sucking insect pests?
8. Write name of any two fruit and shoot borer insect pests?
9. How the plant diseases spread from one place to other?
10. Whether a single pest can harm more than one crop? Give example.

b) Answer in one-two sentences:

1. What are the different methods of plant protection?
2. What are transgenic?
3. What type of situation arises due to failure of plant protection technology?
4. What are the different sucking insect pests of crops?
5. How viral diseases are transmitted and what are their management practices?
6. What are the major fungal diseases of crops?
7. Write the various characteristics of insects to make them most abundant on this earth?
8. How fruit and shoot borer insect cause damage to crops?
9. How leaf feeding insect cause damage to crops?
10. What are precautions to keep in mind at the time of use of insecticides?

c) Answer in five-six sentences:

1. How insect pest damage the crops?
2. What are the major causes of diseases?
3. What is the importance of plant protection?
4. What plant protection measures should be adopted before the attack of insect pest?
5. What plant protection measures should be used after the attack of insect pest?

Activity

- Collect different specimen of insect pest and diseases of crop and prepare a record file.

Lesson-7

NUTRITIONAL GARDEN

Balanced diet is vital for human health. It contains of right amount of essential nutrients such as carbohydrates, proteins, fat, vitamins, minerals and water as required by the body. These essential nutrients are present in different foods like cereals, pulses, vegetables, fruits, milk, eggs, meat, fish etc. Fruits and vegetables are important source of vitamins and minerals and thus prevent many nutritional deficiency diseases like night blindness due to deficiency of vitamin A, anemia due to deficiency of iron. Similarly Vegetables and fruits are good source of dietary fibers. These fibers are helpful in proper functioning of human digestive system. Vegetables and fruits can be grown in domestic nutritional garden to get all the essential nutrients of balanced diet. The other advantages of nutritional garden are:

1. **Balanced diet:** Health experts of Indian Council of Medical Research (ICMR) recommend the consumption of balanced diet consisting of 280-300gm vegetables, 50 gm fruits and 80 gm pulses. However rural people consume very less amount of these food materials.
2. **Chemical free diet:** Even farmers purchase the vegetables and fruits from market for their consumption which are produced by using different types of chemicals like insecticides, herbicides, fertilizers. Sometimes commercial vegetable growers use these chemicals in excess and more frequently which are not recommended by the agricultural experts. Consumption of such vegetables and fruits may prove harmful to human health. Vegetables and fruits produced in domestic nutritional garden are free from harmful chemicals.
3. **Proper use of free time:** All the members of family can perform different agricultural operations in the nutritional garden to make proper use of their free time. It will also serve as a recreational activity for the family members.
4. **Reduced domestic expenditure:** The vegetables, fruits and pulses produced in the domestic nutritional garden helps to reduce the domestic expenditure too by fulfilling the domestic needs.

5. **Fresh fruits and vegetables:** Whenever fruits and vegetables are purchased from the vendor, these are stalled as these are sold with time lg. But these products can be had fresh from the nutritional garden.

To produce vegetables and fruits free from harmful effects of agrochemicals, Punjab Agricultural University, Ludhiana has developed a model of nutrition garden (Table 7.1). According to this model, a family of eight members can meet their domestic requirements of vegetables, fruits and pulses from three kanal areas. From the total three kanal areas, one kanal is used to grow vegetables and two kanals is used to produce pulses. Fruit plants like guava, papaya, lemon, pear, peach, plum, kinnow and grapes can easily be planted in two rows on north side to avoid shade effect on vegetable and pulse production.

Important Points in Developing a Nutrition Garden:

Selection of field: Nutritional garden must be developed near to the residential place so that members can make best use of the free time to work in this garden. Waste water of the house can be drained into the nutritional garden for irrigation purposes. The selected place should not be shady and sufficient sunlight should be available throughout the day.

Selection and planning of vegetable crops: Vegetable crops should be selected keeping in view the liking of the family members. Cucurbits like bottle gourd, spring gourd, summer squash, muskmelon, bitter gourd should be sown in outer rows of nutritional garden so that vines could be trained on bushes/trees or walls. Freshly consumed perishable vegetables like radish, *palak*, turnip, carrot, cucumber, salad gourd, *dhania , methi* etc should be sown at regular interval in small quantity, so that regular supply of these vegetables can be ensured for meeting family needs. Short duration crops like radish, *palak,* turnip etc can be intercropped in long duration crops like tomato, *brinjal*, ladyfinger etc.

Use of Manures: Preference should be given to the use of organic manures in the nutritional garden. Well rotten farm yard manure should be used in nutrition garden. Compost manure can be prepared from house hold waste. Use of chemical fertilizers should be minimum in the nutritional garden.

Management of weeds, insect-pests and diseases: Weeds should be controlled with hand hoeing or mechanical hoeing. Similarly, for the insect pest management, bio-control methods should be preferred e.g. insect-pests can be killed manually at initial stages of infestation. Install a light at one corner of the nutritional garden.

All the insects will gather around the light in the evening. Spray the insecticide on the gathered insects. Seeds of recommended varieties should be sown. If the insect-pests damage increases, the chemical control measures can be used as per the recommendations of agricultural experts. Safe chemical with less residual effects should be preferred and vegetables should be harvested after the waiting period is over.

Harvesting of vegetables: Vegetables should be harvested regularly and consumed fresh. In case of excess of any vegetable or fruits, it can be preserved by preparing squashes, jams, pickles, preserves to be used at any time of the year.

Medicinal plants: Certain plants having medicinal properties can also are grown in nutrition garden. The plants like *tulsi* and *neem* make the air cleaner and repel the small insect-pests. Some other plants like coriander, mint, *suanf, ajwain* etc make the food tasty and more palatable.

Model of Nutritional Garden for meeting domestic consumption of vegetables

Bitter Gourd (February) Black Carrot (September)	Sponge Gourd (February) Bitter Gourd (July)	Bottle Gourd (February) Brinjal (June) Turnip (September)	Muskmelon (February) Early Radish (June)
Squash melon (February) Pea (October)	Cucumber (February) Okra (June) Radish/*Palak* (October)	Summer Squash (February) Radish (June) Carrot (August)	Sponge Gourd (February) Tomato (August)
Chilli (March) Potato (October)	Okra (February) Early Cauliflower (June)	Tomato (February) Coriander (August)	Sweet Pepper (February) *Brinjal* (August)
Cowpeas (February) Radish (July) Potato (October)	*Brinjal* (February) Cabbage (September)	French bean (February) Garlic (September)	Onion (January) Cowpeas (June)*Kharif* Onion (August)
Vegetable Nursery Potato (January)	Cauliflower (August) French bean (June)	Watermelon (Feburuary) Pea *Mithi Phalli* (October)	*Arvi* (February) *Palak/Methi* (September)
Moong (Summer/*Kharif*) Gram (Rabi)	*Moong* (Summer/*Kharif*) Gram (Rabi)	Mash (*Kharif*) Lentil *(Rabi)*	Mash *(Kharif)* Lentil (*Rabi*)

English and Common names of the Vegetables

English Name	Common Name	English Name	Common Name
Bitter Gourd	*Karela*	Okra	*Bhindi*
Sponge Gourd	*Kali Tori*	Sweet Pepper	*Shimla Mirch*
Bottle Gourd	*Ghia Kadoo*	Tomato	*Tamatar*
Squash Melon	*Tinda*	Garlic	*Lassan*
Summer Squash	*Chappan Kadoo*	French Bean	*Phallian*
Muskmelon	*Kharbuza*	Potato	*Aloo*
Watermelon	*Tarbooz*	Cowpeas	*Lobia*
Brinjal	*Baingan*	Radish	*Mooli*
Chilli	*Mirch*	Turnip	*Shalgum*
Cucumber	*Kheera*	Pea	*Matar*
Cauliflower	*Phulgobhi*	Coriander	*Dhania*
Cabbage	*Bandgobhi*	Carrot	*Gajar*

Nutritional Garden

Exercise

a) Answer in one-two words:

1. What is the daily requirement of vegetables for a healthy person as per ICMR?
2. How much fruits a healthy person should consume daily, according to ICMR,
3. Name the disease caused due to the deficiency of vitamin A
4. Name the disease caused due to the deficiency of iron.
5. Which agricultural university has prepared the model for nutritional garden?
6. Name any two cucurbit vegetables.
7. Name any two fruits that can be grown in nutritional garden.
8. Write the names of any two medicinal plants that can be grown in nutritional garden.
9. How much area is required for development of nutritional garden for family of eight members?
10. What should be the appropriate location of nutritional garden?

b) Answer in two-three sentences:

1. Name the different nutrients present in balanced diet.
2. Write the daily dietary recommendation of ICMR for a healthy person.
3. Why nutritional garden should be developed near to the house.
4. What is the role of vegetables and fruits in human health?
5. Which type of methods should be preferred for insect pest management in the nutritional garden?

6. What type of manures should be used in nutritional garden?
7. How the surplus vegetables and fruits can be preserved for future use?
8. What points should be kept in mind while selecting a place for establishing nutritional garden?
9. Why the dietary fibers are important for human health.
10. What purpose the medicinal plants grown in nutritional garden can serve?

c) Answer in five-six sentences:

1. Explain the concept of balanced diet for human health
2. What is the importance of developing a nutritional garden?
3. How the insect pests and diseases are controlled in nutritional garden.
4. Write the important points for developing a nutritional garden?
5. Name five different vegetables of summer and winter along with their sowing time..

Activities:

1. Students should practice to develop nutrition garden at their school and house.
2. Install an electrical light on one corner of the nutritional garden and spray insecticide in the evening on the gathered insects.

Chapter-8

ORNAMENTAL PLANTS

There is a unique place of ornamental plants like trees, shrubs, climbers and seasonal flowers for the beautification of our surroundings. These ornamental plants are planted in buildings, play grounds, avenue plants, colonies, public parks and also near the ponds. These plants increase the beauty of the area and also protect the soil from erosion. They play an important role in cleaning of our living environment. These can be of following types:

1. Ornamental trees

The trees contribute a lot to clean our environment. A judicious planting of trees enhances the beauty of the surroundings. The trees selected for gardening purpose should be hardy, requiring little maintenance and easy to grow. The selection of trees depends upon many factors which are kept in mind while selecting trees for a particular situation and use.

i) **Specimen tree:** Such trees are planted singly for their attractive shape, beautiful foliage, flowers or for drooping branches. e.g. Araucaria, Pagoda, Lal gulmohar, Amaltas etc.

ii) **Shady trees:** These trees have mostly round or umbrella shaped canopy. The leaves of these trees are large and dense so that very little sun is allowed underneath. Examples are Neem, Satpatia, Pipal, Pilkan, Molsari, Shehtoot, Sukhchain, Jamun etc.

iii) **Flowering trees:** These trees are planted for their beautiful flowers. Common examples are – kachnar, Amaltas, Nili gulmohar, Lal gulmohar etc.

iv) **Trees for road side or avenue:** These trees are planted alongside avenues or roads and are generally for shade or flowers. Commonly planted trees are Amaltas, Silver oak, Nili gulmohar, Pilkan,Kusum, Chackrasia etc.

v) **Screening purpose:** Tall and upright trees are planted very close to each other to give a look of curtain or screen. Such trees are planted to hide some object or side. Examples are Silver oak, Eucalyptus, poplar, Ashok (long), Pinari etc.

vi) **For checking air pollution:** Industries are the major source of pollution. Trees with thick leaves and deciduous nature are more successful in these areas. Common examples are Shehtoot, Poplar, Pagoda, Pilkan etc.

vii) **Trees for fragrant flowers:** These trees produce fragrant flowers and are suitable for planting in temples and gurudwaras. Trees with fragrant flowers are Pagoda, Sonchampa, Barrachampa etc.

viii) **For medicinal purpose:** Parts of many trees are used for medicinal purpose like Neem, Eucalyptus, Mahua, Arjun, Jamun etc.

2. Ornamental Shrubs

Ornamental shrubs also have great role to increase the beauty of our surrounding area. Shrubs can be planted at a very ease when we have limited space and can not accommodate trees. Selection of shrubs is as under:

i) **For beautiful flowers:** China rose, Bogainvillea, Single chandni, Pili Kaner, Raat Ki

Raani etc.

ii) **For foliage beauty:** Mussenda, Acalypha, Euphorbia etc.

iii) **For making hedge:** Alier, Kamni, Clerodendrum, Cassia, Pili kaner, etc.

iv) **For use as ground cover:** Lantana, Dwarf Ixora etc.

v) **For planting near foundation:** Tecoma, Acalypha etc.

3. Ornamental Climbers

Climbers are the plants which have weak stem and have specialized organs for climbing upon a support. Climbers add beauty in the garden by their beautiful foliage and fragrant flowers. Climbers can be planted near walls, trees etc. so that they can get support to climb upon these structures. Climbers are selected based on different situations as under:

i) **For sunny situation:** Golden shower, Jhumka veil, Lahsun veil, Bogainvillea etc.

ii) **Heavy climbers:** These climbers produce luxuriant vegetative growth and grow very fast. These climbers are suitable for planting in bigger areas e.g. Begonia, Jhumka veil, Madhavilata, Golden shower , Bougainvillea etc.

iii) **Light climbers:** These climbers grow very slowly and remain light in spread. These climbers are suitable for planting in limited spaces. For example. Lonicera, Sweet pea etc.

iv) **For fragrant flowers:** e.g. Chameli, Madhavilata, etc.

v) **For pots:** Bogainvillea, Butterfly pea etc.

vi) **For making hedge:** Bogainvillea, clerodendrum, Asparagus

vii) **For interior/indoor decoration:** These climbers are planted in the pots and are kept inside the houses e.g. Money plant.

viii) **For screening purpose:** Curtain creeper, Golden shower etc.

4. Seasonal flowers

Seasonal flowers complete their life cycle in one season or one year. They are also called annual flowers. Based on season they are classified into following three groups.

i) **Summer season annuals**

The seeds are sown in the month of February-March and seedlings are ready for transplanting after about 4 weeks. Common summer season annuals are Kochia, Portulaca, Coleus, Zinnia, Sunflower, Gaillardia, Gomphrena etc.

ii) **Rainy season annuals**

The seeds of these annuals are sown in the first week of June and seedlings are ready for transplanting in first week of July, Common rainy season annuals are Balsam, Cock's comb, Amaranthus etc.

iii) **Winter season annuals**

The seeds of these annuals are sown during mid-September and seedlings are ready for transplanting in mid-October. There are large number of winter season annuals, which can be used for different purposes in the garden. Common winter season annuals are Calendula, Dahlia, Petunia, Marigold, Annual chrysanthemum, Pansy, Ice flower, Sweet Pea, Dog flower etc

Exercise

(a) Answer in one to two words:

1. Give one example for specimen Tree.
2. Write the name of the tree with fragrant flowers.
3. Give one example of the shrub suitable for making hedge.
4. Write the name of two flowering shrubs.

5. Write a name of the shrub bearing fragrant flowers.
6. Give one example of the tree having medicinal value.
7. Name the climber useful for making curtain.
8. Name one Climber useful for interior decoration.
9. Name one summer season annual flower.
10. Which month is suitable for seed sowing of winter annuals?

(b) Answer in one to two sentences:

1. Give the characteristics of a shady tree.
2. Name any four shrubs bearing beautiful flowers.
3. Where the climbers can be suitably planted in the garden?
4. Write the name of any two climbers bearing fragrant flower.
5. Give the characteristics of ornamental shrubs.
6. What are seasonal flowers?
7. What is the purpose of planting trees along the road side?
8. What types of trees are selected for making tall hedge?
9. What is the purpose of planting specimen tree?
10. Where the shrubs are used easily?

(c) Answer in five to six sentences:

1. What are the benefits of planting ornamental trees?
2. Write a short note on selection of ornamental shrubs.
3. How the climbers can be selected for different situations?
4. Classify the seasonal flowers according to their season.
5. How the ornamental trees are selected for different purposes? Give examples.

Activity

- Collect different specimens of ornamental plants and prepare a record file.

Chapter-9

SAFE STORAGE OF FOOD GRAINS

There has been many fold increase in food grain production in India. Safe storage of food grains is necessary as it is produced by the hard work of farmers. Food grains are stored for domestic consumption, animal feed, seed and to earn monetary benefits at later stages. The Government stores the food grains to tackle adverse conditions and export it to other countries. Based on an estimate, about 10 per cent of food grains are lost from harvesting until its consumption. These losses took place at harvesting, threshing, transportation and storage of food grains. Insect pests, rodents and birds are mainly responsible for food grain losses. Deterioration of nutrients and change in taste also occurs in damaged food grains. Sometimes such food grains become unsuitable for human consumption.

Harmful insect pests

Usually stored grain insect pests survive in cracks and crevices in floor, walls and roofs of storage structures. Similarly, use of old gunny bags for storage also results in storage losses. The damaged old grains also serves as source of infestation for new food grains to be stored. Approximately 20 insect pests attack stored grains out of which *Khapra* beetle, rust red flour beetle, grain weevil, lesser grain borer, Angoumois grain moth and rice moth cause substantial losses. *Dhora* mostly cause huge damage to chick pea, moong and other pulses.

Grain moths: Angoumois grain moth lays eggs on earhead of crop in the field. The population goes on increasing after threshing and storage of grains. It gives eggs on the upper surface of stored grains. The larvae of grain moth feed on

Larvae and adults of Angoumois grain moth

Food grains Infested by grain moth

internal parts of grains and make them hollow from inside. Normally a small hole is seen on such grains. In later stage, these insects can be seen on grain surface and flying in the store.

2. Grain Weevils: Among these, rice weevil is most important. It lays eggs within the grains. The larvae emerging from these eggs feed inside the grains and then converts into pupa within the grains and emerge as adult. The damage is done by both the grubs and adults by eating and hollowing the grains.

Rice Weevil

3. Beetles: *Khapra* beetle is one of the most destructive pests of stored grains. These have yellow hairy growth on its body. Normally it is found in the crevices of the walls. It causes damage to grain embryo initially but in severe infestation, there is complete reduction of grains to frass. The insect infestation increases the temperature of grains and destroys grains by their excreta. *Khapra* beetle feeds on the stored grains whereas rust red flour beetle feeds on broken grains causing considerable damage to flour.

***Khapra* beetle**

4. Pulse beetle (*Dhora*): It feeds on stored pulses and damage can be identified by white spots present on stored pulses which are actually their eggs. Among these, moong dhora and chickpea dhora are most damaging insects.

Pulse Beetle or *Dhora* of pulses

Integrated management of stored grain pests

Saving of grains from stored grain insect pests is an important task. To remain self sufficient, we must save stored grains from these insect pests. The grains should be dried properly before storage. The moisture content of grain to be stored should not be above 12-13, 10 and 9-10 per cent in rice, groundnut, sunflower and oilseeds, respectively. When temperature drops below 65^0F, these insects stop egg laying and dies below 35^0F. Do not store the new stocks and old infested/broken grains together in the same store.

Methods of grain storage: To minimize the losses caused by these insect pests, grains should be properly stored. The different storage methods are described below:

A. For Domestic Consumption:

1. *Dhol*: For domestic consumption, grains can be stored in iron made storage structures which are readily available in market. Stored grain insect pests and rodents cannot enter these storage structures and the environment within these stores is also not conducive for the growth of insect pests present within the grains. These are cheap and can be easily transported from one place to other. Before storage, the structures should be properly cleaned. The lid should be tightly closed. Grains should be dried properly in sunlight before storage. The moisture content of the grains should not be above 9 per cent at the time of storage.

2. *Pakki kothi*: Some farmers use *pakki kothi* for grain storage. Following things should be kept in mind before preparing such structures:

i. The wall of *kothi* should be kept 45-60 cm away from the walls of other rooms.

ii. The floor level of *kothi* should be 30-45 cm above ground level so as to maintain proper moisture content.

iii. Plastic sheet should be placed on the floor and walls of the store to make it moisture proof.

iv. The opening of the *kothi* should be kept at top for filling the grains and another opening should be kept at base to take out grains.

v. Store clean and dry grains in the *kothi*.

3. **Grain storage room:** Now a day farmers construct permanent rooms for grain storage and such stored grains can be sold at higher price in grain market. The floor level of such rooms should be 75 cm above ground level. A courtyard is constructed around such storage room and one door and minimum ventilator should be kept in such room. The wall of the room should be clean and properly white washed. These rooms are used for staking of gunny bags filled with grains. The gunny bags should be kept in rooms only after proper drying of room. The gunny bags should be kept 1.5-2.0 feet away from walls of the room.

B. Commercial Grain Storage:

These storage structures are required due to more grain production, number of such stores have been constructed in Punjab. These are of three types:

1. Conventional Godowns: The gunny bags filled with grains are kept in such godowns. The grains of different crops can be stored for 1-2 years in such godowns. The moisture content of the grain to be stored should be not b e more than 14-15 per cent. These godowns have elevated floors with no moisture and these are bird and rat proof. These have access to sunlight, road and railway links. The gunny bags should be kept on wooden frames and covered with polythene sheets.

2. Silos: Except rice and pulses all types of grains can be stored in these silos for up to 5 years. In these stores moisture content of grains can be up to 10 per cent. These require less space and grain damage is very less in these types of stores. These silos are of cylinder shape and bottom is hopper type. Generally these are made up of iron and concrete. Long belts and conveyers are used for filling and taking out the grains.

In these stores grains are cleaned. In India, height of silos is 30-50 meter and diameter is 6-10 meter. Centrifugal pumps are used for the aeration of these silos.

3. **CAP Godowns:** These are known as cover and plinth godowns and this is the method to keep the grains safely in open. Size of these godowns is 9.5x6.1 meter In this bags are kept on wooden racks in 6-6 rows. In one godown there should be 96 bags. Bags are covered with thick polythene sheet. This polythene sheet is removed when outside temperature and relative humidity is low

Important hints to save the grains from insect pests in godowns:-

1. Store new grains in clean godowns or bins.
2. Plug all the cracks and crevices in the godown.
3. Always use new gunny bags for the storage of grains. If old gunny bags are to be used, these should be dipped in the solution of Sumicidin or Cymbush insecticides. Dry these gunny bags in shade and then fill with grains.
4. To disinfest the godowns and bins:
   i. Spray 100 ml Malathion 50 EC in 10 litre of water on floor, walls and ceiling of the godown. OR
   ii. Fumigate the godowns/bins with aluminum phosphide @ 25 tablets per 100 cubic meter and keep the godown air tight for 7 days.
5. Moisture content in grains should not be more than 10-12 per cent.

Credit facility for constructing godowns:

Nationalized Scheduled Banks, Punjab Scheduled Castes Land Development and Financial Corporation, Punjab Financial Corporation etc provides credit facility for constructing godowns. Food procurement agencies such as Food Corporation of India, MARKFED, Deptt of Food Supply Punjab, CentralWarehousing Corporation etc take these godowns on rent on a long tern lease.

Exercise

a) Answer in one-two words:

1. Name any two stored grain insect pests.
2. Name one insect which attacks moong and gram.
3. Write two methods to store cereals at household level.
4. Write different types of godowns used to store grains at commercial level.

5. What should be the moisture content in cereal grains for storage?
6. What should be the minimum distance of cereal bags from the wall of godown?
7. How many gunny bags can be stored in one CAP godown?
8. Name any one insecticide which is used to disinfest godowns.
9. Name any one agency providing credit for constructing godowns.
10. Name any one agency hiring the godowns on rent.

b) Answer in one-two sentences:

1. How weevil cause damage to rice?
2. Why broken grains should not be stored in the godowns.
3. Why gunny bags should be placed away from the walls of the godown?
4. What do you mean by silos?
5. How godowns and bins can be made free from insect pest?
6. How old gunny bags can be disinfected before filling the grains?
7. What do you know about CAP godown?
8. Write down precautions for the storage of grains in bins.
9. What type of rooms should be constructed for the storage of grains?
10. What types of credit facilities are available for constructing godowns?

c) Answer in five-six sentences.

1. Why should we control insect pests of stored grains?
2. What points should be kept in mind while constructing a*pakki kothi*?
3. List various insect pests of stored grains.
4. How we can save the grains from insect pests?Write in detail.
5. Describe various types of godowns which are used to store grains at commercial level.

Activities

1. Visit the godowns where grains are stored and observe different methods of grain storage.
2. Prepare a list of various insecticides which are used to protect the stored grains from insect pests.
3. Get the information from the agricultural cooperative bank or nationalized bank for getting credit facility for constructing godowns. Practice in filling the form and preparing other documents for this purpose.

Chapter-10

CONSERVATION OF NATURAL RESOURCES

Nature provides us a variety of goods and services which are called natural resources e.g. air, water, soil, minerals, solar energy, plants, trees, animals and microorganisms. These can be classified into two categories:

Types of natural resources

1) **Renewable resources**: Resources which can be replenished after use are called renewable resources like forests, wild life, wind enegy, biomass energy, tidal energy, hydro-power, solar energy etc.

2) **Non-renewable resources:** The resources which are available in fixed quantity and can exhaust after use and cannot be renewed are called non-renewable resources like coal, iron, petroleum and minerals etc.

Pollution and misuse of natural resources:

1) Natural resources have direct link with agriculture and food. Traditionally agriculture was dependent on rainfall due to which the production was low. With the development of tube well irrigation, production has increased but it resulted in lowering of ground water table.

2) Overuse of fertilizers and chemicals in agriculture resulted in increased pollution of soil, water and environment.

3) Urbanization and industrialization has also led an increase in air, soil and water pollution.

4) Natural resources are over exploited by technologically advanced and developed countries whereas increasing population in China and India is eating up natural resources.

5) Vanishing of forests from earth has resulted in climate change and emission of dangerous gases in the atmosphere has led to increase in temperature.

6) Deforestation in hilly area has resulted in increased siltation in dams, soil erosion, floods and landslides.

7) Water borne diseases are increasing due to water pollution.

Major Natural Resources:

1. Air: Pollution of air is a major problem of the world. Gases like carbon mono-oxide, carbon dioxide, nitrogen oxides, sulphur dioxides, lead oxides, chlorofluorocarbon and smoke etc emitted from vehicles, factories and other sources are increasing the air pollution. It results in depletion of ozone layer around earth, thereby increasing the exposure to ultra-violet radiations coming from Sun causing many diseases like cancer. Acid rains are coming and there is increase in bronchial diseases. Air pollution can be controlled by following methods:-

a) Plantation of trees decreases carbon dioxide and increases supply of oxygen for required for breathing by living beings.

b) Sulphur and lead free petrol should be used.

c) Smoke of factories should be cleaned by installing devices and height of chimneys should be increased.

d) Filter plants should be installed to clean air.

e) Poisonous gases containing smoke should be cleaned by passing through water spray.

f) Less polluting engines and oils should be used in transportation.

g) Solar energy, biogas, gas and electricity should be used as fuel instead of coal.

h) Straw should be used for production of electricity, biogas, composting, industrial use, its incorporation into soil and use as mulch instead of burning in the field.

i) There should be ban on nuclear explosions for testing and war.

j) All railway lines should be electrified.

2. Water: Water is a source of life. Although 70% of earth is covered by water but 97% of water is saline and only 3% is fresh water. Out of 3% fresh water, 2% is present on poles as ice and only 1% is usable which is present in rivers, lakes and beneath the rocks. In India, 90% water is used for irrigation in agriculture, 7% used in industry and only 3% for domestic purpose. Demand for clean water is increasing due to increased population. Due to these reasons water level is falling down every year. Not only the amount of underground water is decreasing but also its quality is decreasing day by day. Poisonous chemicals from industry, sewage of cities, towns and villages is polluting river waters at a faster rate.

Therefore, it is most important to conserve water. Water can be conserved as under:

a) Conservation at domestic level:

1) Fruits and vegetables should be washed in water tub instead of under running tap.
2) Utensils should be washed in a tub containing soap solution.
3) Instead of washing utensils one by one, wash all the utensils once after completing kitchen work.
4) Before washing, clothes should be dipped in water for half an hour.
5) Water left after washing clothes should be used to clean floor or animal shed.
6) Floor should be cleaned with a piece of water soaked cloth instead of direct flushing of water.
7) In house, flush tanks should be small and with valve.
8) Tap should not be kept open all the time during different operations like brushing, shaving and water should be used as per need.
9) Vehicles like car, motorcycle, scooter etc should be cleaned with a piece of cloth instead of washing with water pipe.
10) Kitchen waste water can be applied to kitchen garden, lawn or pots.
11) Car can be washed in lawn to irrigate lawn.
12) Kitchen garden and lawn should be irrigated with sprinkler to save water. Application of irrigation early in the morning results in infiltration of whole water to soil and less water loss through evaporation. Instead of applying water every day to lawn, irrigate as per need.
13) Leaking taps and tanks should be repaired.
14) Install small opening taps in home.
15) Rain water should be recharged into ground through bore or stored in tank for reuse.

b) Conservation in Industry:

1) Automatic opening and closing valves should be installed to use water as per need.
2) Water should be reused as in thermal plants.
3) Water treatment plants should be installed for reuse of water.
4) After treatment water can be used for irrigation purposes.
5) Concrete or plastic sheet ponds should be used to store water and anti evaporation chemicals can be used to stop water evaporation from these ponds.

c) Conservation in agricultural fields:

1) Cultivation of crops requiring less water.
2) Rainwater should be used to recharge underground water.
3) Irrigation water should be used judiciously, as per recommendations of Punjab Agricultural University.
4) To use irrigation water more efficiently, the water channels should be cleaned regularly and wherever possible, concrete channels should be built.
5) Sprinkler and drip system can help to reduce the requirement of irrigation water in many crops.
6) Sprinkler system should be used in sandy and sand dune land where more expenditure is required for leveling the land.
7) Laser land leveler should be used for leveling the field. Paddy crop should not be cultivated in sandy soils.
8) May and June months are hot and dry, so the crop sown during these months requires more water. Paddy should not be transplanted before 15 June.
9) In paddy, water should not stagnate continuously after first 15 days of transplanting. Tensiometer can be used for saving irrigation water in paddy,
10) In sandy soils make 16 plots and in heavy soil make 8 plots per acre to save irrigation water.
11) Sowing of crops on bunds/beds saves irrigation water.

12) Use of paddy or any other straw in crops for mulching can also save water.

3. Soil

Soil is the most important natural resource for agriculture. Besides providing medium for germination and crop growth, soil also supplies nutrients to crops. Demand of land for industry, urbanization, buildings and power plants etc has resulted decrease in agricultural land. Deforestation has increased the problem of soil erosion. Increase in cropping intensity has resulted deficiency of nutrients and deterioration of soil quality. Soil can be conserved as under:

1) In hilly area crops should be sown across the slope to decrease soil erosion.
2) Agro-forestry is helpful to decrease soil erosion.
3) Terrace farming should be done on slopes.
4) Compost from crop residues, green manuring, farmyard manure and biofertilizers should be used.
5) Leguminous crops should be included in crop rotation as it fixes atmospheric nitrogen into soil.
6) To conserve soil from wind erosion, wind breaker trees and bushes should be planted.
7) Growing of grass on slopes can reduce the soil erosion.
8) Balanced fertilizers should be used in crops.
9) Organic farming should be promoted.

Natural resources are important for human life. So we should conserve these resources.

Exercise

a) Answer in two-three words:

1. Name two renewable natural resources present around you.
2. Name two non renewable natural resources.
3. Write the names of two poisonous gases released from different sources to air.
4. Name two dangerous elements in petrol.

5. How much percentage of water on earth is useable?
6. Name the new, efficient and need based irrigation techniques to crops.
7. How many plots should be made per acre in sandy soil?
8. Which crops should be included in crop rotations to increase soil productivity?
9. Which type of farming should be done on slopes?
10. Write one benefit of mulching?

b) Answer in one-two sentences:

1. Why leguminous crops should be grown?
2. Name renewable natural resources?
3. What types of manures are prepared from crop residues and domestic wastes?
4. Give five points to save water at domestic level.
5. What are the types of natural resources?
6. Give in brief about non-renewable natural resources.
7. Why ozone layer around earth is depleting?
8. Why agricultural land is decreasing?
9. How use of laser land leveler is helpful in saving water
10. Write two points to save water in industry.

c) Answer in five-six sentences:

1. What type of problems are associated with overuse of natural resources?
2. What measures can be followed to reduce air pollution?
3. How water can be used efficiently in agriculture?
4. Write your views about soil conservation.
5. Write a note on misuse and pollution of natural resources.

Activity

Prepare a report on degradation of natural resources in your vicinity.

Chapter-11

BIOGAS

From the different renewable energy sources, biogas energy is most suited for all locations, weather and climates. There is small quantity of wood available in Punjab state due to the shortage of forest. Due to this reason, people living in the rural areas use almost 50% of cattle dung for burning. This cattle dung can be utilized in the fields to improve soil health. To provide smokeless fuel to the rural people for cooking purposes and to improve soil health, biogas technique can be used.

What is biogas?

Anaerobic fermentation (i.e. the fermentation in the absence of air) of cellulose containing organic materials like cattle dung, poultry droppings, pig excreta, human excreta, crop residues and kitchen waste etc leads to the production of combustible gas which is called biogas. Initially cow dung was mainly used as fermentable material for the production of biogas. Thus biogas plants in India were mostly popular by the name of *gobar* gas plant. Biogas can be used as cooking fuel, lighting purposes and for running dual fuel engines. This gas is not in liquid form as in Liquefied Petroleum Gas (LPG)

Composition of Biogas

Biogas is a mixture of number of gases. Its composition is as follows:

Sr No.	Gas	Proportion
i.	Methane (CH_4)	50-65%
ii.	Carbon dioxide (CO_2)	30-40%
iii.	Hydrogen (H_2)	1-5%
iv.	Nitrogen (N_2)	1%
v.	Hydrogen sulphide (H_2S)	0.1%
vi.	Oxygen (O_2)	0.1%
vii.	Water vapors (H_2O)	0.1%

Importance of Biogas

By the use of 1 m^3 of biogas, the under mentioned sources of energy can be saved:

One m^3 of biogas	=	0.52 liters of diesel
	=	0.62 litre of kerosene oil
	=	3.50 kg of wood
	=	12.30 kg of cow dung cakes
	=	1.46 kg of charcoal,
	=	0.43 kg of LPG
	=	1.60 kg of coal
	=	0.47 kW of electricity

Advantages of Biogas Technology

1. The use of biogas in the kitchen saves the expenditure on other fuels such as kerosene, coal, firewood.
2. The biogas also provides a conventional and cheap source of power for lighting, heating, irrigation pumps and also can run generator to produce electricity.
3. The use of biogas technology helps to reduce environmental pollution as it is a smokeless fuel.
4. It is a clean source of energy. Use of biogas, prevents chances of eye diseases and respiratory diseases among the rural people while working in the kitchen.
5. All objectionable odour from the bio wastes is removed and most harmful organisms are killed in biogas plant digested wastes. Therefore the use of pesticides, weedicides can be reduced when digested dung is used for the crops as fertilizer.
6. Bio-digested slurry can be applied to the fields as fertilizers. It is a good source of nitrogen and phosphorus nutrient to the crops.
7. Latrine can be attached with the biogas plant. Thus, there is a saving of money for construction of a separate septic tank.

Biogas Plants

The whole system in which anaerobic fermentation of cellulose containing organic material takes place and produces biogas, is called biogas plant. This biogas plant consists of mainly two parts:

- A digester or fermentation tank with an inlet chamber for the entry of fermentable mixture (cow dung and water) in to the digester and outlet chamber for exit of digested slurry.
- A gas holder for the collection of biogas produced by fermentation in the digester. It would also help to maintain anaerobic conditions in the digester.

Classification of Biogas Plants

On the basis of the capacity, the biogas plants are classified into three categories.

1. Family size biogas plants
2. Institutional biogas plants
3. Community biogas plants

1. Family Size Biogas Plants

This type of biogas plants are installed at individual family level. The biogas from this type of biogas plants are used by the individual family. The size of these plants is recommended up to 6 m^3 per day.

2. Community Biogas Plants

It is a plant to be used by a group of people as a community. These types of plants are installed by a Village Panchayat/Municipal Committee for any Village/Mohalla/Town/City. The biogas produced from this type of plant is distributed to the people living in that locality. The size of these plants is recommended to be more than 15 m^3 per day.

3. Institutional Biogas Plants

These types of biogas plants are installed by an institution such as religious institution like *Gurudwara/Mandir/Gowshala* or educational institution like School/College or Industry. The biogas produced from these plants is used for the respective institution. The size of these plants is recommended also to be more than 15 m^3 per day.

Designs of Biogas Plants

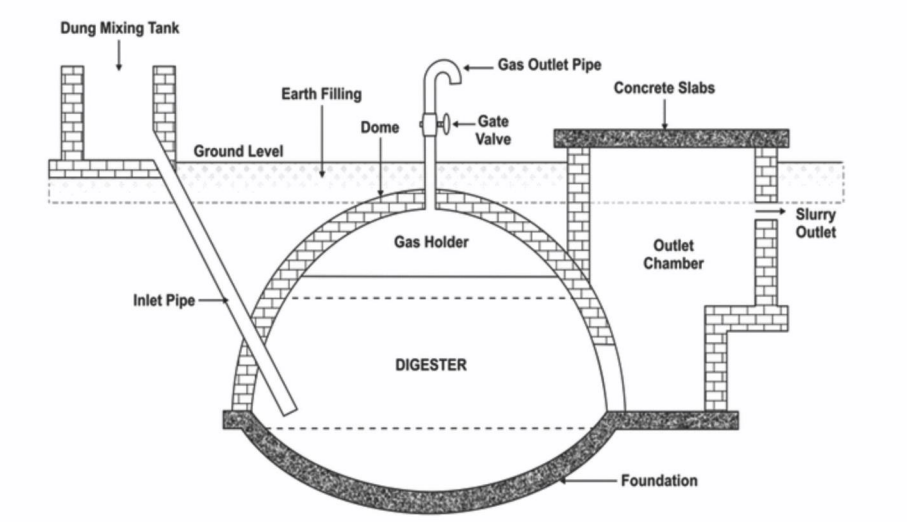
There are two basic designs of biogas plants:

(i) Deenbandhu Model Biogas Plants

(ii) PAU Kutcha – Pucca Janta Model Biogas Plant

(i) *Deenbandhu* Model Biogas Plants

Deenbandhu model biogas plant was developed by AFPRO (Action for Food Production, New Delhi) in 1984. The world *Deenbandhu* is meant as the friend of the poor. This plant is designed on the principle that the surface area of biogas plants is reduced (minimized) to reduce their installation cost without sacrificing the efficiency of the plant. The design consists of segments of two spheres of different diameters, joined at their base. The structure thus formed act as the digester as fermentation chamber as well as the gas storage chamber. The digester is connected with the inlet pipe and the outlet tank. The upper part above the normal slurry level of the outlet tank is designed to accommodate the slurry to be displaced out of the digester with the generation and accumulation of biogas and is called outlet displacement chamber. The size of these plants is recommended up to 6 m^3 per day. The different components of *Deenbandhu* Model Biogas Plant are shown in figure:

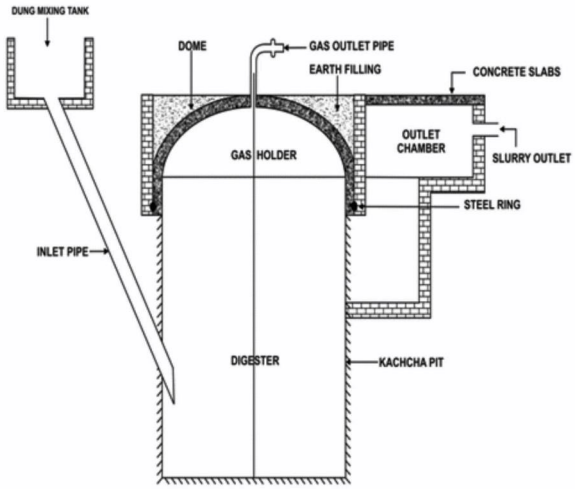


Deenbandhu Model Biogas Plant

ii) PAU Kutcha-Pucca Janta Model Biogas Plant

The construction of biogas plant is costly, due to constantly increasing cost of steel, cement and bricks. Therefore it is absolutely necessary to dispense with the costly construction material altogether or to reduce their quantity to bring down cost. Based on this principle, Punjab Agricultural University (PAU), Ludhiana designed Kutcha-Pucca Janta Model Biogas Plant and cost of the plant was brought down to 25 % to 40 % of the cost of conventional models, as digester was not lined with bricks but was an ordinary dug pit.

For this plant, dig a pit of the required diameter and depth as in the Janta biogas plant. Construct the masonry dome as in the conventional *Deenbandhu* biogas plant. The inlet and outlet for the entry and exit of the dung slurry are also similar to the conventional *Deenbandhu* plant. The different components of PAU Kutcha-Pucca Janta Model Biogas Plant are shown in figure:



PAU Kutcha-Pucca Janta Model Biogas Plant

Selection of proper size of biogas plant

The size (capacity) of biogas plant means the quantity of biogas (in cubic meters) can be obtained from it in 24 hours. The size of the biogas plant largely depends upon the number of cattle that a person or an institution possesses. There is a minimum requirement of 50 kg of cattle dung for the smallest biogas plant. Normally 10 to 20 kg of dung is collected from ordinary cattle and on an

average of 15 kg of cattle dung is collected from an animal. On the basis of the details, the requirement of quantity of dung and number of animals for different size of biogas plants is given below.

Table : Requirement of cow dung and number of animals for different size of biogas plants

Capacity of biogas plant (m^3)	No. of animals required	Quantity of dung required (kg)	Cooking for number of persons
2	3-4	50	4-5
3	5-6	75	7-8
4	7-8	100	10-11
6	10-12	150	14-16

Selection of Site for Installation of Biogas Plant

For the selection of site for installation of biogas plant, following points should be kept in mind:

(i) The site for biogas plant should be at higher level as compared to the surroundings to avoid accumulation of water near the biogas plant.

(ii) The source of water for mixing with dung should be available near to the biogas plant.

(iii) Biogas plant should be installed at least two meter away from the foundation of the house to avoid cracks in the building.

(iv) The site for biogas plant should be at least 10 to 15 meter away from the hand pump.

(v) Biogas plant should be installed near the kitchen and animal shed to save cost of gas pipe and carriage of dung.

(vi) Biogas plant should be installed in the open space. There should not be any tree near the plant and have sufficient availability of sunlight and also the roots of the tree should not damage the biogas plant.

Procedure for operation of biogas plant

1. In the initial stage, a large quantity of cattle dung is required. For this, the

beneficiary of the biogas plant has to arrange the required cattle dung in advance so that the plant should be filled with cattle dung and water (1:1 ratio) within 2-4 days.

2. Cattle dung and water should be mixed as per the recommended ratio (1:1 ratio) so that proper quantity of gas is produced.
3. Initially gate valve is kept closed to stop the gas from coming outside the biogas plant. After some days gas bubbles can be seen in the outlet chamber which shows that the fermentation has been started.
4. The gas produced during the starting stage has more quantity of carbon dioxide and less quantity of methane gas. Due to this reason, the biogas does not burn. After some days the gas starts burning due to the perfect percentage of methane.
5. After this, feed the plant daily with recommended quantity of dung.
6. Do not use the old or dried cattle dung for feeding the plant.
7. Do not allow soil or sand articles, wooden pieces or any other non-biodegradable matter into the biogas plant.

Precautions in operation of biogas plants

1. Feed the plant daily with recommended quantity of dung.
2. Feed the biogas plant with cattle dung and water mixture in the right proportion (1:1 ratio) to make a homogeneous mixture.
3. Do not burn the gas directly, i.e. from the gas outlet pipe even for the testing purpose as it can be dangerous.
4. Cover the top of the inlet and outlet tank opening with wooden, stone or RCC cover, to avoid accidental falling of cattle and children.
5. The slope of the biogas pipe from the plant to the kitchen should be towards the plant so that water should not be accumulated in the gas pipe.
6. Gas pipe should have least number of joints and bends.
7. For the efficient working of burner and gas lamps, they should be cleaned at regular intervals.

EXERCISE

(a) Answer in one-two words.

1. Name any two gases present in biogas.
2. What is the percentage of methane in biogas?
3. What is the percentage of carbon dioxide in biogas?

4. Name the different categories of biogas plants according to their capacity?
5. Which is the main source to produce biogas?
6. How many kilograms of dung cakes can be saved by the use of 1m^3 of biogas?
7. What are different uses of biogas?
8. For what purpose, the bio-digested slurry coming from the plant is used?
9. At what distance, the biogas plant has to be installed from the foundation of the building?
10. Name the institute, which has designed the cheapest model of biogas plant?

(b) Answer in one-two sentences.

1. What do you mean by biogas?
2. What is the composition of biogas?
3. Name any three advantages of biogas?
4. Why cattle dung cakes should not be used for burning in the kitchen?
5. What are the properties of the bio-digested slurry coming from the plant?
6. What are the factors on which size of biogas plant depends?
7. Write a brief note on Deenbandhu Model biogas plant?
8. What is the main advantage of PAU Kutcha-Pucca Janta Model of biogas plant?
9. What are the factors to be kept in mind for selection of site for installation of the biogas plant?
10. What are the precautions in operation of biogas plants?

(c) Answer in five-six sentences.

1. What are the advantages for installation of biogas plants?
2. Define different models of biogas plants? Explain the Deen Bandhu Model biogas plant.
3. Explain the procedure of biogas production?
4. Explain the PAU Kutcha-Pucca Janta Model of biogas plant in details?
5. Explain the procedure for operation of biogas plant?

Activity

Visit the nearby biogas plant and identify its different components.