UNIT 3  WATER HARVESTING FOR CROP PRODUCTION

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3.0 OBJECTIVES

After going through this unit, you should be able to:

- outline the basic concept, identify need and benefits of water harvesting for crop production;
- outline different water harvesting practices of different agro-climatic zones of India; and
- acquaint yourself with irrigation practices including scheduling and methods of irrigation for crop production.

3.1 INTRODUCTION

In the previous unit, basic concept, need and benefits of roof top rainwater harvesting were discussed. Components of roof top rainwater harvesting including construction and maintenance were also dealt with.
Water is the most important resource for public health, industry and irrigation. Keeping this in view, a major thrust was given on increasing irrigation potential by undertaking major, medium and minor irrigation projects. This led to phenomenal increase in food production. Since most of the surface and sub-surface water resources have already been developed, available rainwater needs to be harvested efficiently and utilized to meet ever increasing water requirement of agriculture sector. In order to utilize rainwater efficiently for irrigation, water storage tanks/reservoirs need to be properly developed and maintained on the watershed basis depending on agro-climatic conditions of different regions of the country. The harvested water should be properly applied through suitable methods of irrigation to different crops of the regions. Low water requiring crops in a particular region should be selected depending on its agro-climatic conditions. Irrigation scheduling (depth and time of irrigation) during crop growth period plays an important role in efficient utilization of water resulting in high irrigation efficiency and increase in irrigation command and agriculture production.

In the next unit, basic concept, need and benefits of artificial groundwater recharge will be explained. Different methods and conditions suitable for implementation of artificial groundwater recharge will also be dealt with.

### 3.2 WATER HARVESTING FOR CROP PRODUCTION

#### 3.2.1 Concept

Rainwater harvesting for crop production is of utmost importance to meet ever increasing water demand of different crops for enhancing agriculture production. It involves harvesting, storing and diverting rainwater for irrigation. The harvested water is stored in ponds/tanks at an appropriate location so that maximum rainwater can be collected from a catchment. Most ponds/tanks have their own catchment, which provide requisite amount of water during rainy season. Where the catchment areas are too small to yield enough water, water from nearby streams or irrigated canals is diverted to supplement water in the ponds. The harvested water can directly be used for irrigation. It can also augment groundwater storage, which can be pumped through wells during lean periods.

#### 3.2.2 Benefits

Rainwater harvesting is beneficial for crop production in the following ways:

1. Makes provision for collection and storage of water in the close vicinity of agriculture field for supplemental irrigation during critical period of crop growth;
2. Increases availability of water in hard rock areas where groundwater is scarce;
3. Makes water available for irrigation of different crops in the areas where groundwater is saline and unusable;
4. It helps in controlling runoff, reducing floods and soil erosion. It also results in enhancing soil moisture for meeting water requirement of crops; and
5. Increases groundwater recharge as impounding ponds and lakes act as percolation ponds which can subsequently be used for meeting water requirement for crops.
3.3 COLLECTION AND STORAGE

Rainwater harvesting for crop production involves construction of storage facilities like village tanks, percolation ponds, and on-farm water storage ponds and tanks. They arrest and store surface runoff to be used as source of irrigation water. The stored water can be used for providing supplemental irrigation to the crops. The area to be irrigated depends on the amount of water harvested, storage capacity of the tank/pond and the water requirement of the crops to be irrigated. Water stored in the storage tanks and lakes is measured by establishing a gauge station. The gauge is nothing but a graduated pole which is marked with a scale following metric system. Total volume can be calculated by multiplying the pond area with that of depth of water, which can be measured from the gauging station. Discharge from the small streams and canals can be measured by different methods. You will be applying quite elaborately the methods to estimate storage capacity of different structures and discharge from surface and groundwater structures in the Course on Practicals.

Let us now check your progress.

Check Your Progress 1

Note:  
a) Compare your answers with those given at the end of unit.
   b) Use the space below for your answers.

1) How does rainwater harvesting help in improving the crop production?

2) List the benefits of rainwater harvesting for increasing the crop production?

Now that you have done Check Your Progress 1, you may proceed to learn about Water Harvesting System for Crop Production.

3.4 WATER HARVESTING SYSTEMS FOR CROP PRODUCTION

Different types of rainwater harvesting systems are used in different agro-climatic zones of India. Based on availability of surface runoff, site conditions, slope and volume of water to be stored for irrigational uses, different types of structures need to be constructed.

Various water harvesting techniques can be grouped into in situ water harvesting techniques and surface water harvesting techniques. In situ water harvesting means harvesting rainwater where it falls in soil profile. Soil and water conservation measures falling under this category include contour bunding, bench terracing, contour trenching, nala bunding and contour vegetative barriers. These techniques help in conserving
Rainwater during different rainfall events, which can be used by the crops later according to their requirement at various stages of the crop growth. Depending on the amount of rainfall received during a particular season/year, the crop growth and consequently the productivity may vary. The normal rainfall may result in adequate storage/conservation of water and consequently good crop stand and good yield. In case of below normal rainfall, the water stored in the soil profile will be less and hence low yields. In such a situation an important role is played by the soil conservation techniques to conserve enough water so as to support satisfactory crop growth. Surface water harvesting techniques of rainwater harvesting for crop production include pond/tank, percolation tanks check dams/nala bunds, groundwater dams or sub-surface dykes or underground bandhas, nalis, farm ponds and diversion of stream/canal waters to dried up dug wells. Based on the water requirement, availability and site characteristics, one or combination of more than one rainwater harvesting practices is adopted in different agro-climatic zones. The in situ and surface water harvesting structures are discussed in detail in Unit 1 of Course 3.

3.5 PLANNING AND DESIGN OF WATER HARVESTING STRUCTURES

Rainwater harvesting techniques that are particularly useful in augmenting the availability of water for crop production in rural areas can be adopted at a moderate cost with the involvement of the local people and locally available raw material. The design and construction of these structures are discussed below:

3.5.1 Pond/Tank

Size of a pond is usually dictated by the availability of adequate land in the vicinity of the village. The size of the pond is based mainly on the water requirement and the catchment area, above the pond site, from where the monsoon runoff would be available to fill the pond. The following norms can be followed to calculate the water requirement of a village community:

<table>
<thead>
<tr>
<th>Irrigation</th>
<th>600 m$^3$ of irrigation water for irrigation in a hectare (6 cm depth of irrigation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal needs</td>
<td></td>
</tr>
<tr>
<td>Buffaloes</td>
<td>60 litre/day</td>
</tr>
<tr>
<td>Dairy cows</td>
<td>70 litre/day</td>
</tr>
<tr>
<td>Sheep</td>
<td>9 litre/day</td>
</tr>
</tbody>
</table>

Storage capacity should be at least double the total water requirement to take care of evaporation and seepage losses. 10% extra storage may be provided for sediment deposition.

Example

Calculate the gross capacity of pond for applying 6 cm depth of irrigation to 10 ha area and meeting water need of fifty buffaloes and forty cows for a period of 30 days.
Solution

Assuming that the pond is filled after every 30 days and irrigation is applied after every 30 days.

Volume of water for applying 6 cm irrigation to 10 ha area

\[ \text{Volume} = 10000 \times \frac{6}{100} \times 10 \]

\[ = 6000 \text{ m}^3 \]

Water requirement for 50 buffaloes

\[ \text{Water requirement} = 60 \times 50 \times 30 \]

\[ = 90000 \text{ litre} \]

\[ = 90000/1000 \text{ (1 m}^3=1000 \text{ litre)} \]

\[ = 90.0 \text{ m}^3 \]

Water requirement for 40 cows

\[ \text{Water requirement} = 70 \times 40 \times 30 \]

\[ = 84000 \text{ litre} \]

\[ = 84 \text{ m}^3 \]

Total water requirement

\[ \text{Total water requirement} = 6000+90+84 \]

\[ = 6174 \text{ m}^3 \]

Gross capacity of pond = (total water requirement + 10% of total water requirement)

\[ = (6174 + 6174 \times 0.10) \]

\[ = 6174 + 617.4 \text{ m}^3 \]

\[ = 6791.4 \text{ m}^3 \]

Say 6792 m³

The location of pond in the catchment should be such that a small amount of earthwork should provide a large capacity and the capacity should not be too small to be choked up with sediments very soon. The site should not have excessive seepage losses.

3.5.2 Percolation Ponds

Percolation tanks are artificially created surface water bodies, submerging a land area with adequate permeability to facilitate sufficient percolation of impounded surface runoff to recharge the groundwater. These are quite popular in the states of Maharashtra, Andhra Pradesh, Madhya Pradesh, Tamil Nadu, Karnataka and Gujarat. The percolation tanks have the following characteristics:

- Percolation tanks shall be constructed in the areas where terrain is highly fractured and weathered;
- The aquifer to be recharged should have sufficient thickness of permeable zone to absorb recharge;
- Beneficial area should have sufficient number of wells, hand pumps etc.;
Water Harvesting Techniques

- The size of percolation tank is governed more by the percolation capacity of the formation under submergence rather than the yield of the catchment;
- Depending upon the percolation characters, the tank needs to be designed;
- Percolation tanks are normally earthen dams with masonry structures only for the spillway.

Activity 1
Visit a pond or tank in a nearby village before and after the rainy season. Observe the difference in water levels. What is contributing, factor the change in water levels in pond?

3.6 WATER HARVESTING PRACTICES IN DIFFERENT AGRO-CLIMATIC ZONES

Based on the requirements of agricultural development and rainwater harvesting, the country has been demarcated into 16 regions. The recommended water harvesting structures for these regions are as follows:

1) Humid North-Western Himalayas
In the hilly regions of Jammu & Kashmir, Himachal Pradesh and Uttaranchal, following water-harvesting measures are recommended.
- Diversion of perennial springs and streams water in storage ponds/tanks
- Village ponds
- Collection from hill slopes

2) Himalaya Foot Hills
In the regions covering foothill areas of Jammu & Kashmir, Himachal Pradesh, Punjab and Uttaranchal, Sub-Himalayan Region of West Bengal, Assam and Arunachal Pradesh, the recommended structures are:
- Collection from hill slopes
- Village ponds
- Contour trenching

3) Humid and High Rainfall North-Eastern Zone
In the high rainfall areas of Sikkim, Darjeeling hills, Arunachal Pradesh, Meghalaya, Nagaland, Manipur, Tripura, Mizoram, Assam and Jalpaiguri and Coochbehar with high surface runoff, diversion of perennial springs and streams in storage structures like ponds and tanks are the most important rainwater harvesting structures.

4) Humid Assam-Bengal Plains
Following water-harvesting structures are recommended in the regions covering parts of the lower Gangetic plains comprising alluvium diverse mix of sand, silt and clay in parts of West Bengal and Assam.
• Tanks
• Check dams
• Contour bunding

5) **Sub-humid and Humid Sutlej-Ganga Alluvial Zones**

The region covers parts of Punjab, Haryana, Uttar Pradesh and Bihar. Eastern part of this zone receives very good rainfall and western part faces drought like conditions at few places. The recommended water harvesting measures for this region are:

• Ponds
• Check dams

6) **North-western Semi-arid and Arid Zone**

Rainwater harvesting measures recommended for the zone in Western Rajasthan are:

• Gully plugging
• Nadi/Talab
• Khadin
• Percolation tanks
• Gully plugging
• Contour bunding

7) **Central Semi-arid Vindhyan Zone**

Water harvesting structures in the zone comprising of south-eastern districts of Rajasthan, southern districts of Uttar Pradesh and central parts of Madhya Pradesh having very low irrigation and cropping intensities are:

• Ponds
• Check dams
• Contour bunding
• Gully plugging
• Sub-surface dykes

8) **High Rainfall, High Runoff Chotanagpur Plateau**

This region characterized by soils of medium to shallow depth and undulating topography falls in Jharkhand state and adjoining hilly areas of Bihar. The recommended water harvesting structures in this zone are:

• Tanks/Ponds
• Check dams/Anicuts
• Gully plugging
• Contour bunding
9) **Malwa Plateau and Narmada Basin**

Water harvesting measures in the region covering major part of peninsular India with an annual rainfall of about 900 mm are:

- Ponds
- Check dams
- Sub-surface dams

10) **South-central Deccan Plateau Zone**

In the semi-arid region covering parts of Andhra Pradesh, Tamil Nadu, Karnataka and Maharashtra, the recommended water harvesting structures are:

- Ponds
- Check dams
- Percolation tanks
- Bandharas
- Gully plugging
- Sub-surface dams
- Contour bunding

11) **Chattishgarh Plateau zone**

The rainwater harvesting structures in the region covering Chattishgarh state and southern Orissa hills are almost similar to South Central Deccan Plateau Zone.

12) **South-eastern Brown/Red Soil Zone**

The traditional ponds, tanks, sub-surface dams are the structures recommended for water harvesting in the region covering Pachamalai and Kadavur hills and Pedi plain areas of Tamil Nadu and Veligond hills and part of the plains.

13) **Southern Variable Rainfall, Mixed Soil Zone**

Following water harvesting structures are recommended in the region covering southern parts of Maharashtra and west central parts of Tamil Nadu with highly variable rainfall distribution.

- Ponds/Tanks/Kunta
- Nadi
- Check dams/Percolation tanks
- Sub-surface dam
- Gully plugging
14) **South Bi-modal Rainfall Zone**

The following water harvesting structures are recommended in this region covering the southern parts of Kerala, Karnataka and Tamil Nadu.

- Ponds/tanks
- Percolation tanks
- Check dams
- Gully plugging
- Contour bunding

15) **Eastern Coromandal**

Following water harvesting structures are recommended in the region covering entire coastal belt of Andhra Pradesh, Orissa and West Bengal.

- Ponds/Tanks/Kunta
- Nadi
- Check dams
- Percolation tanks
- Sub-surface dams

16) **Western Malabar**

The recommended water harvesting structures in the region covering the western Malabar and coastal areas of Southern Karnataka are:

- Ponds/Tanks/Kunta
- Check dams
- Bandharas
- Percolation tanks
- Sub-surface dams
- Contour bunding

It is now time for another Check Your Progress

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**Check Your Progress 2**

**Note:**

a) Compare your answers with those given at the end of unit.

b) Use the space below for your answers.

1) Distinguish between *in situ* and surface water harvesting techniques?

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........................................................................................................................................................................
........................................................................................................................................................................
........................................................................................................................................................................
2) What are the factors influencing the size of water storage pond?

3) What are percolation ponds? For what purpose are they used?

4) Name any two water harvesting structures in north-western semi-arid and arid zone.

Activity 2

In which one of above regions, you live? Identify the most commonly used water harvesting structure(s) in your region.

Now, that you have done Check Your Progress 2 and completed the activity 2, let us go over to the next section and discuss about the utilization of harvested water.

3.7 UTILIZATION OF HARVESTED WATER

It is essential to maintain optimum soil moisture in the soil for favourable plant growth. Thus the optimum moisture in the soil is essential for healthy plant growth. Depth of irrigation of a particular crop depends on the water requirement during different crop growth stages. Number and length of crop growth stages vary from crop to crop and therefore, total growth periods are different for different crops. The irrigation should be applied at identified growth stages so as to obtain optimum crop yields. For example, seven main critical growth (phonological) stages of wheat are identified such as i) Crown Root Initiation Stage, ii) Tillering Stage, iii) Jointing Stage, iv) Flowering Stage, v) Milking Stage, vi) Dough Stage and vii) Maturity Stage.

Some growth stages are more critical than the others and therefore depending on the amount of available harvested water, irrigation should not be missed at most critical stage(s). The studies have shown that if irrigation is missed at first stage, i.e. Crown Root Initiation, the yield of wheat is reduced by over 10% even if the additional amount of irrigation is missed at later stages.

3.7.1 Irrigation Scheduling

Irrigation scheduling helps in deciding as to when and how much water to apply to a field in order to maximize irrigation efficiencies by applying the exact amount of water needed to replenish the soil moisture to the desired level. Irrigation scheduling not only saves water and energy but enhances crop productivity as well. Irrigation scheduling criteria is based on soil moisture content and soil moisture tension.
The quantity of water to be applied depends on the irrigator’s strategy. For example, the irrigator can replenish the soil moisture to field capacity or apply less. If no rain is expected and the irrigator wishes to stretch the time between irrigations, it is advantageous to refill the soil profile to field capacity. If rain is expected, it may be wise not to fill the soil profile to field capacity, but leave some room for rain.

Proper irrigation scheduling enables the farmer to apply the exact amount of water to achieve higher irrigation efficiency. The accurate measurement of the volume of water applied or the depth of application is very crucial. The discharge measurement has been dealt in adequate detail in Course 4 pertaining to Practicals. Irrigation scheduling offers following advantages:

- Enables the farmer to schedule water rotation among the various fields to minimize crop water stress and maximize yields;
- Reduces the farmer’s cost of water and labour through fewer irrigations, thereby making maximum use of soil moisture storage;
- Reduces fertilizer costs by holding surface runoff and deep percolation (leaching) to minimum;
- Increases net returns by increasing crop yields and crop quality; and
- Results in additional returns by using the “saved” water to irrigate non-cash crops that otherwise would not be irrigated during water-short periods.

Uniform water distribution across the field is important to derive the maximum benefits from irrigation scheduling and management. Accurate water application prevents over or under irrigation.

The amount of water required for irrigation can be defined in terms of Duty and Delta. Duty represents the irrigating capacity of a unit of water. It is the relation between the area irrigated and the quantity of irrigation water required during the entire period of growth of that crop. Delta is the total depth of water required by a crop during the entire period, the crop is in the field and is denoted by. For example, a crop requires about nine waterings in an interval of 20 days and a water depth of 10 cm in every watering. Considering the crop period of six months, the total water requirement i.e. delta of that crop is \( 9 \times 10 \text{ cm} = 90 \text{ cm} = 0.90 \text{ meter} \). Table 3.1 gives the principal crops of India, along with the crop seasons and delta values.

<table>
<thead>
<tr>
<th>Crop</th>
<th>Sowing Time</th>
<th>Harvesting Time</th>
<th>Average Delta (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kharif Crops</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rice</td>
<td>June-July</td>
<td>October-November</td>
<td>120</td>
</tr>
<tr>
<td>Maize</td>
<td>June-July</td>
<td>September-October</td>
<td>45</td>
</tr>
<tr>
<td>Bajra</td>
<td>July-August</td>
<td>September-October</td>
<td>30</td>
</tr>
<tr>
<td>Jowar</td>
<td>June-July</td>
<td>September-October</td>
<td>30</td>
</tr>
<tr>
<td>Pulses</td>
<td>June-July</td>
<td>October-November</td>
<td>30</td>
</tr>
<tr>
<td>Groundnut</td>
<td>May</td>
<td>November-December</td>
<td>45</td>
</tr>
</tbody>
</table>
### Water Harvesting Techniques

#### Rabi crops

<table>
<thead>
<tr>
<th>Crop</th>
<th>Sowing</th>
<th>Harvesting</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gram</td>
<td>September-October</td>
<td>March-April</td>
<td>30</td>
</tr>
<tr>
<td>Wheat</td>
<td>October-November</td>
<td>March-April</td>
<td>40</td>
</tr>
<tr>
<td>Barley</td>
<td>October-November</td>
<td>March-April</td>
<td>45</td>
</tr>
<tr>
<td>Peas</td>
<td>October-November</td>
<td>March-April</td>
<td>50</td>
</tr>
<tr>
<td>Mustard</td>
<td>October</td>
<td>February-March</td>
<td>45</td>
</tr>
<tr>
<td>Cotton</td>
<td>May-June</td>
<td>December-January</td>
<td>45</td>
</tr>
<tr>
<td>Sugarcane</td>
<td>February-March</td>
<td>December-March</td>
<td>90</td>
</tr>
<tr>
<td>Potato</td>
<td>October</td>
<td>February</td>
<td>75</td>
</tr>
<tr>
<td>Vegetables</td>
<td>August-November</td>
<td>October-April</td>
<td>45</td>
</tr>
</tbody>
</table>

#### 3.7.2 Methods of Irrigation

Irrigation is an artificial application of water to the soil to enable crops to have favourable growth particularly in areas where amount of rainfall is not adequate and is not uniformly distributed. The three basic types of irrigation methods generally used are surface irrigation, sprinkler irrigation and micro or drip irrigation depending on the type of crop, soil, and topographic and climatic conditions. An irrigation method should suit the local conditions. All methods have their advantages and disadvantages. The basic purpose of irrigation is to apply irrigation water uniformly so that each plant gets the desired quantity of water, neither too much nor too little. The suitability of the various irrigation methods, i.e. surface, sprinkler or drip irrigation, depends mainly on the following factors:

- Soil type,
- Crop,
- Topography,
- Climatic conditions,
- Source of water and its quality,
- Power availability, and
- Cost and benefits.

### Surface Irrigation

In surface irrigation system water moves over and across the land by simple gravity flow in order to wet it and, infiltrate into the soil. Historically, this has been the most common method of irrigating agricultural land due to its simplicity and less cost involved. On loam or clay soils, all three irrigation methods can be used, but surface irrigation is more commonly found. Clay soils with low infiltration rates are ideally suited to surface irrigation. All soil types, except coarse sand with an infiltration rate of more than 30 mm/hour, can be used for surface irrigation. If the infiltration rate is higher than 30 mm/hour, sprinkler or drip irrigation should be used.
Surface irrigation includes the following types:

a) Continuous flood or Paddy irrigation, in which small basins are flooded during the growing season.

b) Basin irrigation confines water by ponding over the area. In orchards, a separate basin is formed for each tree and water is supplied through a supply ditch.

c) As shown in Fig. 3.1, border-strip irrigation applies water to one end of a rectangular strip of sloping land so that water advances down slope and either runs off the end or ponds behind a dike. The border strip method wherein the farm is divided into a series of strips 5 to 10 m wide are commonly used for all close-growing crops including cereal crops like wheat.

d) As shown in Fig. 3.2, Furrow Irrigation uses furrows made between crops planted in rows to control and guide water for either steep land or very level land. This method of irrigation is commonly used for row crops like maize, jowar, sugarcane, cotton, tobacco and groundnut.

Where water levels from the irrigation source permit, the levels are controlled by dikes, usually plugged by soil. This is often seen in terraced rice fields, where the method is used to flood or control the level of water in each distinct field. In some cases, the water is pumped, or lifted by human or animal power to the level of the land.
Water Harvesting Techniques

Fig. 3.2: Furrow irrigation

Advantages

• Simple, cheap and easy to operate;
• Suited to most of the close growing (border) and row crops (furrow); and
• Adopted for most of the soils.

Limitations

• Irrigation efficiency (ratio of water gainfully used by the crop and water applied from the source) is very low (30-40%) as a result of which scarce and precious water resource is wasted;
• A considerable area used by the water channels;
• Periodic maintenance required; and
• Leaching of fertilizer and nutrients.

Sprinkler Irrigation

Sandy soils have a low water storage capacity and a high infiltration rate. They therefore, need frequent but small irrigation applications, in particular when the sandy soil is also shallow. Under these circumstances, sprinkler irrigation is more suitable than surface irrigation as shown in Fig. 3.3. The sprinklers operate at a considerably higher pressure of 2-3 kg/cm² (1 kg/cm² = 10 m head of water). The sprinklers apply water in the form of rainwater, which helps in creating better micro-climate and also protect plants from frost. The system is suited under following soil, crop, topographic and climatic conditions.

• Sandy soils with high infiltration rate
• Undulating topography
Sprinkler irrigation systems are divided based on whether the structure moves in the field during the irrigation event. There are four basic categories:

a) Permanent, solid-set sprinklers are fixed on risers from buried lines or lines suspended above a crop or over trees.

b) Hand-move sprinklers are fixed sprinklers that are disassembled, moved and reassembled between irrigations.

c) Continuous-move sprinkler systems move continuously during irrigation.

d) Centre-pivot irrigation systems supply water at a central point and a lateral line rotates around this centre and cover very areas at a time.
**Advantages**

- Uniform water application as per the requirement in the field.
- Improves microclimate.
- High irrigation efficiency (70-80%).
- High fertilizer efficiency.

**Limitations**

- High initial investment and operating costs.
- Needs high energy.
- High wind velocity affects uniformity of water application.

**Drip irrigation**

In drip irrigation, also known as trickle irrigation, water is delivered at or near the root zone of plants, drop by drop under low pressure. As you can see in Fig. 3.4, the system comprises of plastic components such as pipes and drippers in addition to filter and fertilizer applicator. This method can be the most water-efficient method of irrigation, if managed properly, since evaporation and runoff are minimized. In this method, fertilizer is applied with drip irrigation known as fertigation. If a drip system is operated for too long of a duration or if the delivery rate is too high, it may result in deep percolation. As water is applied in the vicinity of the plants, only a part of the area is wetted. As a result of this, there is considerable saving of water. The fertilizer application is also highly efficient due to its use with irrigation water. Due to optimum use of water and nutrients, not only crop productivity is high, its quality is also superior as compared with surface irrigated crops. The drip method is suited under following conditions.

- Widely spaced crops such as orchard crops
- Undulating lands with high infiltration rates
- Widely spaced crops
- Saline irrigation water

*Source: Jain Irrigation Systems Ltd.*

*Fig. 3.4: Layout of drip irrigation*
Advantages
- Considerable saving of water as only part of area wetted.
- Less amount of fertilizer used.
- Relatively saline water usable.
- High irrigation efficiency (>90%).
- High fertilizer efficiency.
- High yields and better quality of produce.
- Less weed infestation.

Limitations
- High initial investment.

Check Your Progress 3

Note:  a) Compare your answers with those given at the end of unit.
       b) Use the space below for your answers.

1) What do you mean by critical growth stages of crops? What is most critical stage in wheat crop in India?

2) What do you understand by irrigation scheduling? List any two advantages of irrigation scheduling.

3) List different methods of irrigation water application. Which is most widely used irrigation method?

4) List the factors governing the choice of irrigation methods.

5) Under what conditions is sprinkler-method of irrigation adopted?
3.8 LET US SUM UP

- Water is the most important resource for public health, industry and irrigation.
- Most of the surface and sub-surface water resources have already been exploited, therefore, it is absolutely essential that available rainwater is harvested and stored efficiently to supplement the ever increasing need of agriculture sector.
- **There is ample scope for harnessing rainwater during monsoon season that receives nearly 80% of annual rainfall.**
- The water harvested and stored during monsoon season can be utilized during non-monsoon period for irrigation.
- The rainwater can also be conserved *in situ* during monsoon period by undertaking various soil and water conservation measures depending on agro-climatic conditions of the region.
- The conserved soil moisture can be used beneficially for crop production. In order to utilize harvested rainwater efficiently for irrigation, water storage tanks/reservoirs should be properly developed and maintained depending on agro-climatic conditions of different regions of the country.
- The efficient on-farm water management practices such as proper irrigation scheduling and appropriate methods of irrigation water applications depending on the soil, crop, topography and climatic conditions of the region need to be used to derive maximum advantage of the harvested rainwater.
- Proper irrigation scheduling not only saves lot of water and nutrients but also results in enhanced crop productivity.
- Selection of an appropriate method of irrigation is crucial in order to achieve high water productivity as well as increasing irrigation command.
- Several factors such as soil type, crop, topography, climatic conditions, source of water and its quality, power availability, cost and benefits influence the selection of surface, sprinkler and drip methods of irrigation.

3.9 KEYWORDS

**Basin**: Area around the plant for irrigation.

**Coromandal**: Crossing the threshold from one place into another.

**Cropping Intensity**: It is the ratio of total cropped area in a year to actual net cultivated area expressed in percentage.

**Crown Root Initiation Stage**: First and most critical stage in wheat which occurs nearly 20-25 days after sowing and refers to initiation of crown roots.

**Delta**: Delta is the total depth of water required by a crop during the entire period the crop is in the field and is denoted by.

**Dough Stage**: Occurs 80-90 days after sowing and has moisture content of grain around is 30%.
Duty : Represents the irrigating capacity of a unit of water. It is the relation between the area irrigated and the quantity of irrigation water required during the entire period of growth of that crop.

Flowering Stage : Flowering starts 45-70 days after sowing.

In situ : It is a Latin phrase meaning in the original or appropriate position.

Irrigation Efficiency : Ratio of water used by the crop and water applied from the source.

Irrigation Intensity : It the ratio of actual irrigated area and culturable command area from a given outlet in year.

Irrigation Scheduling : When and how much water to apply.

Jointing Stage : Occurs 35-45 days after sowing when stem nodes are first detected above the soil.

Maturity Stage : Occurs 110-130 days after sowing when moisture content is reduced to 10-12%.

Milking Stage : Grain formation, 70-80 days after sowing.

Percolation Ponds : Artificially created surface water bodies to facilitate sufficient percolation of impounded surface runoff to recharge the groundwater.

Permeability : It is a measure as to how easily the water can flow through the porous medium or soil.

Permeable Zone : Porous region or the region through which water can percolate.

Ponded Water : Standing water in the field during a particular period.

Recharge : Replenishment of depleted groundwater.

Sediment Deposition : Mud and other finer particles carried by rainwater and deposited in the storage structures.

Tillering Stage : Refers to start of emergence of tillers, and vegetative growth 25-35 days after sowing.

### 3.10 SUGGESTED READING


3.11 MODEL ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 1

1) Rainwater harvesting for crop production is of utmost importance to meet ever increasing water demand of different crops for enhancing agriculture production.

2) Rainwater harvesting is beneficial for crop production in the following ways:
   - Collects and stored water in the close vicinity of agriculture field for supplemental irrigation during critical period of crop growth.
   - Increases availability of water in hard rock areas where groundwater is scarce.
   - Makes water available for irrigation of different crops in the areas where groundwater is saline and unusable.
   - Helps in controlling runoff, reducing floods and soil erosion. It also results in enhancing soil moisture for meeting crop water requirement.
   - Increases groundwater recharge as impounding ponds and lakes acts as percolation ponds which can subsequently be used for meeting crop water requirement.

Check Your Progress 2

1) *In situ* water harvesting techniques refer to harvesting rainwater where it falls in soil profile. These techniques help in conserving rainwater during different rainfall events, which can be used by the crops later according to their requirement at various stages of the crop growth. Surface water harvesting techniques of rainwater harvesting refer to harvesting and storage of rainwater to be subsequently used for supplemental irrigation.

2) Size of a pond is usually dictated by the availability of adequate land in the vicinity of the village. The size of the pond is designed based on mainly the water requirement and the catchment area, above the pond site, from where the monsoon runoff would be available to fill the pond.

3) Percolation tanks are artificially created surface water bodies, submerging a land area with adequate permeability to facilitate sufficient percolation of impounded surface runoff. They are used to recharge the groundwater.
4) Following two water harvesting structures used in northwestern semi-arid areas are:
   - Percolation tanks
   - Contour bunding

**Check Your Progress 3**

1) Critical growth stages are the stages at which irrigation should not be missed so as to obtain optimum crop yields. Some growth stages are more critical than others and therefore depending on the amount of available harvested water, irrigation should not be missed at most critical stage(s). Crown Root Initiation is the most critical stage in wheat crop. If irrigation is missed at this stage, yield reduction is likely to be over 10%.

2) Irrigation scheduling refers to when and how much water to apply to a field in order to maximize irrigation efficiencies by applying the exact amount of water needed to replenish the soil moisture to the desired level. Irrigation scheduling not only saves water and energy but enhances crop productivity as well. Besides, irrigation scheduling has following advantages:
   - Reduces the farmer’s cost of water and labour through fewer irrigations, thereby making maximum use of soil moisture storage.
   - Lowers fertilizer costs by holding surface runoff and deep percolation (leaching) to a minimum.

   The three basic types of irrigation methods generally used are surface irrigation, sprinkler irrigation and micro or drip irrigation depending on the type of crop, soil; topographic and climatic conditions. The surface irrigation method is most widely used method all over the world.

   The suitability of the various irrigation methods, i.e. surface, sprinkler or drip irrigation, depends mainly on the following factors:
   - Natural conditions
   - Type of crop
   - Type of technology
   - Previous experience with irrigation
   - Required labour inputs
   - Costs and benefits.

5) The sprinkler system is suited under following soil, crop, and topographic and climatic conditions.
   - Sandy soils with high infiltration rate
   - Undulating topography
   - Close growing crops
   - Moderate wind speed