**Unit III**

**WATER HARVESTING: IMPORTANCE, ITS TECHNIQUES, EFFICIENT UTILIZATION OF WATER THROUGH SOIL AND CROP MANAGEMENT PRACTICES, MANAGEMENT OF CROPS IN RAINFED AREAS**

**Rain water harvesting:**

* Water harvesting is a method to induce, collect, store and conserve surface runoff of the locality. Harvesting excess water during periods of heavy rainfall and storing it either in the soil profile or farm ponds and tank not only saves water for future use but also helps to conserve water and soil from runoff losses.
* Rain water harvesting is a technology used for collecting and storing rain water from rooftops, the land surface or rock catchments using simple techniques such as jars and pots as well as more complex techniques such as underground check dams.
* Rainwater harvesting is the accumulation and deposition of rainwater for reuse on-site rather than allowing it to runoff.

**Need for rain water harvesting:**

* Water is one of the most essential requirement for existence of living beings. Surface water and ground water are two major sources of water.
* Due to over population and higher usage levels of water in urban areas, water agencies are unable to cope up demand from surface sources like dams, reservoirs, rivers etc.
* This lead to digging of individual tube wells by house owners. Even water supply agencies have resorted to ground water sources by digging tube wells in order to augment the water supply.
* Indiscriminate exploitation of ground water results in lowering of water table rendering many bore-wells dry.
* To overcome this situation bore wells are drilled to greater depths.
* In rural areas also, government policies on subsidized power supply for agricultural pumps and piped water supply through bore wells are resulting in to decline in ground water table.
* The solution to all these problems is to replenish ground water bodies with rain water by man-made means.

 **Advantages of rain water harvesting:**

1. Promotes adequacy of underground water.
2. Mitigate the effect of drought.
3. Reduces soil erosion as surface runoff reduced.
4. Reduces flood hazards.
5. Improves ground water quality / decreases salinity.
6. Improves ground water table, thus saving energy (to lift water).
7. No land is wasted for storage purpose and no population displacement is involved.
8. Storing water underground is environment friendly.

 **Rain water harvesting potential**

* The total amount of water that is received in the form of rainfall order an area is called the rain water endowment of that area. Out of this, the amount that can be effectively harvested is called rain water harvesting potential.

**Area of catchment X Amount of rainfall = Rain water endowment**

Runoff is the term applied to the water that flows away from catchments after falling on its surface in the form of rain. Runoff from a particular area is dependent on various factors i.e. rainfall pattern and quantity, catchment area characteristics etc.

**Rain water harvesting potential=Amount of Rainfall X Area of catchment X Runoff coefficient**

 **Characterization of rain water harvesting systems**

* It is practiced in arid and semi-arid regions where surface runoff often occurring at irregular intervals.
* It is based on the utilization of run off and requires a runoff producing area and a runoff receiving area.
* Because of the intermittent nature of runoff events, storage is an integral part of the water harvesting system.
* Part of the land is left barren and uncultivated. This is known as donor strip and is treated in such a way as to increase runoff from rainfall.
* The runoff from the donor strip is directed towards the lower adjacent strip to increase soil moisture storage there.
* The strip is used for raising crops. This is called as micro watershed approach or micro catchment water harvesting.

 **How we can harvest rain water?**

Broadly there are two ways of harvesting rain water.

1. **Surface runoff harvesting:** In urban area rain water flows away as surface runoff. This runoff could be caught and used for recharging aquifers by adopting appropriate methods. An aquifer is an underground layer of water bearing permeable rock, rock fractures or unconsolidated materials (gravels, sand or silt).
2. **Roof top rainwater harvesting:** It is a system of catching rain water where it falls. In rooftop harvesting, the roof becomes the catchments, and the water is collected from the roof of the house / building. This method is less expensive and very effective.

**COMPONENTS OF THE ROOF TOP RAIN WATER HARVESTING SYSTEM**

1. **Catchment area:** The surface that receives rainfall directly is the catchment of rain water harvesting system. It may be terrace, courtyard.
2. **Transportation:** Rainwater from rooftop should be carried through down take water pipes or drains to storage / harvesting system. Water pipes should be UV resistant (PVC pipes) of required capacity.
3. **Fist flush:** First flush is a device used to flush off the water received in first shower. The first shower of rains needs to be flushed-off to avoid contaminating storable / recharge water by the probable contaminants of the atmosphere and the catchment roof. It will also help in cleaning of silt and other material deposited on roof during dry seasons. Provisions of first rain separator should be made at outlet of each drain pipe**.**
4. **Storage system:** All collected rain water are store in tankor barrels used.
5. **Delivery system:** It is a system to delivered of water for uses. There are use of pumps to take out water from tank and deliver for many purpose. Water isdeliver by pipes.
6. **Filtration system:**
* Filters are used for treatment of water to effectively remove turbidity (turbidity is a measure of the degree to which the water loses its transparency due to the presence of suspended particulates), color and microorganisms. After first flushing of rainfall, water should pass through filters. There are different types of filters in practice, but basic function is to purify water.
* **Sand Gravel Filter:** These are commonly used filters, constructed by brick masonry and filtered by pebbles, gravel and sand. Each layer should be separated by wire mesh.

 **METHODS OF WATER HARVESTING RAIN:** There are three ways of harvesting rain water:

1. **Storing rain water for direct use**
* In place where the rains occur throughout the year, rain water can be stored in tanks.
* However, at places where rains are for 2 to 3 months, huge volume of storage tanks would have to be provided’
* In such places, it will be more appropriate to use rain water to recharge ground water aquifer rather than to go for storage.
* If the strata is impermeable, then storing rain water storage tanks for direct use is a better method.
* Similarly, if the ground water is saline / unfit for human consumption or ground water table is very deep, this method of rain water harvesting is preferable.
1. **Recharging ground water aquifers, from roof top runoff:**
* Rain water that is collected on the roof top of the building may be diverted by drain pipes to a filtration tank (for bore well, through settlement tank) from which it flows in to the recharge well.
* The recharge well should preferably be shallower than the water table.
* This method of rain water harvesting is preferable in the areas where the rainfall occurs only for a short period in a year and water table is at a shallow depth.
1. **Recharging ground water aquifers with wit runoff from ground area:**

The rain water that is collected from the open areas may be diverted drain pipes to a recharge dug well / bore well through filter tanks. The abandoned bore well / dug well can be used cost effectively for this purpose.

 **COMPONENTS OF RAIN WATER HARVESTING:**

 The rain water harvesting system consists of following basic components: -

1. Catchment area
2. Coarse mesh / leaf screen
3. Gutter
4. Down spout or conduit
5. First flushing device
6. Filter
7. Storage tank

 **Description in detailed:**

1. **Catchment area:**
* The catchment area is the surface on which the rain water falls. This may be a roof top or open area around the building. The quality of water collected from roof top is comparatively much better than collection from the ground.
* Rain water harvested from catchment surfaces along the ground should be for lawn watering, flushing etc. because increased risk of contamination.
* This water can also be used for recharging ground aquifers after proper filtration.
* The roofs made of GI sheets, corrugated sheets, tiles etc. are preferable for roof top collection. But thatched roofs are not preferred as these add colour and dissolved impurities to water.
1. **Coarse mesh / leaf screen:**
* To prevent the entry of leaves and other debris in the system, the coarse mesh should be provided at the mouth of inflow pipe for flat roofs.
* For slope in roofs where gutters are provided to collect and divert the rain water to downspout or conduits, the gutters should have a continuous leaf screen, made of ¼ inch wire mesh in a metal frame, installed along their entire length and a screen or wire basket at the head of the downspout.
1. **Gutter**
* Gutter is required to be used for collecting water from sloping roof and to divert it to downspout.
* These are the channels all around the edge of a sloping roof to collect and transport rain water to the storage tank.
* Gutters can be of semi-circular, rectangular or trapezoidal shape.
* Gutters must be properly sized, sloped and installed in order to maximize the quantity of harvested rain.
* Gutter can be made using any of the following materials:
1. Galvanized iron sheet
2. Aluminum sheet
3. Semi-circular gutters of PVC material which can be readily prepared by cutting these in to two equal semi-circular channels.
4. Bamboo or betel trunks cut vertically in half (for low cost housing projects).
5. **Down spout or conduit:**
* The rain water collected on the roof top is transported down to storage facility through downspouts / conduits.
* Conduits can be of any materials like PVC, GI or cast iron. The conduits should be free of lead and any other treatment which could contaminate the water.
1. **First flushing device:**
* Roof washing or the collection and disposal of the first flush of water from a roof, is very important if the collection rain water is to be used directly for human consumption.
* All the debris, dirt and other contaminants especially bird droppings etc. accumulated on the roof during dry season are washed by the first rain and if this water will enter into storage tank or recharge system it will contaminate the water.
* Therefore, to avoid this contamination a first flush system is incorporated in the roof top rain water harvesting system.
* The first flushing device, dispose of the first spell of rain water so that it does not enter the system.
* The pipe is usually 6 or 8 inch PVC pipe which has a valve and cleanout at the bottom.
1. **Filter:**
* If the collected water from roof top is to be used for human consumption directly, a filter unit is required to be installed in RWH system before storage tank.
* The filter is used to remove suspended pollutants from rain water collected over roof.
* The filter unit is basically a chamber filled with filtering media such as fiber, coarse sand and gravel layers to remove debris and dirt from water before it enters the storage tank.
* The filter unit should be placed after first flush device but before storage tank.

**Sand filter:** In the sand filters, the main filtering media is commonly available sand sandwiched between two layers of gravels.

The filter can be constructed in a galvanized iron or Ferro cement tank. This is a simple type of filter which is easy to construct and maintain. The sand filters are very effective in removing turbidity, color and microorganism.

**Charcoal water filter:** This is almost similar to sand filter except that a 10-15 cm thick charcoal layer placed above the sand layer.

Charcoal layer inside the filter result into better filtration and purification of water.

1. **Storage tank:**
* Whenever the rain water collected from roof top is used directly for various purposes, storage tank is required. The storage tank can be cylindrical, rectangular or square in shape
* The material of construction can be RCC, Ferro cement, masonry, PVC or metal sheets. Depending upon the availability of space, the storage tank can be above ground, partially underground or fully underground.

 **WATER HARVESTING TECHNIQUES**

* India can be divided into 3 district zones according to the rainfall, viz. (i) heavy rainfall zone with rainfall above125 cm, (ii) moderate rainfall zone with rainfall between 75 to 125 cm and (iii) low rainfall zone receiving less than 75 cm of annual rainfall.
* Water harvesting under deficit rainfall conditions (arid regions).
* Many soils of arid region have a very low absorption capacity for rainfall, the sparse vegetation, the large proportion of bare rocks, the low organic matter content and the hard impermeable crusts are all contributing factors.
* Under arid conditions, reducing runoff and increasing infiltration rates are ineffective as the amounts of moisture that can be stored in soil are not sufficient for crop production. In these areas efforts should be made to conserve water in an area, situated at a lower elevation in order to supplement moisture in an area for crop production.

**Some of the water harvesting techniques are follows:**

1. **Micro watershed:**
* Part of the land is left barren and uncultivated. This is known as donor strip and is treated in such way as to increase runoff from rainfall.
* The runoff from the donor strip is directed towards the lower adjacent strip to increase soil moisture storage there.
* The strip is used for raising crops. This is called as micro watershed approach or micro catchment water harvesting.
1. **Lister furrow:** Lister furrows on cultivated land retain water for a short period only. The crop can be grown in furrows. It may be used in clay or loam soil.
2. **Constructions of furrow and ridges:** In this method water is conserved in furrows. The crops grow in the furrow or on the ridges depending upon the quantity of rainfall.
3. **Construction of level and sloping strips in the field:** Eight meter wide strips are chosen or this technique. Four meter land is leveled in which crop is grown and 2 m wide compact slopes are made each side of 4 m wide level strip. Rain water is accumulated in the level strips where crops can be grown.
4. **Collection of rain water in ponds and reservoirs:** The rain water stored in tanks and reservoir constructed on wastelands.

 **WATER HARVESTING UNDER HEAVY RAINFALL**

1. **Reduction of impacts of rain drops:** by mulching and growing crops.
2. **Increase the period of retention of rain water:** Land shaping such as raised sunken bed, broad bed furrow, land leveling, tillage, organic management.
3. **Creating barriers to obstruct the runoff:** Contour bunds, graded bunds, contour ridges, tied ridges, bench terracing, trenches.
4. **Creation of suitable structure for storing of rain water**: Farm ponds, percolating ponds, check dams.
5. Safe disposal of excess rain water through water ways.

 **UTILIZATION OF THROUGH SOIL AND CROP MANAGEMENT PRACTICES**

 **Introduction**

* Irregular or insufficient rainfall can be a serious limitation to agricultural production, causing low yields and even crop failure. This is particularly true in dry lands, where productivity levels are generally low.
* In most cases, a great deal can be done to improve the efficiency of rain water use.
* In arid and semi-arid regions, uncertain erratic and scanty rains coupled with meager irrigation facilities leads to low and unstable yields.
* Low and erratic rainfall, high evaporation rate and limited water holding capacity of surface soils are the main constraints in agricultural production.
* Annual rainfall in several parts of dry lands is sufficient for one or more crops per year. Erratic and high intensity storms lead to runoff and erosion.
* The effective rainfall may be 65% or sometimes less than 50%. Hence, conservation agriculture is one way of improving soil moisture management. To cope with drought which is a regular feature in one or the other part of the country, contingent crop planning is required.
* Success in rainfed agriculture depends on the efficient utilization of rainwater. Therefore, soil management practices have to be tailored to store and conserve as much rainfall as possible by reducing the runoff and increasing storage capacity of soil profile.

 **EFFICIENT SOIL AND WATER MANAGEMENT PRACTICES**

 **Soil management practices:**

1. Contour bunding
2. Contour trenching
3. Contour farming
4. Field bunding and leveling
5. Runoff farming
6. Sub-surface barrier
7. Uses of mulches
8. Soil amendment
9. Stubble mulch farming
10. Wind strip cropping
11. Tillage
12. Bench terracing.

 **Crop management practices**

* Crops and cultivars
* Sowing time
* Sowing method
* Seed treatment
* Seed rate and plant population
* Intercultural operations
* INM
* Weed control
* Irrigation and critical growth stages
* Rain water harvesting
* Transpiration
* Anti transpirant
* Wind break
* Shelterbelts

 **Traditional methods of rain water harvesting:**

 Traditional rainwater harvesting, which is still prevalent in rural areas, was done in surface storage bodies like lakes, ponds, irrigation tanks, temple tanks etc. In urban areas, due to shrinking of open spaces, rainwater will have to necessarily be harvested as ground water. Hence harvesting in such places will depend very much on the nature of the soil viz., clayey, sandy etc. The below listed are the various kinds of traditional rainwater harvesting methods.

1. **Bamboo method of rainwater harvesting**
* In Meghalaya (one of the seven northeastern states in India), an indegenious system of tapping of stream and spring water by using bamboo pipes to irrigate plantations is widely prevalent.
* It is so perfected that about 18-20 litres of water entering the bamboo pipe system per minute gets transported over several hundred meters and finally gets reduced to 20-80 drops per minute at the site of the plant.
* The tribal farmers of Khasi and Jaintia hills use the 200-year-old system.
* The bamboo drip irrigation system is normally used to irrigate the betel leaf or black pepper crops planted in arecanut orchards or in mixed orchards.
* Bamboo pipes are used to divert perennial springs on the hilltops to the lower reaches by gravity.
* The channel sections are made of bamboo, divert and convey water to the plot site where it is distributed without leakage into branches.

1. **Paar:** Paar is a common water harvesting practices in the western Rajasthan region. It is a coomon place where the rain water flows from the catchment and percolates into the sandy soil. In order to access the percolated water kuis or beris are dug in storage area. Kuis or beris are normally 5 m to 12 m deep. The structure was constructed through traditional masonry technology. Normally 6 to 10 of them are constructed in a paar.

However, depending on the size of the paar the numbers of kuis or beris are decided.

1. **Taanka / Kund / Kundi:** Taanka is a traditional rain water harvesting techniques to the Thar desert region of Rajasthan. Tanka is generally circular in shape and is constructed in stone masonry in 1:3 cement-sand mortar. While small tankas of 3 to 4.22 m diameter and about 21-59 cm capacity are built by individual households, larger ones of 6 m diameter and 200 cm capacity are built for the village communities.
2. **Tankas:**
* Found traditionally in most Bikaner houses. Tankas were often beautifully decorated with tile, which helped to keep the water cool. The water was used only for drinking. If in any year there was less than normal rainfall and the tankas did not get filled, water from nearby wells and tanks would be obtained to fill the household tankas.
* In this way, the people of Bikaner were able to meet their water requirements. The tanka system is also to be found in the pilgrim town of Dwwarka where it has been in existence for centuries. It continues to be used in residential areas, temples, dharamshalas and hotels.
1. **Kunds or Kundi:** Kund the local name given to covered underground tank, was developed primarily for tackling drinking water problems.
2. **Talai:** Similar to Tanka, still deeper (2-3cm depth). Special attention paid for selection of location such that there is adequate flow of rain water into Talai. Care is also taken so that loose soil does not flow along with water stream.
3. **Nada:** In this method, low lying areas in between hillocks is excavated as pit and provided embankment to arrest rain water from these hillocks. The catchment area of Nada is 5 to 10 ha. The Nada is constructed on rangeland, barren land pastureland and agriculture field. It provides short-term storage of rainwater and mainly used for animals.
4. **Nadi:** Compared to Nada, the Nadi is bigger in size. A village or group of Villages uses the runoff water collected in the Nadi. Depth is 6-8m, catchment area 10-150 ha. In the Nadi, water is available for whole of the year as a result it provides shelter for many wild animals and birds.

1. **Talab:** It is relatively shallow and spread over to more area compared to Nadi. It is generally constructed in rangeland. The catchment area of Talab is 480 ha, when it is filled its fullest capacity can have lost for many years.
2. **Khadin** Accumulation of runoff water in between hillocks is known as Khadin. Khadin means cultivation crops. The khadin water is generally used for crop cultivation and animals.