ONR-003: Water Harvesting, Conservation and Utilisation
Guess Paper-1

Q1. Recognize the regional perspectives of water harvesting.

Ans.

Water harvesting is the collection, storage and conservation of any form of water; rainwater, runoff, stream flow for its productive use for irrigation, domestic and livestock consumption and fish rearing.

There are a number of factors which impact water harvesting technology. However, rainfall is the most important parameter due to its high variability not only in time but in space. Due to highly uneven distribution of water resources, per capita water availability is highly variable with 380 m^3 in Tamil Nadu while in the north-east, it is as high as 18400 m^3. The types of water harvesting systems depend on physico-topographical conditions and pattern and extent of rainfall of the region. Therefore, due to considerable variation in the rainfall pattern and agro-climatic conditions, different sets of water harvesting systems need to adopted and practiced.

Q2. What do you mean by Water Harvesting Pond/Storage Tank.

Ans.

Ponds/storage tanks should be constructed at lower or middle reaches of the hill slope in order to receive runoff from the catchment during monsoon season. The size of the pond depends upon the amount of annual rainfall and area of catchment. Generally dugout-cum-embankment ponds are constructed in hilly areas for collection of runoff as shown in Fig. 1.21. The size of the pond is decided mainly on the basis of the water requirement and the catchment area. The storage capacity should at least be two times the total water requirement to take care of evaporation and seepage losses. 10% extra storage may be provided for sediment deposition. Embankment type of ponds are created by constructing a small length of dam across a water course whereas dugout-cum-embankment type of pond can be created by excavating a site surrounded by hillocks from two or three sides and making the embankment from excavated soil on the remaining sides. Depending upon the site conditions, storage/earthwork ratio of 5 to 20 can be achieved for embankment and dugout-cum-embankment. In flat areas, dugout ponds are constructed with storage/earthwork ratio of around 1:1.



(a) (b)

Fig. 1.21: (a) Dugout-cum-embankment and (b) Dugout pond with cement lining

Q3 What are the types of rainwater harvesting systems?

Ans.

Rainwater harvesting is basically the capture, diversion and storage of rainwater mainly for domestic, irrigation and industrial purposes. Two types of rainwater harvesting systems can be designed and constructed for collection of rainwater.

Domestic

This is also known as rooftop rainwater harvesting as the rainwater is collected from roofs, courtyards and small catchment platforms and is stored in storage tanks for each family. Rooftop rainwater harvesting schemes are economically feasible due to

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adequate availability of rainwater in most parts of the country during monsoon season. Harvested rainwater is the cheapest source of water supply and easier to mobilise household for a family rainwater tank. Rooftop rainwater harvesting schemes are much easier to construct in mountaineous, islands, coastal and saline areas as compared to other schemes.

Community

Larger catchments are used in rural areas for collection of runoff into village ponds and reservoirs. Community rainwater collection systems are provided for collecting runoff through watershed management techniques or by collection of runoff from the hill slopes by constructing the cross drains from where it is taken to the sump through pipes.

The decision to construct a rooftop rainwater harvesting system/community based rainwater harvesting system or groundwater recharge system depends on the rainfall pattern. A small storage tank for rooftop rainwater harvesting will serve the purpose for humid areas of Shillong, Mizoram and Kerala where it generally rains throughout the year, whereas large tanks are required for dry areas of Rajasthan, Delhi and Gujarat with rainfall confined to 3 to 4 months of monsoon. The water collected during the monsoon shall be stored and used for water requirements throughout the year.

Q4. What are the basic components of rooftop rainwater harvesting systems?

Ans.

- **Catchment:** Roof surface, agricultural watershed and hill slopes act as surface for rainwater collection.
- **Drain pipes:** The pipelines which carry rainwater to one side of the house.
- **Gutters:** Gutters are channels fixed to the edges of roof all around to collect and transport the rainwater from the roof to the storage tank.
- **Down pipe:** These pipes carry rainwater from roof to ground surface.
- **First flush pipe:** These are the components which remove debris and dust from rooftop rainwater harvesting before it is stored in cistern.
- **Filter unit:** This is the purification unit required to remove impurities like dust, bird droppings etc.
- **Storage tank:** The storage tank is the most important and expensive component of the rooftop rainwater harvesting system. A number of makes, shapes and sizes of storage tanks are available.
- **Collection sump and Pump unit:** The mode of transferring water from tank to end-use makes collection sump and pump unit.

Q5. List the benefits of rainwater harvesting for increasing the crop production?

Ans.

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.

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Q6. What are the Methods of Irrigation?

Ans.

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.

Q7. What are the Types of earth fill dam?

Ans.

Types of earth fill dam

1) Homogenous

This type of embankment is constructed of homogenous soil material. If homogenous soil material is impervious, then embankment is keyed to the impervious stratum (Fig.5.15a). If homogenous fill soil material is moderately pervious then in that case, an upstream blanket of impervious material such as puddled clay is provided (Fig.5.15b). Homogenous type is adopted when earth fill dam height is low and satisfactory fill material is available.

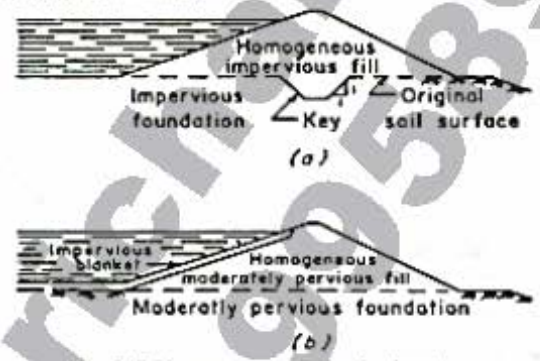

Fig. 5.15: Homogenous type of embankment

2) Diaphragm

In this type, bulk of the embankment is constructed of pervious material such as sand, gravel or rock and a thin diaphragm of impermeable material like plastic, concrete, steel or wood as shown in Fig.5.16 is provided in the centre of the embankment. The impervious diaphragm checks the seepage through the embankment. The diaphragm is keyed in the impervious foundation and extends up to the height of water level. This type of diaphragm is called full diaphragm. Sometimes diaphragm may be partial i.e. not extending to the water level height. In this case in addition to partial diaphragm, a central core of impervious material is formed up to the full height of the embankment and on either side of central core pervious material is filled.

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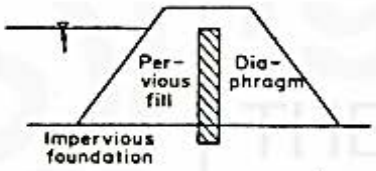
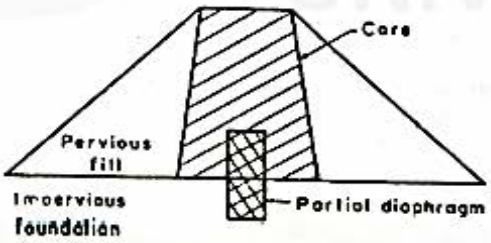


Full diaphragm



Partial diaphragm

Fig.5.16: Schematic diagrams of diaphragm

Main considerations in construction

Height of dam: The height of dam should be selected in such a way that cost of dam per unit of storage is minimum. The height of earthen dam should not normally exceed 16 metre.

Free board: It is the added height of the dam provided as a safety factor against very high runoff. Normally 10-15 % is added as free board to the highest water level.

Settlement allowance: Settlement includes the consolidation of the fill materials and the foundation materials due weight of the dam. It varies from 10 % of the design height for manually compacted fill and 5 % for machine compacted fills.

Top width of embankment: Up to 5 metre height of dam, a minimum top width of 3 meter is recommended. If top width is to be used as a road, width of 5 meter or more is to be adopted.

Embankment side slope: Side slope of the embankment is important for its stability. Side slope primarily depends on the stability of the material in the embankment. The greater the stability of the material, the steeper will be the side slope and vice versa. The recommended side slopes for earthen embankment are presented below:

Type of Material	Upstream Slope	Downstream Slope
Homogenous well graded material	2.5: 1	2.5: 1
Homogenous coarse silt	3: 1	2.5: 1
Homogenous silty clay or clay with height less than 15 m	2.5: 1	2: 1
Homogenous silty clay or clay with height more than 15 m	3: 1	2.5: 1
Sand or sand and gravel with clay core	3:1	2.5: 1

Q8. Discuss Adoption of water conservation and water harvestings techniques.

Ans.

Adoption of water conservation and water harvestings techniques

Water conservation/water harvesting at macro or micro level leads to sustainability in water sector for mitigating water scarcity and drought effects. India is characterized with wide variations in physiographic, climatic, soil, environmental and socio-economic conditions. Therefore, rainwater harvesting technology is highly location-specific. The various rainwater harvesting practices in vogue may be broadly grouped as: (i) *in situ* retention of rainfall on the land itself by agronomic/mechanical measures, (ii) harvesting surface runoff from land surface and its storage for later use, (iii) diversion of perennial surface/sub-surface water source (springs and streams) in storage structures, and (iv) rooftop rainwater harvesting.

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The *in situ* water harvesting practices include bunding and terracing, vegetative barriers, contour bunding, contour ditching, levelling, contour farming, cover crop and mulching, conservation tillage and deep ploughing.

The surface runoff water harvesting can be achieved through *Nadis* (dugout ponds), *Tankas, Khadins, Ahars/Havelis*, diversion bunds and rooftop rainwater cisterns.

Stream flow runoff harvesting is practiced through nala bunding, check dams, stop dams, *bandharas* (weirs), percolation tanks/ponds and *nadi*. Sub-surface dams/ barriers, diaphragm dams, *bandharas* are used for sub-surface flow harvesting. Indigenous rainwater harvesting and conservation techniques adopted in different parts of the country depending on agro-climatic conditions have been discussed in detail in Unit 1 of Block 1 of Course 3.

The water conservation in various sectors namely domestic, industrial and agriculture needs to be practiced vigorously for long term sustainability. Different water conservation strategies for each sector need to be identified and implemented.

Q9. What do you mean by Irrigation Efficiencies?

Ans.

As mentioned above, the irrigation system should be well equipped to provide high irrigation efficiencies so that the scarce and costly limited water resources is optimally and efficiently used. The water resources have to be used in such a way that they command as much area as possible without adversely affecting crop productivity. Presently, the share of water for irrigation is more than 70 % which is likely to decrease considerably in future to meet competing demand from other users like industry and domestic. There is a serious challenge for the country to not only produce more food with declining available water but also to meet domestic and industrial requirement in view of the growing population. This can be ensured by optimizing every drop of water for maximizing returns. It is in this context that the concept of irrigation efficiencies assumes added significance.

Irrigation efficiency is used to evaluate how effectively the available water supply is used for crop production. Water is conveyed through canal system, water courses, and field channels to the fields. Irrigation water is stored in the effective root zone of the soil. A considerable loss of water occurs from the source to the point of actual usage by the crop. The performance of an irrigation system is determined by the efficiency with which water is stored in the surface reservoir at the head works, diverted and conveyed to the irrigated area through the conveyance system and applied to the field and by the adequacy and uniformity of the water application in each field. The overall performance of an irrigation system is defined as the per cent of water supplied to the farm that is beneficially used for irrigation on the farm. The extent of water loss in this process determines the irrigation efficiencies. Less the water losses higher the irrigation efficiencies. The tube well commands have higher irrigation efficiency than the canal commands. The efficiency provides a measure for comparing various systems or methods of water application, i.e. sprinkler compared to surface method. Presently, the irrigation efficiency in surface method of irrigation is very low (about 40%) which means that about 60% water is either wasted and flows as runoff or goes back to the aquifer from where it is pumped again requiring high amount of energy. Irrigation efficiency in surface method of irrigation can be easily increased to 60 % by proper design and operation of the system. However, irrigation efficiency is considerably high in case of pressure system of irrigation.

Q10. Discuss Factors Influencing Water Use Efficiency.

Ans.

Factors Influencing Water Use Efficiency

Following factors play important role in enhancing water use efficiency:

- **Plant species adaptation:** Plant species should be selected depending upon the amount and distribution of water in the area as their water requirement varies;
- **Plant factors:** Plant factors such as stomatal closure, its number and size, leaf area and root depth;
- **Agronomic practices:** The practices such as time of sowing, plant and row spacing affect water use and crop yield and eventually water use efficiency;
- **Weed control:** Weed control leads to higher uptake of nutrient, water and light and eventually resulting in higher water use efficiency, and
- **Disease and insect control:** It helps in increasing yield and water use efficiency.

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