



30

METHODS OF WATER HARVESTING

Water is “elixir of life”. In the previous lesson you have learnt about the various sources of fresh water. We need to conserve the water for the present and for the future generations. In this lesson you shall learn about the need for water conservation and the different methods of water harvesting.



OBJECTIVES

After completing this lesson, you will be able to:

- *describe the need and importance of water conservation;*
- *explain the need for water harvesting;*
- *categorize and describe different methods of traditional water harvesting;*
- *categorize and describe different methods of modern water harvesting.*

30.1 NEED FOR WATER CONSERVATION

Water is the most essential natural resource for life. It is likely to become a critical scarce resource in many regions of the world in the coming decades. Although water is the most abundant substance on earth, it is not equally distributed. Variations in latitude, rainfall patterns, topography, etc. affect its availability.

Water is a resource which cannot be produced or added as and when required by any technological means. The total fresh and sea water content of the earth is essentially fixed.

The fresh water which is so essential for our life is only a small portion of the total water available on this earth- about 2.7%. Nearly all of this 2% is locked in the masses of ice caps, glaciers and clouds. The remaining small fraction of fresh water has accumulated over centuries in the lakes and underground sources of the world. Surprisingly it is the salt

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water of the oceans that is the ultimate source of fresh water on this earth. Almost 85% of the rain water falls on directly into the sea and never reaches the land. The small remainder that precipitates on the land fills up the lakes and wells, and that keeps the river flowing. For every 50,000 grams of ocean water only one gram of fresh water is available to mankind making water a scarce and thus a precious commodity.

The condition in India is still worse. Although India is one of the wettest country in the world, the availability of water with time and space is highly uneven. On an average, it receives about 1150 mm of rainfall annually, which is highest in the world for a country of similar size. However, its distribution is highly uneven. For example, the average number of rainy days in a year is only 40. Thus there is a long spell of dry period in a year. Also, the rainfall is as high as 13 m in some areas of North-East regions and as a low as 20 cm in certain parts of Rajasthan. This uneven distribution of rainfall results in severe water scarcity in many parts of our country.

With increasing demand for domestic, industrial and agriculture purposes the water availability is decreasing and likely situation is going to worsen in future. Moreover, for the past few decades efforts have been made to increase irrigation in the country. This has resulted in over exploitation of our water resources. Our increasing urbanization and industrialization has also put additional demand for water. All the above factors have resulted in severe water scarcity in many parts of the country. Hence, it is important to prevent waste and conserve water. To feed our growing population we need to grow more food. In order to increase food production we need more and more water for irrigation. Thus, there is an urgent need for conservation of water.

In ancient times, water was acknowledged and regarded as a valuable resource. In fact, almost every ancient culture has regarded water as sacred. In 20th century, however, the advent of the industrial revolution and the consequent dawn of western materialism have led to a non-traditional commodity based perception of nature's resources.

Just as the 20th century focused on the importance of oil, the 21st century is likely to be focused on issues concerning safe and adequate drinking water. The most important step in the direction of finding solutions to issues of water and environmental conservation is to change people's attitudes and habits. If the world continues to treat water as a cheap resource that can be wasted, then not even the best policies and technologies can help to solve water scarcity.

At the current rate of population growth in India, combined with the growing demand on available water resources, India could well have the dubious distinction of having the largest number of water-deprived persons in the world in the next 25 years. This is the scenario if the available resources are not managed judiciously and with care. Urbanization rapid industrialisation and an ever-increasing population have polluted most of the surface water bodies, making their wastes unfit for human use. These coupled with growing needs, have led to increasing dependency on ground water. Excessive tapping of ground water, through numerous boreholes, has led to a decline in the water table. It is estimated that by



the year 2050, half of India's population will be living in urban areas and will face acute water problems. Furthermore, there are serious inequities in the distribution of water.

Throughout the world, shortage of water is growing due to increasing:

- droughts,
- irrigation demand,
- industrial demand,
- pollution, reducing usability of water resources, and
- wastage and irresponsible attitude towards water.

As mentioned earlier, we have long dry period in our country. During dry period our demand for water is fulfilled through the water stored in lakes, reservoirs or underground water. With increasing demand for water these sources are becoming increasingly inadequate. Hence, efforts are required to retain more and more rain water for use during the dry period. Rain water harvesting at local level by either storing in ponds, tanks and lakes or by recharging ground water are simple methods of augmenting water supply. In the following sections some important methods of rainwater harvesting are described.



INTEXT QUESTIONS 30.1

1. India is the wettest country in the world and yet certain parts of it suffer from severe water scarcity. What causes this water scarcity? (one reason)

2. What is the average number of rainy days in India?

3. "Water harvesting is a wise step towards water conservation". Justify giving reasons.

4. List any three reasons for water shortage in the world.

30.2 TRADITIONAL METHODS OF WATER HARVESTING

Rain water harvesting is an enjoying a renaissance of sorts in the world, but it traces its history to biblical times. Extensive rain water harvesting apparatus existed 4000 years ago in the Palestine and Greece. In ancient Rome, residences were built with individual cisterns

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and paved courtyards to capture rain water to augment water from city's aqueducts. As early as the third millennium BC, farming communities in Baluchistan and Kutch impounded rain water and used it for irrigation.

Our ancient religious texts and epics give a good insight into the water storage and conservation systems that prevailed in those days. Over the years rising populations, growing industrialization, and expanding agriculture have pushed up the demand for water. Efforts have been made to collect water by building dams and reservoirs and digging wells; some countries have also tried to recycle and desalinate (remove salt) water. Water conservation has become the need of the day. The idea of ground water recharging by harvesting rainwater is gaining importance in almost all societies.

In forests, water seeps gently into the ground as vegetation breaks the rain fall. This ground water in turn feeds wells, lakes, and rivers. Protecting forests means protecting water catchments. In ancient India, people believed that forests were the mothers of rivers and worshipped the sources of these water bodies.

30.2.1 Ancient Indian methods of water harvesting

Water has been harvested in India since antiquity, with our ancestors perfecting the art of water management. Many water harvesting structures and water conveyance systems specific to the different cultures were developed. The Indus Valley Civilization, that flourished along the banks of the river Indus and other parts of western and northern India about 5000 years ago, had one of the most sophisticated urban water supply and sewage systems in the world. The fact that the people were well acquainted with hygiene can be seen from the covered drains running beneath the streets of the ruins at both Mohanjodaro and Harappa. Another very good example is the well planned city of Dholaviras, on Khadir Bet, a low plateau in the Rann in Gujarat. One of the oldest water harvesting systems is found about 130 km from Pune along Naneghat in the Western Ghats. A large number of tanks were cut in the rocks to provide drinking water to tradesmen who used to travel along this ancient trade route. Each fort in the area had its own water harvesting and storage system in the form of rock cut cisterns, ponds, tanks and wells that are still in use today. A large number of forts like Raigad had tanks that supplied water.

- In ancient times, houses in parts of western Rajasthan were built so that each had a roof top water harvesting system. Rainwater from these rooftop was directed into underground tanks, this system can be seen even today in all the forts, palaces and houses of the region.
- Underground baked earthen pipes and tunnels to maintain the flow of water and to transport it to distant places, are still functional at Burhanpur in Madhya Pradesh, Golkunda and Bijapur in Karnataka, and Aurangabad in Maharashtra.
- They harvested the rain drop directly. From rooftop, they collected water and stored it in tanks built in their courtyards. From open community lands, they collected the rain and stored it in artificial wells.

- They harvested monsoon runoff by capturing water from swollen streams and rivers during the monsoon season and stored it various forms of water bodies.



INTEXT QUESTIONS 30.2



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1. Mention any two instances that prove that water harvesting existed in ancient India.

2. How do forests help in recharging ground water?

3. Mention how in ancient times houses in western Rajasthan conserved water.

30.3 MODERN METHODS OF WATER HARVESTING

Rain water harvesting techniques: There are two main techniques of rain water harvesting:

1. Storage of rain water on surface for future use
2. Recharge to ground water

The storage of rain water on surface is a traditional technique and structures used were tanks, ponds, check dams, weirs etc. recharge to ground water is a new concept of rain water harvesting and the structures generally used are:

- **Pits:** Recharge pits are constructed for recharging the shallow aquifer.
- **Aquifer:** The aquifer is porous, water saturated layers of sand, gravel or bed rock that can yield significant or usable amount of water. These are constructed 1 to 2 m wide, 1 to 1.5 m deep which are back filled with boulders, gravels, coarse sand.
- **Trenches:** These are constructed when the permeable rock is available at shallow depth. Trench may be 0.5 to 1 m wide, 1 to 1.5 m deep and 10 to 20 m long depending upon the availability of water. These are back filled with filter materials.
- **Dug wells:** Existing dug wells may be utilized as recharge structure and water should pass through filter media before putting into dug well.
- **Hand pumps:** The existing hand pumps may be used for recharging the shallow/deep aquifers, if the availability of water is limited. Water should pass through filter media to avoid choking of recharge wells.



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- **Recharge wells:** Recharge wells of 100 to 300 mm diameter are generally constructed for recharging the deeper aquifers and water is passed through filter media to avoid choking of recharge wells.
- **Recharge Shafts:** For recharging the shallow aquifer which is located below clayey surface, recharge shafts of 0.5 to 3 m diameter and 10 to 25 m deep are constructed and back filled with boulders, gravels and coarse sand.
- **Lateral shafts with bore wells:** For recharging the upper as well as deeper aquifers lateral shafts of 1.5 to 2 m wide and 10 to 30 m long depending upon availability of water with one or two bore wells is constructed. The lateral shaft is back filled with boulders, gravels and coarse sand.

30.3.1 Diversion of run-off into existing surface water bodies and its benefits

Construction activity in and around the city is resulting in the drying up of water bodies and reclamation of these tanks for conversion into plots for houses. Free flow of storm run off into these tanks and water bodies can be used as harvesting system. The storm run off may be diverted into the nearest tanks or depression, which will create additional recharge.

In urban areas, the construction of houses, footpaths and roads has left little exposed earth for water to soak in. In parts of the rural areas of India, floodwater quickly flows to the rivers, which then dry up soon the rains stop. If this water can be held back and allowed to seep into the ground for recharging the ground water supply.

This becomes a very popular method of conserving water especially in the urban areas. Rainwater harvesting essentially means collecting rainwater on the roof of building and storing it underground for later use. Not only does this recharging arrest groundwater depletion, it also raises the declining water table and can help augment water supply. Rain water harvesting and artificial recharging are becoming very important issues. It is essential to conserve surface water runoff during the rainy season and stop the decline in ground water levels, arrest sea water ingress in coastal areas, i.e. prevent sea water from moving landward excessive withdrawal of ground water pulls sea water that spoils coastal ground water resources by them salty.

All you need for a water harvesting system is rain, and a place to collect it. Typically, rain is collected on rooftops and other surfaces, and the water is carried down to where it can be used immediately or stored. You can direct water run-off from this surface to plants, trees or lawns or even to the aquifer.

Realizing the importance of recharging of ground water, the government of India and many state governments, non-government organizations and other institutions are taking steps to encourage rain water harvesting in the country. A number of government buildings have been asked to go take up water harvesting in Delhi and in some other cities of India.



Town planners and civic authority are introducing bylaws making rainwater harvesting compulsory in all new structures. No water or sewage connection would be given if a new building did not have provisions for rain water harvesting. Such rules should also be implemented in all the other cities to ensure a rise in the ground water level.

Some of the benefits of rainwater harvesting are as follows:

- Increases water availability;
- Check the declining water table;
- It is environmentally friendly;
- Improves the quality of groundwater through the dilution of fluoride, nitrate, and salinity;
- Prevents soil erosion and flooding especially in urban areas.

Case Study

Rainwater harvesting: a success story

In the area surrounding the River Ruparel in Rajasthan is a good example of proper water conservation. The site receives very little rainfall, but proper management and conservation have ensured the water availability through out the year. The water level in the river began declining due to extensive deforestation and agricultural activities along the banks and, by the 1980s, a drought-like situation began to spread. Under the guidance of local peoples, the women living in the area were encouraged to take the initiative in building johads (round ponds) and dams to hold back rain water. Gradually, water began coming back as proper methods of conserving and harvesting rainwater were followed. The revival of the river has transformed the ecology to the place and the lives of the people living along its banks. Their relationship with their natural environment has been strengthened. It has proved that mankind is not the master of the environment, but a part of it. If human beings put in an effort, the damage caused by us can be undone.

30.3.2 Rainwater harvesting and water conservation in agriculture

Conservation of water in the agricultural sector is essential since water is necessary for the growth of plants and crops. A depleting water table and a rise in salinity due to irrigation is a serious matter. Various methods of water harvesting and recharging have been and are being applied all over the world to tackle the problem. In areas where rainfall is low and water is scarce, the local people have used simple techniques that are suited to their region and reduce the demand for water.

- In India's arid and semi arid areas, the tank system is traditionally the backbone of agricultural production. Tanks are constructed either by building or by excavating the ground and collecting rainwater.



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- Rajasthan, located in the Great Indian Desert, receives hardly any rainfall, but people have adapted to the harsh conditions by collecting whatsoever rainfalls. Large bunds to create reservoirs known as khadin, dams called johads, tanks, and other methods were applied to check water flow and accumulate run off. At the end of the monsoon season, water from these structures was used to cultivate crops. Similar systems were developed in other parts of the country. These are known by various local names jal talais in Uttar Pradesh, the haveli system in Madhya Pradesh, ahar in Bihar, and so on.

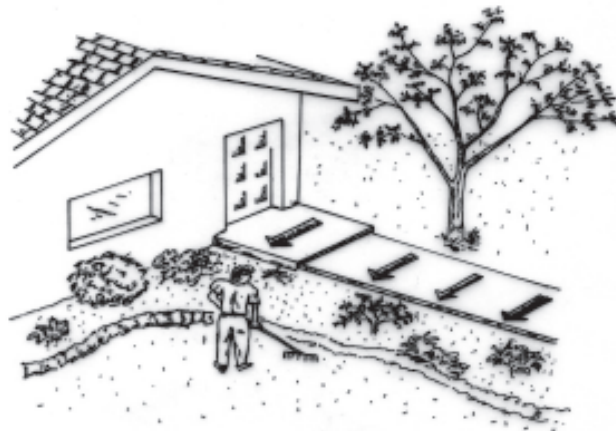


Fig. 30.1: Rain water harvesting and water conservation in agriculture



INTEXT QUESTIONS 30.3

1. List any three structures that can be constructed to recharge the ground water.

2. Mention the new bylaws being introduced by the civic authorities in many cities to ensure water conservation.

3. List any four benefits of rain water harvesting at any place of the states.

4. Name some of the structures that are used in Rajasthan, U.P. and Madhya Pradesh to collect rain water for cultivating crops during dry seasons.

30.4 RAINWATER HARVESTING AT HOUSEHOLD LEVEL

Water harvesting is simply collecting rainwater that falls over ones property and then putting it to use around ones home or yard—that’s all! Many homeowners in our country already use rainwater to irrigate trees, lawns and for landscaping. One can substantially lower



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water bill, help reduce local flooding and reduce landscaping and property maintenance needs—all by putting water harvesting ideas to use around ones home. Building a new home on a single plot, designing a major subdivision, or just making a few improvements around, water harvesting can be easily incorporated into the plans.

Water harvesting systems can range from the simple to complex, depending on the area, need and budget. It can be helpful to think of rain water harvesting system as having **four main** components.

(a) Rainwater collection

One can capture rainwater from any rooftop area, **patio**, driveway or other impermeable surface. Make sure that collected water is kept at least three feet away from the foundation of your house. The amount of water you will be able to harvest depends on the size of your catchment area. To determine the amount of water you can collect, multiply the area of your roof (catchment) in square metre times the amount of rain received each year in metre. (average rainfall in India is 1.17 m). Next, multiply that value by 0.909 to account for evaporation and other losses, and then multiply this result by 1000 to determine the number of litres. As an example, a square metre catchment area will yield about 105300 litres of water per year ($1.17 \times 100 \times 0.90 \times 1000 = 105300$)

(b) Storage

Storage systems can vary in complexity depending on ones needs. An effective system can involve a 250 litre drum fed by rooftop gutters and downspouts. A more involved system might include **buried cisterns**, plumbing and a timed watering system. Debris and leaves should be filtered before storing the water by placing screens over gutters or downspouts. Water kept in tanks or cisterns should also be covered to minimize algal growth and eliminate the potential for mosquito breeding. Placing floating lids on storage tanks is an effective solution.

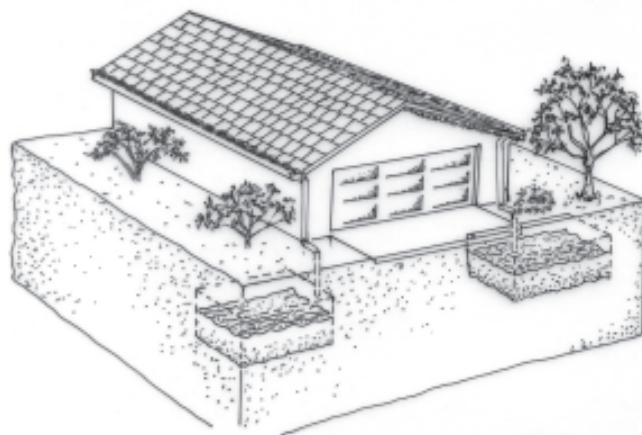


Fig. 30.2: Storage of water

**Notes****(c) Distribution**

Gutters (a narrow channel which collects rainwater from the roof of a building and diverts it away from the structure, typically into a drain) and downspout (is a vertical pipe for carrying rainwater from a rain gutter to ground level) or berms (is a level space, shelf or raised barrier separating two areas) and swales (is a low tract of land, especially one that is moist or marshy) can be designed to catch rainwater and distribute it directly to landscape plants or into the soil. Many people store harvested rainwater and then distribute it later through their regular drip irrigation system.

(d) System maintenance

Water harvesting systems require occasional maintenance, but this is easily accomplished. Debris screens over gutters should be cleaned periodically and storage tanks should be drained and cleaned when it is convenient to do so.

30.4.1 Benefits of rainwater harvesting

While many people may not realize it, those few inches of annual rainfall is a valuable resource. Harvesting rainwater not only helps reduce the possibility of flooding, but it also decreases the community's dependence on groundwater. Unlike groundwater, however, rainwater is remarkably pure with virtually no dissolved salts or minerals. Because of this, rainwater is perfectly suited for landscape irrigation, use in evaporative coolers, washing and many needs, hardness deposits do not accumulate and there is no problem with soap scum. Imagine not having to scrap your evaporative cooler every year! By reducing runoff and using rainwater that falls on your evaporative cooler every year! By reducing runoff and using rainwater that falls on your property, you can put a valuable water resource to work around your house and yard.

- Conserves valuable ground water and reduces your monthly water bill.
- Reduces local flooding and drainage problems.
- Flushes salt build up from soils- your plants and notice the difference.
- Decreases landscaping and property maintenance needs.
- Provides excellent quality water for various uses.

Some activities for the learners

Activity 1: Do an audit of your home/your work place. Can you see any of the following?

- Leaks and drips.
- Toilets and urinals that do not have a water saving device installed.
- Garden hoses that are left on during the day.
- Taps that are left on while teeth are brushed or dishes etc. are washed.

Choose one issue and brainstorm some ways to prevent it. Here are some examples of action projects which help to reduce water wastage.



Activity 2: Some ideas for action projects

- (a) **Design leaflets** about being water-wise; it's an easy and effective way to get information across. Create enough leaflets to do a drop to your local community.
- (b) **Retrofit the school's toilet** with a cheap and low-tech solution: a 1 litre plastic bottle filled with water placed in the toilet cistern. This displaces water and saves 1 litre per flush-which can be a huge saving where toilets are used frequently, such as in schools.
- (c) As a technology project, your class could invent a system or technology to collect roof water so that it can be reused to water the garden. A bucket catching the down pipe overflow might work.

Or you could invent a home made sprinkler to water specific parts of the garden rather than wasting water where it is not needed. Installing a strong hosepipe with holes pierced in strategic places works well.

- (d) **Organize a water wise week** at your study centre/work place. You could read the water meter to find out how much water your study centre/workplace uses each week, then attempt to reduce that amount by a quarter (on average, these places can reduce their water consumption by at least a third). Get the whole organization involved by running an event each day to show ways to reduce water wastage.
- (e) **Plant natives instead of exotics:** (Native plants use less water than exotics). Ask the caretaker to water the plants in the cool of the day (early morning or better still, late afternoon). You could set up your own water-wise gardening club. Some work places have very successful gardening clubs and mulch all their plants to save water.



INTEXT QUESTIONS 30.4

1. List the four main components required for harvesting water at household level.

2. List any two precautions to be taken while storing rain harvested water in cisterns/tanks.

3. How do we benefit by harvesting water at household level? (any three)



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**Notes****WHAT YOU HAVE LEARNT**

- Earth has plenty of water but freshwater is only a small fraction of it.
- With growing demand for water, its resources are over-exploited.
- Although plenty of rain occurs in India, due to its un-even distribution over time. and space, it faces severe water scarcity in its many parts.
- For feeding ever growing population, India need to grow more food grains.
- Since, duration of rainfall is short, the agricultural activities depend on irrigation.
- Irrigation consumes nearly 85% of the total water used in India.
- With increasing demands for agriculture and other developmental activities, water resources are over-exploited.
- Urbanization and industrialization further aggravate the situation by over-exploiting and polluting the water resources.
- Thus, conservation is one of the most important and simple methods of water conservation.
- Rainwater harvesting is one of the most important and simple methods of water conservation.
- Rainwater harvesting is collection of rainwater and its storage for direct use or for percolating in the ground to artificially recharge the ground water.
- Traditionally rainwater is harvested through various means all over the world.
- There are evidence of rain water harvesting in Indus Valley, Palestinian, Greek and Roman Civilizations.
- They had wisdom of conserving water.
- Rainwater harvesting is getting significant importance in recent past due to severe scarcity being faced in many parts of the world including India.
- Several initiatives are taken by the government of India and various state governments to promote rainwater harvesting in the country.
- Many local bodies are considering making it mandatory to install rainwater harvesting system in housing complexes, large buildings and offices.

**TERMINAL EXERCISE**

1. Why we should go for rainwater harvesting?
2. Explain traditional methods of rainwater harvesting.
3. Which methods of rainwater harvesting prevailed in ancient India?
4. How rainwater harvesting helps in overcoming water scarcity?
5. Explain in brief roof-top rainwater harvesting.
6. How ground water is artificially recharged?
7. Narrate a success story of rainwater harvesting in India.
8. Explain in brief the important benefits of rainwater harvesting.
9. Describe the steps involved in rainwater harvesting.
10. Provide in brief initiatives taken by the government on rainwater harvesting in India.

**Notes****ANSWER TO INTEXT QUESTIONS****30.1**

1. Uneven distribution of rain in time and space.
2. 40 days
3. There is scarcity of fresh water and increasing population, unequal distribution of rain in certain parts of our country, increasing industrialization and urbanization but excessive demand on this scarce resource. Therefore harvesting rain water and storing it for dry spells of times is a very step.
4. Drought, expanding population, increasing irrigation demand, pollution which is reducing usability of water, abuse of available water. (any three)

30.2

1. One of the oldest water harvesting system is found near Pune in the Western Ghats where large number of tanks were cut out in the rocks to provide drinking water to the tradesmen, forts like Raigad had tanks, ponds, rock cut cisterns to harvest and store water. These ponds and wells are still in use; well planned system of urban water supply and sewage in the ruins of Mohanjodaro and Harappa of Indus Valley Civilization. (Any two) or any other.

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2. In the forests the vegetation helps in seepage of water into the ground and thus recharges the water table.
3. Each house in this region was built in such a way that they could harvest rain water and this rain water was stored in underground tanks. This system can be seen even today.

30.3

1. Recharge wells shafts, trenches, pits, check dams or bunds, lateral shafts with bore wells (any three)
2. No water or sewage connection would be given if a new building did not have provision for rain water harvesting.
3. Increases water availability, checks declining water table, improves the quality of ground water through the dilution of salts, prevents soil erosion and flooding specially in urban areas.
4. Khadin, Johad, talai, haveli (any three).

30.4

1. Place/area to collect rain water, storage unit, distribution component, system maintenance.
2. Storage structures should be covered to prevent mosquito breeding and minimize algal growth.
3. a) Conserve ground water and reduce the monthly water bill
b) Reduce local flooding and drainage problem.
c) Flushes salt build up from soils.
d) Provide excellent quality water for gardening in water codes. (any three)