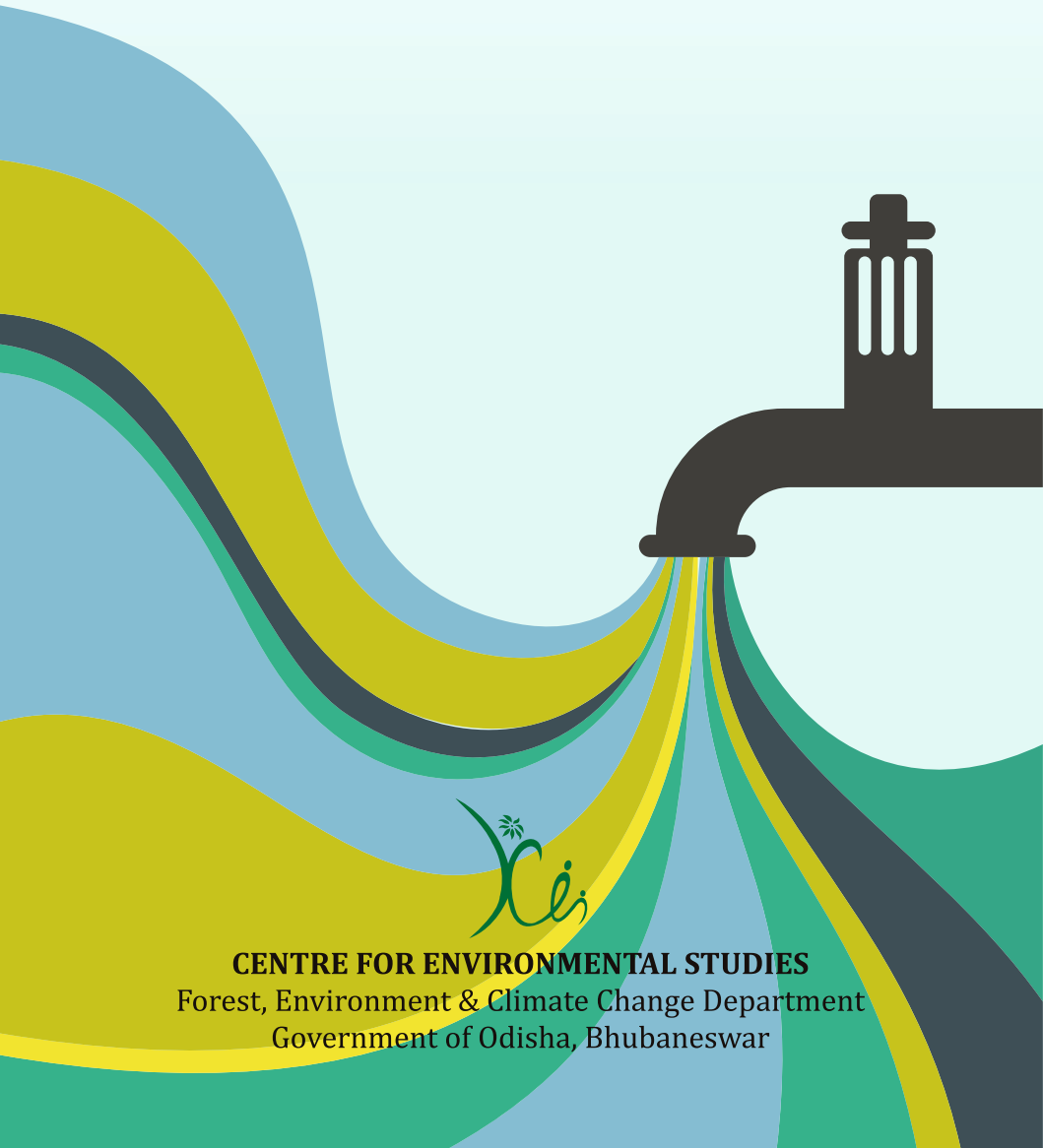
# WATER CONSERVATION



**CENTRE FOR ENVIRONMENTAL STUDIES**
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# PREFACE

This book, compiled by the Centre for Environmental Studies (CES), serves as a comprehensive guide to understanding and addressing the challenges of water conservation in the 21st century.

The book delves into the critical importance of water as a finite resource, exploring traditional and modern methods of conservation, sustainable agricultural practices, and innovative technologies for efficient water use. It highlights the role of rainwater harvesting, watershed management, and efficient irrigation techniques in mitigating water scarcity, particularly in regions like India, where water stress is a pressing issue.

It aims to inspire proactive water stewardship, encouraging individuals and communities to adopt responsible water conservation practices. Dr. Sasanka Lenka has played a pivotal role in compiling this valuable resource, enriching its scientific content with his expert contributions. Let this book be a call to action, reminding us that every drop saved is a step toward a sustainable future.

I would like to thank Ministry of Environment, Forest & Climate Change (MoEF&CC), Govt. of India for giving opportunity to compile this book under Environment Education Programme (EEP).

**(Dr. K. Murugesan)**

# CONTENT



**"Either excess or no water destroys the Universe"**
**(*Jala Bahule shristi nasha, Jala bihune shristi nasha*)**

## 1.0 Introduction

Water is one of the basic requirements for every living being and we cannot imagine a life without water. Water is an essential natural resource for life. It is at the core of sustainable development and is crucial for socio-economic development, energy and food production, healthy ecosystems, and human survival. It is the natural resource and the main constituent of our planet Earth. Water is the universal solvent and plays a key role in the existence of various forms of life on Earth. It is widely used for multiple purposes such as washing, bathing, cleaning, cooking, drinking, and other industrial and domestic uses. Water is vital to our health. It plays a key role in many of our body's functions, including bringing nutrients to cells, getting rid of wastes, protecting joints and organs, and maintaining body temperature. Water should almost always be your go-to beverage. Water conservation is the practice of using water more efficiently and reducing waste. It can include reusing water, collecting rainwater, and using water-saving appliances.

Water conservation is the careful management and use of water to ensure it provides the best long-term benefit to the public. Conservation is the preservation of water from loss, damage or neglect. It includes processes that help provide long-term access to clean water by preventing unnecessary water usage and waste. Water is a colourless and odourless substance that is essential for the survival of living beings. There are various sources of water such as wells, rivers, ponds, lakes, oceans, big dams, and streams. As we all know, nearly 70 to 80 per cent of the Earth's surface is covered by water, among which only 1-2 per cent is pure and suitable for human use.

Water conservation makes it possible to avoid water scarcity. It covers all the policies, strategies and activities to reach these aims. Population, household size, growth and affluence all affect how much water is used. Climate change and other factors have increased pressure on natural water


**Fig 1, Traditional Water Conservation Methos in India**

resources. Water conservation is a process of preventing wastage of water, using water carefully and recharging groundwater. Water conservation can be done by: 1) Repairing leaking pipes and taps. 2) Not wasting water while brushing teeth, shaving, bathing, washing clothes and during other activities. 3) Rainwater harvesting. Different traditional water conservation methods are practising by States are as follows:

Although the earth is rich in water, only one per cent is liquid fresh water, the form we require for our highest priority needs. The demands on this liquid fresh water are growing, and many scientists feel that a future shortage of fresh water will be imminent. Water conservation and management emphasizes water quality protection, a growing area of employment and environmental concern. Water conservation and management encompasses the policies, strategies and activities made to manage water as a sustainable resource, to protect the water environment, and to meet current and future human demand. Population, household size, and growth and affluence all affect how much water is used. Factors such as climate change will increase pressures on natural water resources, especially in industrial and agriculture.

Better water conservation and management have economic benefits and help protect the environment. The more water you use, the more you pay for water and sewer service on a municipal water and sewer system. Excessive water use can overload both individual septic systems and municipal sewer systems, thereby resulting in untreated sewage contamination of freshwater supplies. Water conservation can extend the useful life of both community and individual

household sewer systems. Excessive withdrawals of groundwater can lead to saltwater intrusion, a subtle environmental impact with long-lasting effects. These areas are usually associated with large population centres or agriculture, where water use is high. Agriculture is our most essential industry, but it is also our largest consumer of fresh water. Water conservation and management will become bigger issues for agriculture and metropolitan areas as they compete for limited freshwater resources in the future.

Four billion people across the globe, which is two-thirds of the world's population, continue to experience water scarcity for over a month, every year. According to UNICEF's estimate, half of the world's population by 2025 will be living in areas facing acute water scarcity. NITI Aayog report stated that 600 million people in India, which is almost half its population, face extreme water crises daily. The situation is so bad that almost three-fourths of India's rural households have to rely on surviving on dirty polluted water as they have no access to piped potable water in their homes.

In this situation, water conservation is the only way to avert impending doom. Eco-friendly and sustainable traditional water conservation methods will save millions of lives from flood- and drought-affected areas. Almost every region in India is blessed with homegrown water harvesting and conservation techniques that are tailored to fit the unique geographical and cultural needs of the place and the community inhabiting it.

## 2.0 Objectives

Water conservation is important because of growing water scarcity and climate change. Modern methods use

technology, innovation, and sustainable practices. The main objectives of water conservation are to manage water sustainably, protect water bodies, and meet current and future water needs.

1. **Protect water bodies**: Conserving water helps protect natural water bodies and aquatic wildlife.
2. **Avoid water scarcity**: Conserving water helps prevent water scarcity, which is when there isn't enough water to meet demand.
3. **Reduce energy consumption**: Conserving water can help reduce energy consumption and carbon emissions.
4. **Improve water use efficiency**: Conserving water can help improve water use efficiency and optimize yields.
5. **Enhance soil health**: Conserving water can help enhance soil health.

## 3.0 Methods

- **Rainwater harvesting**: Collecting rainwater to reduce reliance on municipal water sources
- **Greywater recycling**: Recycling water that has been used in the home
- **Metering water**: Recording how much water is being used
- **Using valves**: Using valves to reduce pressure in hydraulic systems
- **Water irrigation scheduling**: Ensuring crops receive adequate water without overwatering

## 4.0 Aims & Scope

Water conservation aims to sustainably manage the natural resources of fresh water, protect the hydrosphere, and meet current and future human demand. Water conservation makes it possible to avoid water scarcity. It covers all the policies, strategies and activities to reach these aims. Water conservation aims to sustainably manage freshwater resources, protect water sources, and meet current and future human needs. Water conservation also aims to avoid water scarcity and pollution. Water conservation and management contributions that potentially involve multidisciplinary research and consider sustainable management and conservation of water as a valuable resource. Contributions should have relevance and implications on sustainable water conservation practices from individual households to the community level, as well as from regional, national and international scales. The scope of water conservation is as follows:

- **Water use**: Reduce water loss, use, and waste
- **Water quality**: Avoid damaging water quality
- **Water management**: Improve water management practices
- **Water distribution**: Ensure fair water distribution
- **Water supply**: Maintain water levels for current and future use
- **Water sustainability**: Maintain or control the amount of usage to keep the resources at their current level

## 5.0 Sources of Water

Mainly water comes from various sources including rainwater, groundwater, surface water and soil moisture. The details are as follows:


### 5.1 Rain Water:

Rainwater falls from the sky and is a major part of the water cycle. It's a natural resource that's usually free of harmful chemicals. Rainwater can be used for many purposes, including drinking, irrigation, watering gardens, and flushing toilets. Its uses include watering gardens, livestock, irrigation, domestic use with proper treatment, and domestic heating. Rainwater will be very low in elemental or chemical contamination unless there is industrial air pollution or fallout on the roofs. The pH of collected rain may be low (4.0 – 5.0) but is not considered detrimental to crops because it is not buffered (does not resist change in pH) and changes readily. Rainwater is an excellent and underutilized source of irrigation water. The harvested water can also be used for long-term storage or groundwater recharge. The major source of irrigation is rainwater. Out of the total rainwater, 27 per cent of water is lost by evaporation, 15 per cent by seepage and percolation, 4.5 per cent is used for crop production and 4.5 per cent by stored in WHS/FP/Reserves. Total rainwater loss is 49 per cent. Rainwater harvesting is a technique that involves collecting and storing rainwater for irrigation and other uses. It can help farmers reduce their reliance on groundwater and other water sources. The details are as follows:

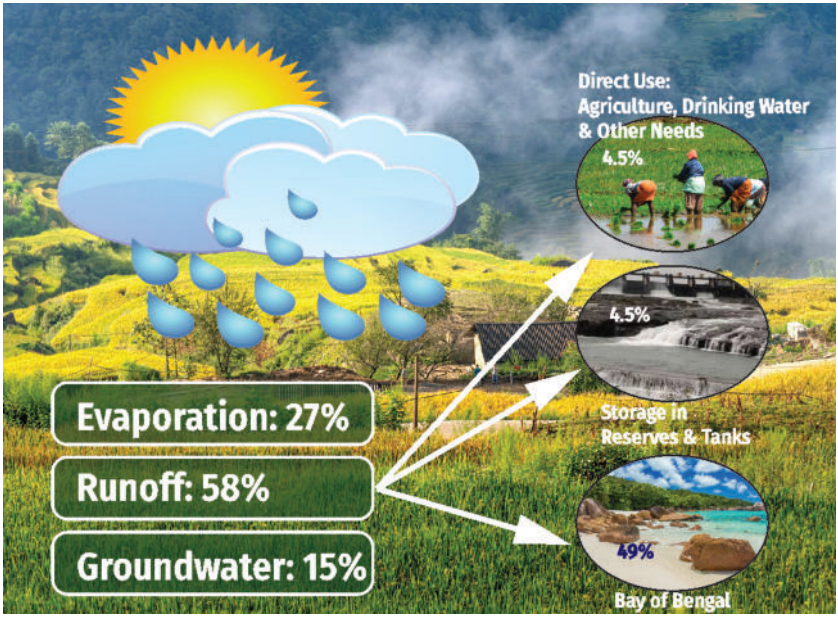



Fig 2, Rainwater and its uses

## 5.2 Groundwater

Groundwater is the water present beneath the Earth's surface in rock and soil pore spaces and the fractures of rock formations. About 30 per cent of all readily available fresh water in the world is groundwater. Groundwater is the water found underground in the cracks and spaces in soil, sand and rock. It is stored in and moves slowly through geologic formations of soil, sand and rocks called aquifers.

India heavily relies on groundwater, with approximately 85% of rural drinking water and over 60% of irrigated agriculture depending on it, making India the world's largest user of groundwater, consuming over a quarter of the global total; essentially, a significant portion of India's water needs are met by groundwater. The largest use of groundwater is to

irrigate crops. Aquifers are typically made up of gravel, sand, sandstone, or fractured rock, like limestone. Water can move through these materials because they have large connected spaces that make them permeable. The speed at which groundwater flows depends on the size of the spaces in the soil or rock and how well the spaces are connected. Groundwater can be found almost everywhere. The water table may be deep or shallow and may rise or fall depending on many factors. Heavy rains or melting snow may cause the water table to rise, or heavy pumping of groundwater supplies may cause the water table to fall.

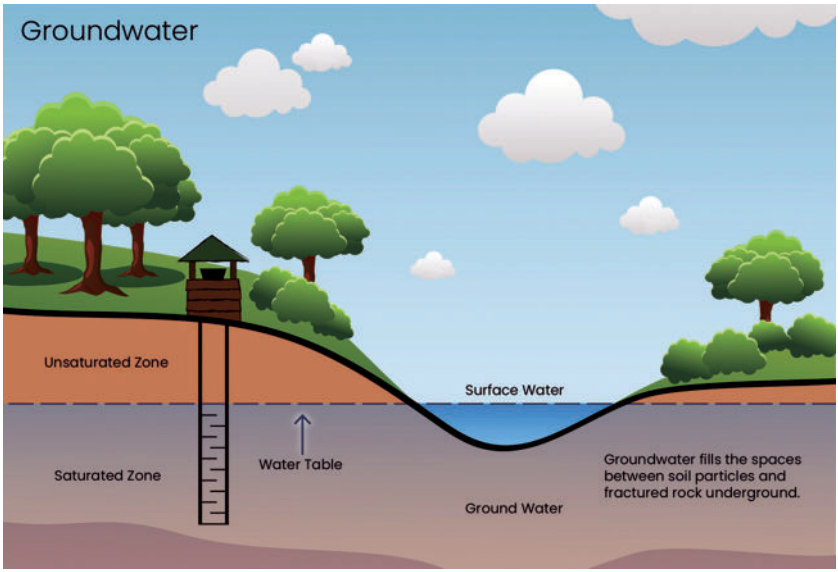



Fig 3, Groundwater

Groundwater supplies are replenished, or recharged, by rain and snow melt that seep down into the cracks and crevices beneath the land's surface. In some areas of the world, people face serious water shortages because groundwater is used faster than it is naturally replenished.

In other areas, groundwater is polluted by human activities. Water in aquifers is brought to the surface naturally through a spring or can be discharged into lakes and streams. Groundwater can also be extracted through a well drilled into the aquifer. A well is a pipe in the ground that fills with groundwater. This water can be brought to the surface by a pump. Shallow wells may go dry if the water table falls below the bottom of the well. Some wells, called artesian wells, do not need a pump because of natural pressures that force the water up and out of the well.

In areas where material above the aquifer is permeable, pollutants can readily sink into groundwater supplies. Groundwater can be polluted by landfills, septic tanks, leaky underground gas tanks, and from overuse of fertilizers and pesticides. If groundwater becomes polluted, it will no longer be safe to drink. Key points about India's groundwater dependence:

- **High usage:** India uses more groundwater than the United States and China combined.
- **Rural dependence:** Around 85% of rural households rely on groundwater for drinking water.
- **Agriculture reliance:** Over 60% of irrigation needs in India are met by groundwater.
- **Urban usage:** While less prevalent, a significant portion of urban water supply also comes from groundwater.

Part of the precipitation that falls, infiltrates into the ground. Water that percolates below the root zone finally reaches a level at which all the openings or voids in the earth's

## Dynamic Ground Water Resource of Odisha, 2022

| | | | |
|---|---|---|---|
| Dynamic Ground Water Resource | Total Annual Ground Water Recharge | 1778937.42 | Ham |
| | Total Annual Natural Discharge | 144468.95 | Ham |
| | Annual Extractable Ground Water Resource | 1634468.47 | Ham |
| | Current Annual Ground Water Extraction for Irrigation Use | 583087.20 | Ham |
| | Current Annual Ground Water Extraction for Industrial use | 16422.51 | Ham |
| | Current Annual Ground Water Extraction for Domestic use | 123770.84 | Ham |
| | Current Total Annual Ground Water Extraction for all uses | 723280.55 | Ham |
| | Stage of Ground Water Extraction | 44.25 | % |
| | Annual GW Allocation for Domestic Use as on 2025 | 137652.23 | Ham |
| | Net Ground Water Availability for future use | 903275.29 | Ham |
| | Total no. of blocks (Assessment Units) | 314 | No. |
| | Safe blocks | 300 | No. |
| | Semi-critical blocks | 8 | No. |
| | Saline blocks | 6 | No. |

materials are filled with water. This zone is called the zone of saturation. The water in the zone of saturation is called the groundwater, and the upper level of the zone of saturation is called the water table. The extraction of groundwater is mainly by:

- Dug well with or without staining walls
- Dug cum bore wells
- Cavity bore
- Radial collector wells
- Infiltration galleries
- Tube wells & bore wells.
- **Aquifers**: A unit of rock or unconsolidated deposit that can yield a usable quantity of water.
- **Springs:** Groundwater that flows naturally from the ground is called a Spring.

### 5.3 Surface Water

Surface water is water on the surface of the planet such as in a river, lake, wetland, or ocean. It can be contrasted with groundwater and atmospheric water. Surface water accumulates mainly as a result of direct runoff from precipitation (rain or snow). Precipitation that does not enter the ground through infiltration or is not returned to the atmosphere by evaporation flows over the ground surface and is classified as direct runoff. Direct runoff is water that drains from saturated or impermeable surfaces into the stream, channels, and then into natural or artificial storage sites (or into the ocean in coastal areas). The amount of available

surface water depends largely upon rainfall. The availability of surface water varies considerably between wet and dry years. Surface water sources may be further divided into rivers, lakes, ponds, and reservoirs. Dams are constructed to create artificial storage. Canals or open channels can be constructed to convey surface water to the storage reservoir and/ or water treatment plant. The water is also conveyed through pipes either by gravity or pumping mains. In general, the quality of surface water sources is characterized by colour, pH, turbidity, hardness, dissolved oxygen, suspended solids, and microbial contamination. There are certain instances wherein the quality of water gets affected adversely at the source due to sewage discharge or Industrial wastewater discharge. These fluctuations have to be monitored, and the operation and maintenance of the entire water supply system to be readjusted/ calibrated accordingly.

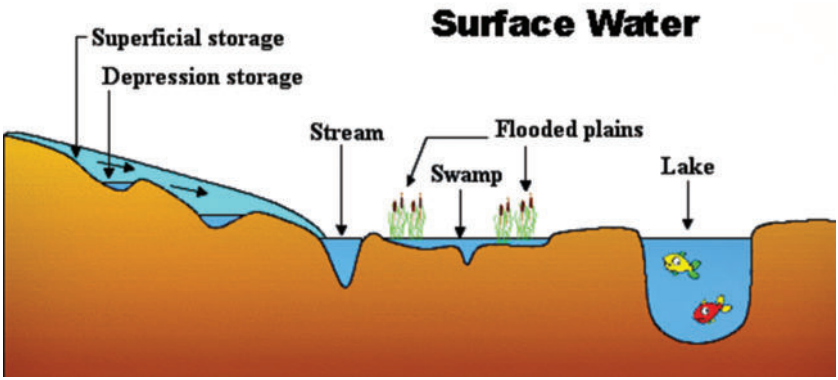



Fig 4, Surface Water

**Surface water** includes streams, rivers, lakes and ponds which are dependent on runoff from adjacent land or from groundwater springs. These are dependent on rainfall rates

that vary from year to year. Surface water is subject to contamination from sources such as sediment, chemicals and plant growth. High levels of particles can reduce the life of pumps and clog irrigation systems and multiple filters may be required. It is also possible that surface waters can become contaminated with road salt, industrial, and agricultural chemicals, algae and plant pathogens.

### 5.4 Soil Moisture

Soil moisture is the amount of water in the soil, including water vapour. It's also known as soil water. Soil moisture is important for agriculture, climate dynamics, and the water cycle. Factors affecting soil moisture weather, climate patterns, soil type, and vegetation. Mainly soil moisture is categorised into two types and these are:

- **Surface soil moisture**: Water in the top 10 cm of soil
- **Root zone soil moisture**: Water in the top 200 cm of soil that's available to plants

The soil moisture can be monitoring the following methods.

- **Soil moisture sensors**: Simple, inexpensive devices that indicate if the soil is too dry, moist, or wet for plants
- **Soil moisture indicators**: Portable devices that indicate soil moisture levels
- **Soil moisture datasets**: Datasets from Copernicus Land Monitoring Service that provide information on soil moisture

Soil moisture and plant growth are interrelated to each other. Soil moisture levels affect plant growth, water

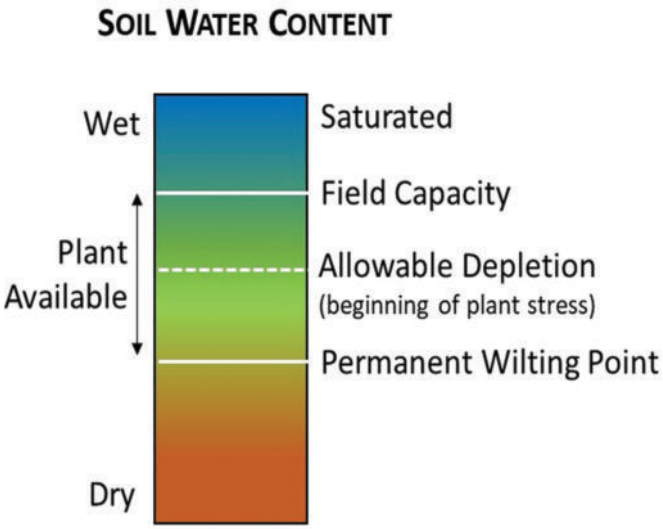



Fig 5, Soil Water Content

consumption, and the presence of many plant and animal species. Accurate monitoring of soil moisture helps manage environmental challenges like drought. Soil moisture is the amount of water in the soil, including water vapour, not groundwater, lakes, or rivers. It's also known as soil water. Soil moisture is the water content of the soil. It can be expressed in terms of volume or weight. Soil moisture measurement can be based on in situ probes or remote sensing methods. Water that enters a field is removed from a field by runoff, drainage, evaporation or transpiration.

### Importance

- Soil moisture is the primary water source for plants and agriculture.
- It affects the climate by influencing evaporation and transpiration, which in turn affects cloud and precipitation distribution.

- Soil moisture also affects runoff, which determines how much water goes into rivers and streams.
- A lack of soil moisture can lead to drought.

## 6.0 Conservation of Water

Conservation of water mainly refers to protecting, preserving, and controlling the usage of water and its resources. It is the system introduced to manage freshwater, reduce wastage and protect the water and its resources to reduce and avoid scarcity. Therefore, we all should come forward to create awareness about the conservation of water among our friends, family, neighbours, society, etc. Conservation of water is very much essential as it saves life on earth. Conserving water helps us by supplying more amount of water for longer usage. It has become necessary in all areas because these natural resources are reducing along with the increasing population and their usage. There are several ways to conserve water. Here are some important and easy ways for the conservation of water

- Keeping the tap closed when not in use.
- Check for openings or leaks in water distribution pipes.
- Make sure to use collected rainwater for gardening or washing purposes.
- Always have a measure of how many buckets of water are wasted in a day and try to reduce.
- Do not run more water than necessary while washing and cleaning clothes, utensils, etc.
- Do not prolong your bathing. Go for a quick shower rather than wasting buckets of water

- Rainwater harvesting is one of the best methods used for conserving water. There are different methods used to preserve rainwater instead of getting it wasted.

Farmers can also contribute to this system of conservation of water by using a Drip irrigation system in their fields. This is a type of irrigation system that can be practised by all farmers to save water. In this system, water is directly supplied to the plant roots and prevents water from being wasted by evaporation.

## 7.0 Agricultural Techniques for Water Conservation

Water is the vital essence of agriculture, and its efficient management is key to regenerative farming for a growing population. The perspective of water in the 21st century, and the importance of water conservation has reached unprecedented heights. Climate change, increasing population growth, and their multifarious demands have put tremendous pressure on our planet's freshwater resources. In this era of environmental awareness and corporate responsibility, innovative water conservation techniques have become a foundation of sustainable management and conservation of water resources.

India with its vast population and diverse climatic conditions, faces significant challenges in managing its water resources. Factors such as erratic rainfall patterns, depleting groundwater levels, and increasing demand from agriculture, industry, and urban areas exacerbate the water crisis. Therefore, adopting effective water conservation measures is crucial to mitigate these challenges and ensure water security for all.

## 7.1 Rainwater Harvesting

Rainwater harvesting is a traditional practice that involves collecting and storing rainwater for future use. Monsoon rains are a significant source of water, and rainwater harvesting systems, such as rooftop harvesting, check dams, and recharge pits, are widely implemented. These systems help replenish groundwater levels and provide an additional source of water for domestic, agricultural, and industrial purposes.

Rainwater harvesting is the simple process or technology used to conserve rainwater by collecting, storing, conveying and purifying rainwater that runs off from rooftops, parks, roads, open grounds, etc. for later use. Here, let us have a look at the diagram of the rainwater harvesting system. Water is a precious, essential and abiotic component of the ecosystem. Today we all are heading toward the scarcity of water, and this is mainly because of the lack of water conservation and pollution of water bodies. So, let us not waste a drop of water and start conserving water for further use.

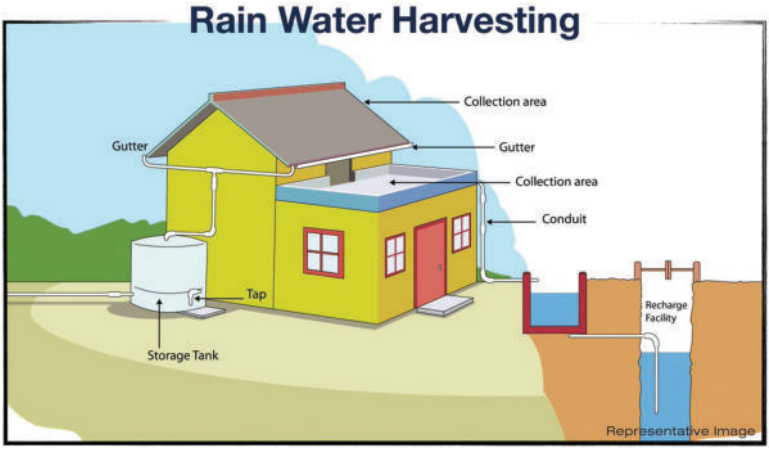



Fig 6, Rainwater harvesting model

**Rainwater harvesting systems consist of the following components:**

- **Catchment:** Used to collect and store the captured rainwater.
- **Conveyance system:** It is used to transport the harvested water from the catchment to the recharge zone.
- **Flush:** It is used to flush out the first spell of rain.
- **Filter:** Used for filtering the collected rainwater and removing pollutants.
- **Tanks and recharge structures:** Used to store the filtered water which is ready to use.

The process of rainwater harvesting involves the collection and storage of rainwater with the help of artificially designed systems that run off naturally or man-made catchment areas like- rooftops, compounds, rock surfaces, hill slopes, artificially repaired impervious or semi-pervious land surfaces. Several factors play a vital role in the amount of water harvested. Some of these factors are:

- The quantum of runoff
- Features of the catchments
- Impact on the environment
- Availability of the technology
- The capacity of the storage tanks
- Types of the roof, its slope and its materials
- The frequency, quantity and quality of the rainfall
- The speed and ease with which the rainwater penetrates through the subsoil to recharge the groundwater.

## Benefits of rainwater harvesting for Agriculture

- **Increases crop yields:** Rainwater can help plants grow and develop, which can lead to higher crop yields
- **Reduces chemical fertilizer use:** Rainwater can improve soil health, which can reduce the need for chemical fertilizers
- **Replenishes groundwater:** Rainwater harvesting can help restore groundwater aquifers, which can keep wells and boreholes supplied with water
- **Reduces reliance on potable water:** Rainwater can be used for irrigation, which can reduce the need for potable water
- **Improved Water Availability:** Rainwater harvesting enhances water availability for irrigation, ensuring that crops receive adequate water supply, even during periods of water scarcity. This helps in reducing the risk of crop failure and improving overall agricultural productivity.
- **Reduced Dependence on Groundwater:** By capturing and utilizing rainwater, rainwater harvesting reduces the dependence on groundwater resources, thereby promoting sustainable water management and reducing the pressure on over-extracted aquifers.
- **Enhanced Soil Health:** In-situ rainwater harvesting techniques help in reducing soil erosion and improving soil moisture, which in turn, contributes to improved soil fertility and crop growth.

- **Climate Change Resilience:** Rainwater harvesting practices, when integrated with other sustainable agricultural practices, can enhance the resilience of farming systems to the impacts of climate change, such as erratic rainfall patterns and prolonged droughts.
- **Diversification of Crops:** With increased water availability through rainwater harvesting, farmers can diversify their crop choices and cultivate high-value and water-efficient crops, contributing to improved food security and income generation.
- **Community Empowerment:** Rainwater harvesting initiatives that involve community participation and capacity-building efforts help empower rural communities to take ownership of their water resources and manage them sustainably.

Rainwater harvesting involves collecting and storing rainwater from roofs and other surfaces. The water can be stored in tanks, cisterns, wells, or reservoirs.

## Types of Rainwater Harvesting

- **In-situ:**

Rainwater is captured and stored directly on the farm, using techniques like trench farming, contour bunds, and mulching

- **Ex-situ:** Rainwater is captured and stored off the farm, in structures like check dams, ponds, or tanks

## 7.2 Watershed Management

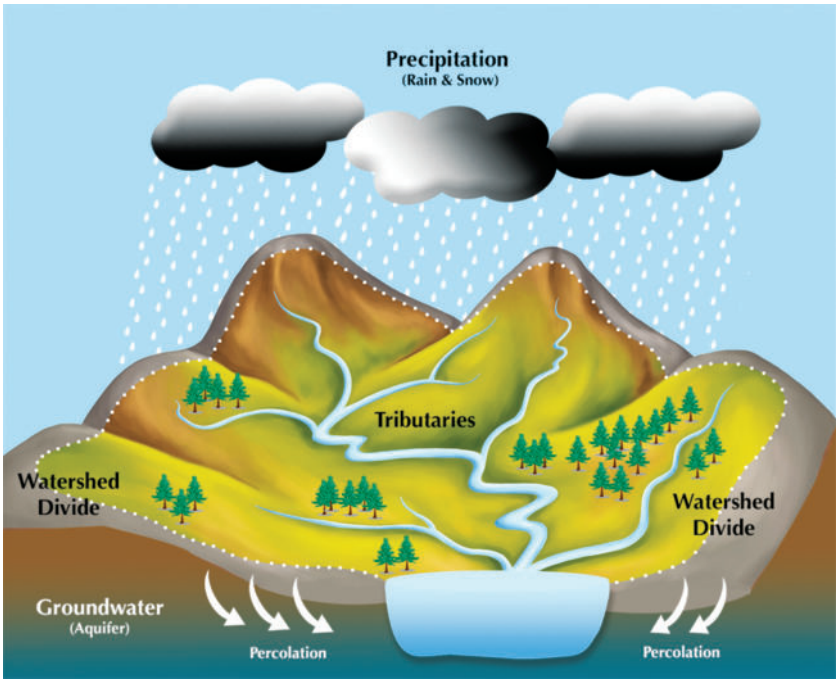



Fig 7, Watershed management

The major focus of watershed management is to conserve and protect water resources within a watershed by managing land use practices, aiming to mitigate soil erosion, regulate water flow, enhance groundwater recharge, and improve overall ecological health, while also considering the needs of

local communities and sustainable livelihoods; essentially, it strives to balance water quality and quantity by addressing issues like flooding, drought, and pollution through comprehensive strategies like reforestation, vegetation management, and sustainable agricultural practices. Watershed management focuses on conserving and restoring the ecological balance of watersheds to sustainably manage water resources.

Community-based watershed development projects have been successful in promoting soil and water conservation, afforestation, and the construction of small-scale water harvesting structures. These efforts help prevent soil erosion, recharge aquifers, and improve water availability in rural areas.

**Key aspects of watershed management include:**

- **Water conservation:** Capturing rainwater through structures like check dams and ponds to increase groundwater recharge.
- **Soil conservation:** Preventing soil erosion through techniques like contour farming, terracing, and vegetative cover establishment.
- **Flood control:** Managing water flow to mitigate flood risks in downstream areas.
- **Riparian zone protection:** Maintaining healthy vegetation along streams and rivers to stabilize banks and improve water quality.
- **Land use planning:** Implementing sustainable land use practices like agroforestry and rotational grazing.

- **Community engagement:** Involving local communities in planning and implementing watershed management projects to ensure long-term sustainability.

## 7.3 Efficient Irrigation Techniques

Agriculture accounts for the largest share of water usage in India. Therefore, promoting efficient irrigation techniques is essential for water conservation. Drip irrigation, sprinkler irrigation, and laser levelling are some of the modern irrigation methods that help optimize water usage by delivering water directly to the roots of plants and minimizing evaporation losses. Government initiatives such as the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) aim to promote these techniques to enhance water productivity in agriculture.

Fig 8, Drip Irrigation

Water use in food production is a growing problem in the face of climate change and a rising global population. Water is an increasingly scarce global resource, and agriculture is the biggest consumer of our planet's finite water resources. Globally, agriculture uses 70% of the world's freshwater supply and 95% of all water withdrawals in some developing countries. Drip irrigation is a highly efficient method that delivers water directly to the root zones of plants, minimizing water loss due to evaporation and runoff. It involves a network of tubes, pipes, and emitters that release small, controlled amounts of water. Drip irrigation is the most water-efficient irrigation system, capable of dramatically reducing a farm's water use while increasing crop yields and quality.

## Sprinkler Irrigation

- Mimics rainfall and can be used in many types of fields
- Uses a network of pumps, valves, and pipes that lead to sprinklers

Fig 9, Sprinkler Irrigation

## Subsurface Irrigation

- Delivers water below the ground surface to plant roots
- Reduces evaporation and minimizes contact with foliage
- Minimizes weed growth

## Center pivot Irrigation

- A mechanized system that waters crops in a circular pattern around a central pivot point
- Can be equipped with low-pressure sprinklers or drip hoses

Fig 10, Pivot Irrigation System

## Other irrigation Techniques

**Furrow irrigation**: Used for row crops, where water flows through the lower row or furrow.

**Surface irrigation**: Also known as flood irrigation, this method uses the force of gravity to distribute water

**Canal irrigation**: Uses gravity to distribute water from higher to lower areas

Fig 11a, Furrow Irrigation System

Fig 11b, Surface Irrigation System

Fig 11c, Canal Irrigation System

Smart irrigation systems are revolutionizing the way farmers manage water resources. These systems leverage technology and data to ensure precise and efficient watering, reducing water wastage significantly.

### Key features:

- **Soil moisture sensors:** Smart systems use soil moisture sensors to detect the actual moisture levels in the soil. This data informs the irrigation schedule, ensuring that crops receive just the right amount of water, preventing overwatering.
- **Weather-based adjustments:** These systems integrate real-time weather data to adjust irrigation schedules. If rain is in the forecast, the system may turn off the water to avoid unnecessary watering.
- **Remote control:** Farmers can monitor and control irrigation remotely through mobile apps or computer interfaces. This feature provides flexibility and ensures that water is applied precisely when needed.
- **Drip and sprinkler integration:** Smart systems can work with various irrigation methods, including drip and sprinkler systems, allowing for customization based on crop and field requirements.

### Major Benefits:

- **Water efficiency:** By optimizing water usage, smart irrigation reduces water wastage, conserving this precious resource.
- **Cost savings:** Farmers can save on water and energy costs, as well as reduce labour expenses through automation.
- **Improved crop health:** Precise watering leads to healthier crops with reduced risk of diseases caused by overwatering.

## 7.4 Water Recycling and Reuse

Water recycling and reuse involve treating wastewater to make it suitable for various non-potable purposes, such as irrigation, industrial processes, and urban landscaping. In India, wastewater treatment plants are being increasingly deployed in cities to treat sewage and industrial effluents. Additionally, decentralized treatment systems and constructed wetlands are being implemented to treat wastewater at the source, thereby reducing the burden on centralized treatment facilities and conserving freshwater resources.

Water recycling and reuse is a sustainable practice that involves treating and reusing wastewater in agricultural operations. It's a way to make the most of available water resources and reduce the environmental impact of farming.

### Key Features:

- **Treatment systems:** Implement wastewater treatment systems to purify water for reuse. This can involve physical, chemical, or biological treatments.
- **Storage and distribution:** Store treated water in reservoirs or tanks and distribute it through irrigation systems.
- **Irrigation management:** Use recycled water for non-potable irrigation needs, such as field crops or orchards.
- **Water quality monitoring:** Regularly test the quality of recycled water to ensure it meets safety standards for agricultural use.

**Benefits:**

- **Water conservation:** Recycling and reusing water reduce the demand for freshwater sources.
- **Cost savings:** Farms can save on water costs and wastewater disposal fees.
- **Environmental impact:** Properly treated and managed recycled water minimizes the environmental impact of agricultural operations.

## 7.5 Afforestation and Soil Conservation

Forests play a crucial role in regulating the water cycle by influencing rainfall patterns, reducing soil erosion, and maintaining groundwater recharge. Afforestation and soil conservation measures such as reforestation, agroforestry, and contour bunding help preserve watersheds, enhance soil moisture retention, and prevent runoff. Initiatives like the National Afforestation Programme (NAP) and the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) promote community-led afforestation and soil conservation efforts across India.

Conserving soil moisture is essential for sustainable farming. It involves practices that help retain moisture in the soil and hinder water flow, which will reduce the need for excessive irrigation. Healthy soil with good moisture levels is the foundation for robust crop growth.

**Key Features:**

- **Mulching:** Applying mulch, such as organic matter or straw, to the soil's surface helps reduce evaporation

and keeps the soil cool. It also prevents weed growth, conserving moisture for crops.

Fig 12, Poly Mulching

- **Cover cropping:** Planting cover crops like clover or rye during fallow periods helps improve soil structure and moisture retention. These cover crops act as a natural mulch.

Fig 13, Cover crop

- **Reduced tillage:** Minimizing soil disturbance through reduced tillage practices helps maintain soil structure, and reduce runoff.
- **Compost application:** Adding compost to the soil enhances its water-holding capacity. Organic matter in compost acts like a sponge, retaining moisture.

**Benefits:**

- **Water efficiency:** Soil moisture conservation reduces the need for frequent irrigation, and improves water saving.
- **Improved soil health:** Healthy soil with adequate moisture levels promotes better root development and nutrient uptake by plants.
- **Weed suppression:** Mulching and cover cropping help suppress weed growth, reducing competition for water.

## 7.6 Policy Interventions and Awareness Campaigns

Effective water conservation requires supportive policies, regulations, and public awareness. The Government of India has formulated various policies and programs, such as the National Water Policy, Jal Shakti Abhiyan, and Swachh Bharat Mission, to promote water conservation, improve water governance, and address water-related challenges. Additionally, awareness campaigns, educational initiatives, and community mobilization efforts play a crucial role in fostering a culture of water conservation and sustainable water management practices.

Rainwater harvesting is a sustainable practice that involves collecting and storing rainwater for later use in irrigation. It's a straightforward yet highly effective method of water conservation.

### Key Features

- **Collection surfaces:** Rainwater is collected from rooftops, greenhouses, or other impermeable surfaces.
- **Gutters and downspouts:** These direct rainwater into storage tanks or cisterns.
- **Storage tanks:** Rainwater is stored in tanks or cisterns, often equipped with filtration systems to remove debris and contaminants.
- **Distribution system:** Pumps and pipes distribute collected rainwater to irrigation systems.

### Benefits:

- **Sustainability:** It reduces the reliance on traditional water sources.
- **Cost savings:** By using free rainwater, farmers can reduce their water bills.
- **Environmental impact:** Rainwater harvesting reduces stormwater runoff, which can carry pollutants into rivers and streams.
- **Drought resilience:** Stored rainwater provides a buffer during dry periods, ensuring a continuous water supply for crops.

## 7.7 Crop Selection and Rotation: Strategic planning for water efficiency

Strategic crop selection and rotation are integral to water conservation in farming. Choosing the right crops and rotating them judiciously can optimize water usage and enhance soil health.

### Key Features:

- **Drought-tolerant varieties:** Opt for crop varieties that are well-suited to your region's climate. Drought-tolerant crops require less water.
- **Crop rotation:** Rotate crops to break pest and disease cycles and improve soil health. Certain crop rotations can also reduce water demands.
- **Companion planting:** Planting complementary crops together can help conserve moisture and deter pests.
- **Timing:** Plan planting and harvesting times to align with the natural rainfall patterns in your area, reducing the need for irrigation.

### Benefits:

- **Optimized water usage:** Choosing the right crops and rotation patterns reduces water requirements, making farming more sustainable.
- **Improved soil quality:** Crop rotation improves soil fertility and structure, enhancing its ability to retain moisture.
- **Pest and disease control:** Smart crop selection and rotation can reduce the risk of pest and disease outbreaks, limiting the need for chemical treatments.

## 7.8 Controlled Grazing: Sustainable Livestock Management

Controlled grazing is a water-efficient approach to managing livestock while preserving pasture health. It involves carefully planned grazing patterns and rotational systems to prevent overgrazing and promote sustainable land use.

Controlled grazing is a sustainable livestock management practice that involves managing the relationship between livestock, forage, and land to meet the goals of a farm. It involves dividing pastures into smaller paddocks and moving animals between them.

Fig 14, Controlled grazing by Cow

## Key Features:

- **Rotational grazing:** Divide pastures into smaller paddocks and rotate livestock between them. This allows grazed areas to recover and regrow while minimizing soil erosion and nutrient runoff.
- **Rest periods:** Provide rest periods for pastures to allow vegetation to thrive and capture rainwater effectively.
- **Water source management:** Ensure that water sources for livestock are strategically placed to reduce trampling and soil erosion.

- **Monitoring:** Regularly monitor pasture conditions and adjust grazing patterns as needed to maintain healthy vegetation.

**Benefits:**

- **Water efficiency:** Controlled grazing reduces soil erosion, which can contribute to water pollution, and preserves pasture health.
- **Pasture improvement:** Grazing management enhances pasture quality and resilience, providing better forage for livestock.
- **Sustainable livestock:** Livestock can thrive in a healthier environment, reducing the need for supplemental feeding.

## 7.9 Financing Optimal Water Management with RegenX

By adopting these best practices, farmers benefit the environment, save costs, improve crop and soil health, and address the challenges of climate change. Our choice today can secure livelihoods and contribute to global food security in an era of water scarcity.

RegenX is a company that provides financial solutions to help farmers implement water conservation practices. RegenX's goal is to help farmers transition to sustainable agriculture. At RegenX, we are committed to supporting farmers in their journey towards sustainable agriculture. Our innovative financial solutions empower farmers to implement regenerative practices that conserve water, enhance soil health, and promote overall sustainability while improving their income and livelihood.

### RegenX helps

- **Working capital financing:** RegenX provides working capital financing to Farm Producer Organizations (FPOs) to help them grow their businesses.
- **Regenerative agriculture:** RegenX helps smallholder farmers transition to regenerative agriculture.
- **Sustainable practices:** RegenX helps farmers implement regenerative practices that improve soil health and conserve water.

Water management is important for sustainable economic growth, public health, and biodiversity conservation. Under investment in water management can lead to water scarcity, disease, and climate change. This can negatively impact food security and agricultural productivity.

### Other ways to finance water management

- Green loans are another way to finance water management. These loans are offered at preferential terms to encourage companies and governments to invest in water sustainability.

## 7.10 Conservation Tillage

Conservation tillage refers to a collection of farming techniques aimed at reducing soil erosion, conserving water, and enhancing soil health. These practices create a protective layer on the soil surface that helps retain moisture, making them particularly beneficial in regions with limited water availability or frequent drought conditions. By minimising or eliminating traditional tillage methods that disturb the soil,

conservation tillage helps maintain soil structure and organic matter, reduce water runoff, and prevent erosion. Conservation tillage helps with water conservation by reducing runoff, improving soil infiltration, and reducing erosion.

Fig 15, Conservation Tillage operation

Conservation tillage helps with water conservation like:

- **Reduces runoff:** Crop residue protects the soil surface from raindrops and slows water movement.
- **Improves soil infiltration:** Conservation tillage improves soil structure, which allows more water to be absorbed by the soil.
- **Reduces erosion:** Conservation tillage reduces soil erosion, which helps to reduce sedimentation in water bodies.
- **Improves soil quality:** Conservation tillage can increase soil organic matter and carbon content.
- **Reduces compaction:** Conservation tillage can reduce soil compaction.

- **Moderates soil temperatures:** Conservation tillage can moderate soil temperatures.
- **Maintains economic productivity:** Conservation tillage can maintain economic productivity.
- **Provides food and shelter for wildlife:** Conservation tillage can provide food and shelter for small mammals and birds.

## 7.11 Crop Rotation: Boosting Water Conservation and Soil Health

Crop rotation is a practice that involves growing different crops in a specific sequence on the same piece of land over time. This technique offers several benefits for optimizing crop performance and water use efficiency. For example, alternating between water-demanding crops and more drought-tolerant crops allows the soil to replenish moisture levels during periods of lower water demand. Crop rotation also helps break pest and disease cycles, reducing the need for chemical interventions and further enhancing crop health. Crop rotation improves water conservation and soil health by increasing organic matter in the soil, which helps soil retain water. It also helps to prevent soil erosion and reduce the risk of flooding.

Crop rotation helps with water conservation like:

- **Increases organic matter**: This improves soil structure and water-holding capacity.
- **Preserves moisture**: This helps plants use moisture during droughts.
- **Reduces surface runoff**: Cover crops, such as legumes, grasses, or clovers, reduce surface runoff.

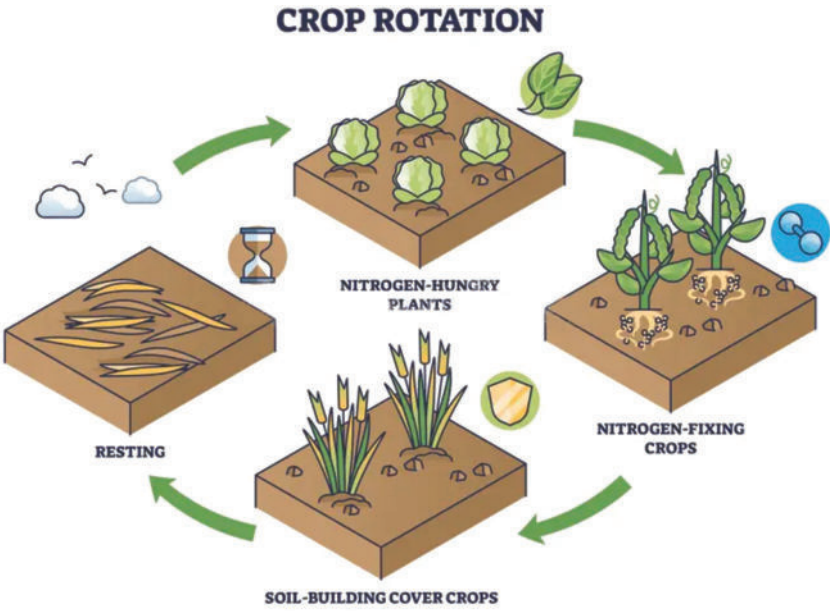



Fig 16, Crop rotation practice

- **Increases water infiltration**: Cover crops increase water infiltration.
- **Minimizes soil evaporation**: Cover crops minimize soil evaporation.
- **Improves soil structure**: Crop rotation can improve soil structure by alternating deep-rooted and shallow-rooted plants.
- **Boosts soil fertility**: Crop rotation can boost soil fertility.
- **Prevents soil erosion**: Crop rotation can prevent soil erosion.
- **Reduces weed growth**: Crop rotation can reduce weed growth.

- **Prevents the concentration of pests and diseases:** Crop rotation can prevent the concentration of pests and diseases.

## 7.12 Organic Farming

Organic farming encompasses a set of farming techniques that prioritise using natural methods and materials to promote soil fertility, reduce reliance on synthetic chemicals, and conserve water. For instance, crop rotation helps to diversify the types of crops grown in a field over time, reducing the risk of nutrient depletion and pest build-up and promoting healthier soils that can retain water better.

Organic farming offers a range of benefits for water conservation, from improving soil structure and moisture retention to reducing water pollution and promoting efficient irrigation practices. Organic farming practices that help conserve water include:


Fig 17, Organic farming

- **Drip irrigation**: Delivers water directly to plant roots, reducing evaporation and runoff
- **Rainwater harvesting**: Collects and stores rainwater for later use
- **Conservation tillage**: Reduces soil erosion and water runoff by leaving crop residue on the soil surface
- **Cover crops**: Improves soil health and moisture content, and controls erosion
- **Green manuring**: Replenishes soil nutrients and helps stabilize soil aggregates
- Increasing the water-holding capacity of the soil
- Reducing evaporation from the land
- Increasing the water level
- Reducing runoff
- Improving soil structure
- Minimizing topsoil loss

**Other organic farming practices include:**

- Crop rotation
- Manuring and composting
- Intercropping and companion planting
- Biological pest control
- Sanitation
- Mulching

Organic farming prohibits the use of synthetic pesticides, herbicides, fertilizers, and genetically modified organisms (GMOs).

## 7.13 Dryland Farming

In dryland farming, water conservation primarily focuses on techniques that maximize the capture and retention of rainwater by using methods like mulching, cover cropping, crop rotation, terracing, and specialized planting pits (like Zai pits) to minimize evaporation and optimize soil moisture absorption, all while selecting drought-tolerant crop varieties suited to the arid environment. Dryland farming is a method

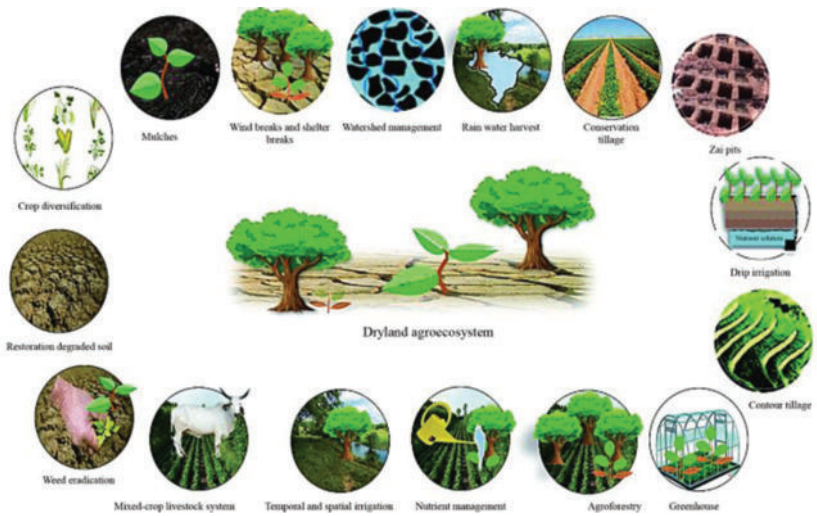
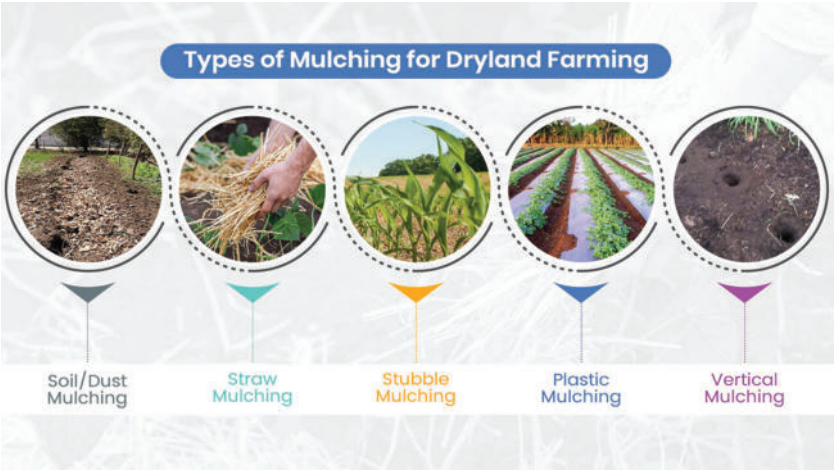



Fig 18, Major strategies to improve water use efficiency in dryland agroecosystem

of crop production that does not rely on irrigation during dry seasons, but instead utilises moisture stored in the soil from the previous rainy season. It is a location-specific, low-input strategy for growing crops within the constraints of the climate.

In this approach, a crop may receive minimal irrigation or none at all.

This method emphasises maximising the natural moisture content of the soil and adapting crop choices and management practices to suit the local climate, to achieve sustainable crop production with minimal water use.




## Key practices for water conservation in dryland farming:

- **Mulching:** Covering the soil surface with organic materials like straw or leaves to reduce evaporation and regulate soil temperature.

- **Zai pits:** Small planting pits dug in the soil, often with added organic matter, to trap rainwater around the plant roots.

- **Cover cropping:** Planting a temporary crop during fallow periods to protect the soil from erosion and improve water infiltration.

- **Crop rotation:** Alternating crops with different water needs to optimize soil moisture use and prevent nutrient depletion.

- **Contour farming:** Planting along the contours of the land to slow down water runoff and promote infiltration.

- **Terracing:** Creating step-like structures on slopes to capture rainwater and prevent erosion.

- **Deep tillage:** Breaking up compacted soil to improve water penetration and storage capacity.

- **Compartmental bunding:** Building small bunds to collect rainwater in small areas.

- **Ridge tillage:** Creating raised ridges to channel water towards plant roots

### Important considerations in dryland farming:

- **Choosing drought-tolerant crops:** Select crop varieties that can withstand periods of drought and require less water.
- **Precision planting:** Optimizing plant spacing to ensure efficient water use
- **Monitoring soil moisture:** Regularly checking soil moisture levels to determine irrigation needs
- **Rainwater harvesting:** Collecting rainwater runoff through structures like ponds or tanks for later use

## 8.0 Conclusion

Water conservation is imperative for ensuring water security, environmental sustainability, and socio-economic development in Odisha. By implementing a combination of

innovative technologies, traditional practices, policy interventions, and community participation, Odisha can effectively address its water challenges and build resilience against future water-related risks. Stakeholders at all levels need to collaborate and prioritize water conservation efforts to safeguard this precious resource for generations to come. Water conservation in agriculture has become increasingly crucial for the health of the environment and the sustainability of agriculture. By adopting techniques such as drip irrigation, capturing and storing water, crop rotation, conservation tillage, and organic farming, farmers can optimise water use, maximise crop yields, and promote long-term sustainability in agriculture. With these techniques, farmers can achieve higher yields while using less water, fertilisers, and energy. It is vital to recognise the importance of water conservation in agriculture to ensure a sustainable future for all.

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