



NAVODAYA INSTITUTE OF TECHNOLOGY, RAICHUR

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

WATER CONSERVATION & RAIN WATER HARVESTING

Module - 2

General Aquifer:

An aquifer is an underground layer of porous or permeable rock or sediment that can store and transmit groundwater, acting as a natural reservoir for water.

- **Definition:**

An aquifer is essentially a body of saturated rock or sediment that can yield usable quantities of water.

- **Porosity and Permeability:**

The key characteristics of an aquifer are its porosity (the amount of pore space within the rock or sediment) and permeability (the ability of the rock or sediment to allow water to flow through it).

- **Groundwater Source:**

Groundwater enters an aquifer as precipitation seeps through the soil and into the ground.

- **Types of Aquifers:**

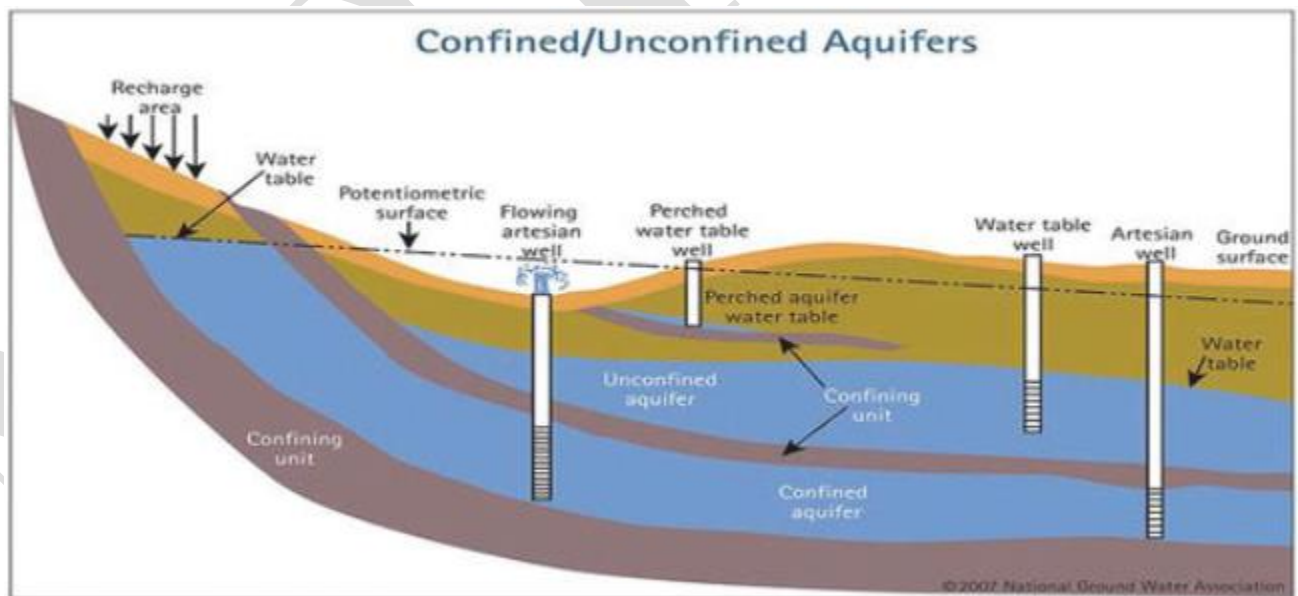
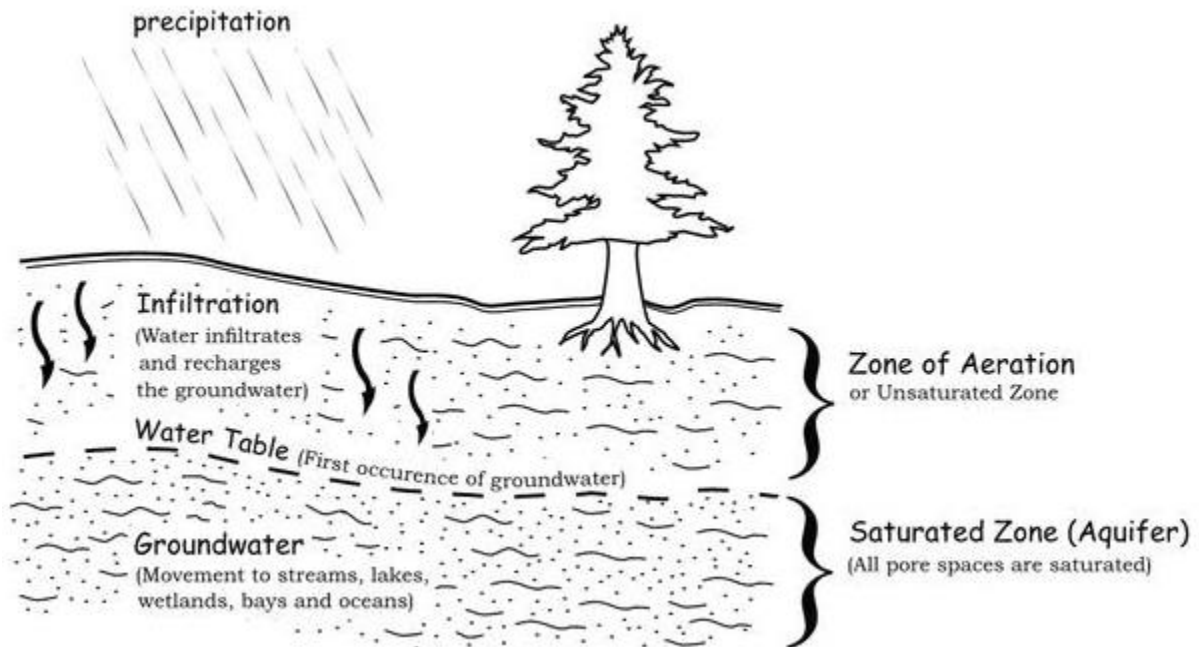
- **Unconfined Aquifers:** These are not bounded by impermeable layers and are directly connected to the surface, allowing for easy recharge and depletion.
- **Confined Aquifers:** These are bounded by impermeable layers above and below, meaning the water is under pressure and can rise to the surface in wells.
- **Leaky Aquifers:** These are partially confined, with some water able to move in and out of the aquifer.

- **Importance:**

Aquifers are a vital source of freshwater for human use, agriculture, and ecosystems.

- **Examples**

Sand and gravel aquifers are common and widespread



Water quality and its impact on human beings:

Water quality refers to the condition and characteristics of water that determine its suitability for various uses and the health of aquatic ecosystems. It encompasses the chemical, physical, and biological properties of water and the presence of contaminants and pollutants. Monitoring and

maintaining good water quality is crucial for human health, ecosystem sustainability, and the overall well-being of communities.

In natural water bodies such as lakes, rivers, and oceans, various factors can influence water quality. These include natural processes like weathering, erosion, and biological interactions, as well as human activities such as industrial discharges, agricultural runoff, and improper waste disposal. Contaminants commonly found in water include organic and inorganic substances, pathogens, heavy metals, pesticides, and nutrients like nitrogen and phosphorus.

Measuring and assessing water quality involves analyzing multiple parameters, including temperature, pH, dissolved oxygen levels, turbidity, conductivity, nutrient concentrations, and specific pollutants. This data helps scientists and environmental agencies understand the health of water ecosystems, identify sources of contamination, and develop appropriate management strategies.

Contaminated water can pose serious risks to human health when consumed or used for bathing and irrigation. It can lead to waterborne diseases, reproductive problems, and long-term health issues. Additionally, aquatic organisms and ecosystems can suffer detrimental effects, such as reduced biodiversity, habitat degradation, and the decline of sensitive species.

Waterborne Diseases:

- **Pathogens:**

Contaminated water can harbor bacteria, viruses, and parasites, causing diseases like cholera, typhoid, dysentery, and hepatitis A.

- **Diarrheal Diseases:**

Unsafe drinking water is a major cause of diarrheal diseases, which can be fatal, especially in children.

- **Other Waterborne Illnesses:**

Other illnesses linked to contaminated water include giardia and schistosomiasis.

Chemical Contamination:

- **Heavy Metals:**

Exposure to heavy metals like lead, mercury, and arsenic through contaminated water can lead to serious health problems, including neurological disorders, developmental issues, and cancer.

- **Pesticides:**

Pesticides in water can cause various health problems, including reproductive issues and developmental problems.

- **Industrial Chemicals:**

Industrial runoff can introduce toxic chemicals into water sources, leading to long-term health effects.

Other Health Impacts:

- **Skin Irritations:** Contact with polluted water can cause skin irritations, rashes, and other dermatological problems.
- **Respiratory Problems:** Water pollutants can evaporate and mix with air, causing respiratory problems when inhaled.
- **Cardiovascular Issues:** Exposure to certain water contaminants can contribute to cardiovascular problems.
- **Reproductive Issues:** Certain chemicals in water can disrupt the reproductive system.
- **Cancer:** Long-term exposure to certain water contaminants can increase the risk of developing cancer.
- **Developmental Problems:** Exposure to contaminated water, especially during pregnancy, can lead to developmental problems in children.
- **Kidney and Liver Damage:** Some pollutants can cause damage to these organs.

Water harvesting: Need, Principles and Methods of water harvesting:

Water harvesting involves collecting and storing rainwater for later use, addressing water scarcity and promoting sustainable water management. Its principles focus on capturing runoff and infiltrating water into the ground, while methods include rooftop collection, recharge pits, and check dams.

Need for Water Harvesting:

- **Address Water Scarcity:** Raichur, like many regions in India, faces water scarcity, especially during dry seasons, making water harvesting essential for supplementing water resources.
- **Sustainable Water Management:** Water harvesting promotes sustainable water management by reducing reliance on groundwater and surface water sources, which can be overexploited.
- **Reduce Flooding and Erosion:** By capturing and storing rainwater, water harvesting helps reduce the risk of flooding and soil erosion, especially in areas prone to heavy rainfall.
- **Recharge Groundwater:** Water harvesting helps recharge groundwater aquifers, ensuring a sustainable source of water for the future.

Principles of Water Harvesting:

- **Catchment Area:** Identifying and utilizing areas where rainwater can be effectively collected, such as rooftops, open spaces, or natural depressions.
- **Runoff Conveyance:** Designing systems to channel rainwater efficiently from the catchment area to storage or recharge areas.
- **Storage:** Implementing storage structures, such as tanks, ponds, or wells, to hold the harvested water for later use.
- **Infiltration:** Encouraging the infiltration of rainwater into the ground to recharge groundwater aquifers.

- **Water Quality:** Maintaining water quality through proper filtration and storage to ensure the harvested water is suitable for intended uses.

Methods of Water Harvesting:

1. Rooftop Rainwater Harvesting:

- **How it works:** Rainwater is collected from rooftops using gutters and downpipes and then stored in tanks or cisterns for later use.
- **Benefits:** Simple, cost-effective, and can provide a reliable water source for domestic use, irrigation, and other purposes.
- **Example:** A homeowner can install gutters and a storage tank to collect rainwater from their roof.

2. Surface Runoff Harvesting:

- **How it works:** This method involves collecting rainwater runoff from open surfaces like roads, fields, and other areas, and directing it into storage reservoirs or infiltration systems.
- **Benefits:** Can be used to recharge groundwater aquifers and provide water for irrigation and other uses.
- **Example:** Creating small dams or ponds to capture and store runoff from a field or watershed.

3. Groundwater Recharge:

- **How it works:** This involves directing rainwater into the ground to replenish groundwater resources.
- **Methods:** This can be done through recharge pits, recharge trenches, or by using borewells to recharge aquifers.
- **Benefits:** Helps to increase the availability of groundwater for drinking, irrigation, and other uses.
- **Example:** Constructing recharge pits or trenches to allow rainwater to infiltrate into the soil and recharge the groundwater table.

4. Other Methods:

- **Khadin Water Harvesting:** A traditional method in India that involves constructing earthen embankments across the contours of hills or plateaus to capture and store runoff.
- **Percolation Tanks:** These are small, shallow tanks that are designed to allow rainwater to percolate into the ground, recharging groundwater.
- **Check Dams/Nala Bunds:** These are small dams or bunds constructed across streams or gullies to slow down water flow and allow it to infiltrate into the ground.
- **Rain Barrels:** Simple, portable containers that can be used to collect and store rainwater from rooftops.
- **Community Rainwater Harvesting:** This involves large-scale rainwater harvesting systems that can supply water to entire communities.

Rainwater harvesting: Methods, Classes, Benefits, Approaches

Rainwater harvesting, a method of water conservation, involves collecting and storing rainwater for various uses, including irrigation, domestic use, and groundwater recharge. It can be implemented through rooftop collection, surface runoff harvesting, or groundwater recharge techniques, offering numerous benefits like water conservation, reduced water costs, and environmental protection.

Methods of Rainwater Harvesting:

- **Rooftop Rainwater Harvesting:**
 - **Collection:** Rainwater is collected from rooftops using gutters and downspouts.
 - **Filtration:** Collected water is filtered to remove debris and contaminants.
 - **Storage:** The filtered water is stored in tanks or cisterns for later use.
 - **Recharge:** Water can be directed to recharge groundwater aquifers through recharge pits or trenches.
- **Surface Runoff Harvesting:**
 - **Collection:** Rainwater is captured from surfaces like roads, gardens, and open fields.
 - **Storage:** The collected water is stored in reservoirs, ponds, or other storage structures.
- **Groundwater Recharge:**
 - **Infiltration:** Rainwater is directed to recharge groundwater aquifers through infiltration techniques.
 - **Recharge Structures:** Recharge structures like recharge pits or trenches can be used to facilitate groundwater recharge.

Classes of Rainwater Harvesting Systems:

- **Individual/Household Systems:** Small-scale systems designed for individual homes or buildings.
- **Community Systems:** Larger-scale systems designed to serve a community or a group of households.
- **Agricultural Systems:** Systems designed for irrigation and other agricultural purposes.
- **Industrial Systems:** Systems designed for industrial water needs.

Benefits of Rainwater Harvesting:

- **Water Conservation:** Reduces reliance on traditional water sources and conserves water resources.
- **Reduced Water Costs:** Lower water bills due to reduced reliance on municipal water supplies.
- **Environmental Protection:** Reduces stormwater runoff, soil erosion, and water pollution.
- **Groundwater Recharge:** Helps recharge groundwater aquifers, ensuring long-term water sustainability.
- **Sustainable Water Use:** Promotes sustainable water management practices.
- **Reduced Flooding:** Helps manage stormwater runoff and reduces the risk of flooding.

- **Improved Water Quality:** Rainwater is naturally soft and free from chemicals, making it ideal for irrigation and other uses.
- **Food Security:** In arid and semi-arid regions, rainwater harvesting can support agriculture and improve food security.

Approaches to Rainwater Harvesting:

- **Community-Based Approach:** Involves community participation in the planning, implementation, and maintenance of rainwater harvesting systems.
- **Government Support:** Government policies and incentives can encourage rainwater harvesting adoption.
- **Private Sector Involvement:** Private companies can play a role in the development and installation of rainwater harvesting systems.
- **Education and Awareness:** Educating the public about the benefits of rainwater harvesting can promote its adoption.
- **Technological Innovation:** Developing and implementing innovative rainwater harvesting technologies can improve efficiency and effectiveness.

Rooftop rainwater harvesting:

Rooftop rainwater harvesting is a sustainable water management technique that involves collecting and storing rainwater from rooftops for various uses like irrigation, domestic purposes, and groundwater recharge.

How it works:

- **Collection:** Rainwater is channeled from rooftops through gutters and downspouts.
- **Filtration:** A filter removes debris and impurities before the water enters the storage tank.
- **Storage:** The filtered water is stored in tanks or cisterns.
- **Utilization:** The stored water can be used for various purposes, including gardening, washing, and even potable uses after proper filtration and treatment.
- **Groundwater Recharge:** Excess water can be used to recharge groundwater through bore wells, dug wells, or percolation tanks.

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 technology
- The capacity of the storage tanks

- Types of the roof, its slope and its materials
- The frequency, quantity and the quality of the rainfall
- The speed and ease with which the rainwater penetrates through the subsoil to recharge the groundwater.

Benefits / Advantages:

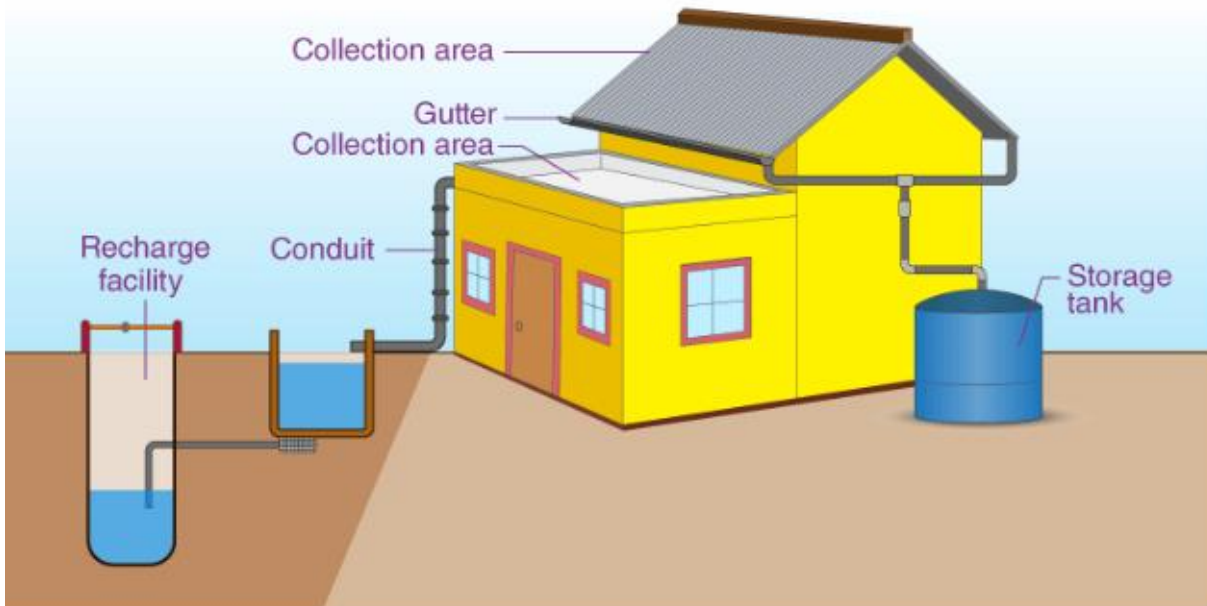
- **Water Conservation:** Reduces reliance on conventional water sources and conserves groundwater and surface water resources.
- **Cost-Effective:** A cost-effective way to manage water sustainably.
- **Environmental Benefits:** Helps reduce water runoff, replenishes groundwater, and promotes efficient water management.
- **Sustainable Water Source:** Provides a supplementary water source for domestic or agricultural use.
- Help in reducing the water bill.
- Does not require a filtration system for landscape irrigation.
- This technology is relatively simple, easy to install and operate.
- It reduces soil erosion, stormwater runoff, flooding, and pollution of surface water with fertilizers, pesticides, metals and other sediments.
- It is an excellent source of water for landscape irrigation with no chemicals, dissolved salts and free from all minerals.

Disadvantages of Rainwater Harvesting

In addition to the great advantages, the rainwater harvesting system has a few disadvantages like unpredictable rainfall, unavailability of the proper storage system, etc.

Listed below are a few more disadvantages of the rainwater harvesting process.

- Regular maintenance is required.
- Requires some technical skills for installation.
- Limited and no rainfall can limit the supply of rainwater.
- If not installed correctly, it may attract mosquitoes and other waterborne diseases.
- One of the significant drawbacks of the rainwater harvesting system is storage limits.



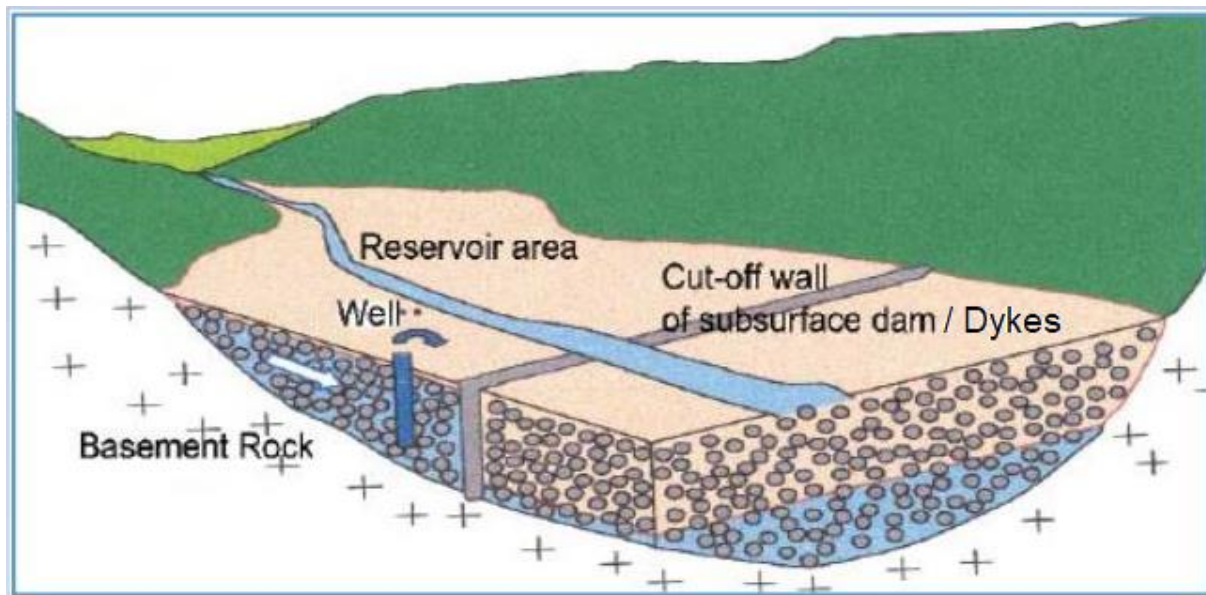
Rainwater harvesting

Dykes/Subsurface barrier:

Subsurface dykes, also known as groundwater dams or subsurface barriers, are structures built below the riverbed to arrest subsurface flow and increase water storage in aquifers, offering a sustainable water solution, especially in dry regions.

- **Function:** Subsurface dykes act as underground barriers, impeding the natural flow of groundwater and raising the water table.
- **Purpose:** They are designed to control groundwater flow, increase water storage in aquifers, and provide a sustainable source of water for drinking and irrigation, particularly in arid and semi-arid regions.
- **Advantages:**
 - **Reduced Evaporation:** Since the stored water is underground, there's minimal water loss due to evaporation, making them more efficient than surface dams in dry areas.
 - **No Loss of Cultivable Land:** They don't require any land for construction, unlike surface dams, which can displace farmland.
 - **Sustainable Water Supply:** They help create a sustainable water supply for local communities without negatively impacting the local river ecology.
- **Construction:** Subsurface dykes are constructed across a stream or river below the riverbed, using materials that create an impermeable barrier to water flow.
- **Effectiveness:** Subsurface dykes have been proven to be effective groundwater conservation structures in undulating/hilly terrains

- **Alternative to surface dams:** Subsurface dykes are more advantageous than surface dams in dry regions as they suffer virtually no loss of stored water from evaporation.



Conceptual Diagram of the Subsurface dam / Dykes

Farm ponding:

Farm ponding, or the construction of farm ponds, involves creating small, artificial water bodies on farms to harvest and store rainwater, which can be used for irrigation, livestock, and other agricultural purposes, especially during dry periods.

What are farm ponds?

- Farm ponds are essentially dug-out or embankmented water reservoirs designed to collect and store rainwater or surface runoff.
- They act as a source of water during dry spells, ensuring crops and livestock have access to water even when natural water sources are scarce.
- They can also be used for fish farming and other aquaculture activities.

Benefits of farm ponds:

- **Water Storage:**

Farm ponds provide a reliable source of water for irrigation, livestock watering, and other farm needs.

- **Increased Crop Yields:**

By providing water during dry periods, farm ponds can lead to increased crop yields and improved agricultural productivity.

- **Multiple Cropping:**

Farm ponds can enable farmers to cultivate multiple crops throughout the year, enhancing their income and food security.

- **Soil and Moisture Conservation:**

Farm ponds help to conserve soil and moisture by capturing and storing rainwater, which can reduce soil erosion and improve soil fertility.

- **Diversification of Income:**

In addition to irrigation, farm ponds can be used for fish farming, providing an additional source of income for farmers.

- **Improved Livelihoods:**

Farm ponds can significantly improve the livelihoods of farmers in drought-prone areas by providing a reliable water source and enabling them to cultivate more crops and diversify their income.

- **Wildlife Habitat:**

Farm ponds can also provide a habitat for local wildlife, enhancing biodiversity.

Construction and Design:

- Farm ponds are typically constructed by excavating a pit or creating an embankment to hold water.
- The size and depth of the pond depend on the available land, rainfall patterns, and the water needs of the farm.
- Proper design and construction are crucial to ensure the pond's longevity and effectiveness.
- **Inlet and Outlet:** Farm ponds usually have an inlet for collecting water and an outlet for releasing excess water or for irrigation purposes.
- **Bunds:** A bund, or embankment, is often constructed around the pond to prevent erosion and contain the water.
- **Lining:** In some cases, the pond may be lined with a waterproof material to prevent water seepage.
- **Maintenance:** Regular maintenance, such as cleaning out sediment and repairing any damage, is necessary to ensure the pond's continued functionality.

