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# IRRIGATION TECHNIQUES AND THE SUSTAINABLE USE OF GROUNDWATER IN IRRIGATION

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**Abstract:**

Agribusiness is the backbone of any country because it is necessary for the survival of living things. One of the most important processes for growing crops is the water system. Irrigation is the artificial application of water to the land or soil; it is the replacement or supplementation of water with another source of water; it is used in arid regions and during periods of insufficient precipitation; it is regarded as an essential infrastructure and vital input needed for agrarian production. The main purpose of irrigation systems is to help agrarian crops and vegetation by using the least amount of water possible, maintaining landscapes, and re-vegetating disturbed soils. Water management strategies are the key of sustainable use of ground water and farmers can use it to lessen the footprints in agriculture. Aim of sustainable irrigation is to reduce water scarcity and environmental damage to protect the soil from erosion. Surface irrigation techniques include flow irrigation, lift irrigation, free or uncontrolled flooding, broad strip irrigation, ring irrigation Basin flooding method is prominently used for orchard plants. Drip irrigation and sprinkler irrigation are widely used techniques in India to conserve water. Drip irrigation having advantages of lowest seepage and evaporation losses, possess drawback of extensive piping network causing obstacles in farming, whereas sprinkler irrigation is typically employed in fields with irregular topography and permeable soil. In rice farming it is not applicable but it keeps the crops cool during summer and shield crops from frost damage during winter. In India irrigation system also aids in production of hydroelectric electricity. Irrigation is though crucial for agriculture it may results in nitrous seeping into the ground water table which could have detrimental consequences including blue baby syndrome.

**Keywords:** Irrigation, agriculture, sustainable, drip, sprinkler

## Introduction

Since the agriculture sector uses 72% of all water withdrawals, water shortage already has a major influence on agricultural development. About 3.2 billion people live in agricultural areas with high to very-high water scarcity or shortages, with 1.2 billion of them residing in places with extreme water constraints. (FAO, 2020) The IPC Sixth Assessment Report states that during the 1950s, there is strong evidence that human activity has increased the frequency of simultaneous heat waves and drought extremes.

Adopting water-saving irrigation (WSI) practices will significantly increase farmers' resistance to the acute water constraints they are currently facing. (Masson-Delmotte, 2021). WSI equipment includes private facilities like pipelines and field irrigation equipment as well as public infrastructure like ditches and machine wells. However, the main barrier to

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advancing WSI technology is the high investment cost of both private facilities and infrastructure.( Bjornlund *et al.*, 2009).

Sustainable irrigation practices are those that minimise adverse environmental effects and encourage effective water use. This is important for the ecology and for agriculture. In agriculture, sustainable irrigation methods are crucial since they maximise water use, save expenses, and boost crop yields.

Sustainable irrigation techniques also help the environment by reducing water waste, stopping soil erosion, and safeguarding natural water supplies. Farmers may guarantee long-term agricultural productivity and lessen the consequences of climate change by using sustainable irrigation systems. Using effective irrigation technologies, like drip irrigation or precision sprinklers, is a crucial component of sustainable irrigation. By supplying water straight to the roots of the plants, these systems reduce water loss and evaporation.

Sustainable irrigation practices also heavily rely on water management strategies including crop-specific irrigation schedule and soil moisture monitoring. The sustainability of irrigation techniques can also be increased by putting water-saving techniques like mulching, crop rotation, and better soil management into practice. Farmers may monitor and improve irrigation techniques with the help of contemporary technologies like IoT devices and remote sensing.

Farmers may lessen the overall water footprint of agriculture and guarantee better water supply for future generations by adopting sustainable irrigation practices. To put it briefly, environmentally friendly irrigation methods are essential for agriculture. We can obtain improved crop yields, less environmental impact, and efficient water usage by putting these strategies into practice.

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**Definition of irrigation**

Irrigation systems are designed to help cultivate agricultural crops and plants by providing them with an adequate but not excessive supply of water, limiting the spread of weeds in grain fields, preventing soil consolidation, and so on. There are various types and methods of irrigation. Irrigation is the practice of applying water to the soil to aid in the growth of crops throughout their base period, which is the number of days between the first and last watering before harvesting the crop.

**Definition of Types of Irrigation**

The many methods used to supply water to crops in order to promote their development and productivity are referred to as irrigation types. These methods include drip irrigation, subsurface irrigation, sprinkler irrigation, and surface irrigation. Every strategy has unique benefits and works well with different crop species, soil types, and climates. The many techniques used to provide water to crops in order to promote their development and productivity is referred to as irrigation types. Surface irrigation, drip irrigation, sprinkler

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irrigation, and subsurface irrigation are some of these techniques; each has special benefits and is appropriate for different soil types, climates, and crop types.

**Irrigation System Types**

There are various kinds of irrigation and irrigation systems, such as:

- Surface Irrigation: This sort of irrigation uses mechanical techniques or gravity to apply water to the crop.
- Subsurface Irrigation: This kind of irrigation involves applying water beneath the earth using tile lines, trenches, or subterranean perforated pipelines.

**Surface Irrigation**

The most popular approach in India is surface irrigation, which applies water to the crop via mechanical methods or gravity. This kind of irrigation system uses pumps or gravity to apply water to the field's top or to different channels, covering the entire area. The water is absorbed by the crop for growth once it seeps into the soil and travels to the crop's roots. Two major categories can be used to classify surface irrigation systems.

- Flow irrigation
- Lift Irrigation

**Flow Irrigation**

Water is supplied at a specific height in this kind of irrigation system so that gravity alone can apply it directly to the field. canal irrigation, for example. There are two further classifications for this kind of irrigation: -

1. Perennial Irrigation: During the crop's base phase, water is continuously applied in this sort of irrigation. With this kind of irrigation, water is applied to the field under control, allowing it to flow at regular intervals during the course of the base time. As a result, this kind of irrigation method is more cost-effective and efficient than others.
2. Uncontrolled irrigation, flooding, and inundation: With this kind of watering, the soil

**Lift Irrigation**

This kind of irrigation uses gravity to transfer the water to the farmers' fields after it has first been pumped out of a natural source. Despite being more expensive since it involves pumping water out, this kind of irrigation is far more efficient than others because it can effectively distribute water across the entire area.

**Methods of Surface Irrigation**

**Free or Uncontrolled Flooding:** This type of wild flooding occurs when there is no control over the water flow. Where water is plentiful, this kind of irrigation is used. There is no organised plan in place for applying water to the field using this kind of irrigation. This kind of irrigation technique results in a comparatively high rate of water loss. Furthermore, this kind of irrigation method is only utilised on small fields because it is inefficient and occasionally leaves some areas of the field un-irrigated. For instance, because it needs standing water, this kind of irrigation technique is frequently employed to cultivate rice. For that reason, the field is inundated.

**Border strip irrigation:** This kind of irrigation divides the land into many strips, known as borders that are separated by low levees. Fields that are confined between 100 and 400 meters

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in length and 10 to 20 meters in breadth are typically the target of this kind of irrigation technology. Bay irrigation and border check are other names for it.

**Check basin flooding:** This kind of irrigation uses cross-connecting levees to split the entire field to be irrigated into multiple tiny regions or basins. It is an altered version of regular flooding that can be applied to fine soils to achieve the appropriate penetration. Each basin receives an application of water, which is then allowed to seep in. The majority of the time, this kind of irrigation technique is applied on soils with low infiltration rates.

**Contour Border Method:** This kind of irrigation is frequently employed in hilly regions with a variety of contours. In hilly regions, borders are drawn using this technique along the contours. By doing this, runoff losses are greatly decreased. When the land slope surpasses safe bounds, this kind of irrigation is favoured. It is created throughout the field's overall slope.

**Ring Basin Flooding:** This unique form of check flooding is widely used for orchard plants. The tree is surrounded by little basins, and water is left there until the appropriate percolation is achieved. Apple trees, mangoes, and other plants are grown there.

**Furrow Irrigation**

This kind of irrigation creates tiny, parallel channels that run the length of the field in the direction of its main slope. Furrows are the name given to these waterways. Water is poured into each furrow, and gravity irrigates the entire planted area. Compared to earlier techniques, this kind of irrigation system reduces evaporation losses because only 20–50% of the area is wetted. Sugarcane, potatoes, cotton, and delicate crops like leafy vegetables are among the crops that it is typically used for.

**Sub-Surface Irrigation**

As the name implies, this kind of irrigation method applies water beneath the earth using tile lines, trench construction, or subterranean perforated tubes. Instead of wetting the surface, the water is transferred to the crop's root zone through capillarity. Thus, the fundamental idea underlying this kind of irrigation is capillary action.
In order to facilitate the lateral and upward transfer of water by capillarity to the soil between trenches, water is released into trenches and allowed to stay there for the duration of irrigation.

The subsurface irrigation system can be broadly divided into two categories:

- **Natural Subsurface Irrigation**: This type of subsurface irrigation occurs when underground watering is accomplished naturally without the need for further work. For instance, the root zone of the crops can readily draw water from the ground water table.
- **Artificial sub-surface irrigation:** This is the process of artificially laying a network of open jointed drains beneath the soil to supply water to the crops through capillary action. For example, drip irrigation.
- **Drip irrigation**: This is a subsurface irrigation technique that uses a system of pipes with drip nozzles to deliver water straight to the crop's root zone. Trickle irrigation is another name for this kind of irrigation technique. The emitters, pipe system, and control head are

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the parts of drip irrigation. In essence, the control unit consists of a pumping unit, an above tank, a filter, a water-measuring device, and a pressure control device.

A controlled flow of water from the overhead tank is permitted to pass through the main line pipe. Numerous lateral pipes collect the water from the main line pipe and then distribute it to numerous small diameter pipes known as trickle lines. The term "trickle irrigation" comes from the way these pipes deliver water drop by drop to the crops' root zone.

**Advantages**

- This kind of irrigation technique has the lowest seepage and evaporation losses.
- This kind of irrigation technique lowers runoff from weed populations.
- This technique has the highest water application efficiency among the many kinds of irrigation systems.

**Drawbacks**

- This type of irrigation system disrupts farming activities because of the extensive piping network and other accessories.
- Heavy irrigation, such as that used in rice production, is not appropriate for this kind of irrigation technique.
- Similar to sprinkler irrigation, this kind of irrigation requires technical know-how, which is why regular farmers typically don't use it.
- The initial outlay for installation, operation, and upkeep is substantial.

**Sprinkler irrigation**: This type of irrigation uses a system of pipes and pumps to apply water, which is then sprayed onto the crops. Three components make up this approach: sprinklers, a pipe network, and a pumping device. Water is drawn from the source by the pumping unit, which then moves it to the lateral pipes, risers, and sprinklers.

**Advantages**

- It is typically employed in fields with irregular topography and permeable soil.
- By using this technique, no land is spent creating canals.
- It aids in keeping crops cool during the summer and shields them from frost damage during the winter.
- It can be applied when fewer workers are needed.

**Disadvantages**

- To run the system, technical personnel are needed.
- The initial cost of installation, operation, and maintenance is significant.
- With this kind of irrigation technique, evaporation loss increases with surface area.
- The wind's direction and speed might readily affect it. Because it is made up of a field-installed network of pipes, it interferes with farming operations.
- Heavy irrigation, like that used in rice farming, is not appropriate for this kind of irrigation technique.

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**Importance of Irrigation**

It is beneficial for raising crop yields.

- It guarantees that the crops in the field grow as best they can.
- India's irrigation system aids in the production of hydroelectric electricity.
- Inland navigation also benefits from irrigation systems.
- It aids in preserving the soil's ability to produce.
- Another useful tool for replenishing groundwater is an irrigation system.
- In regions without access to natural water supplies for irrigation, this approach becomes crucial.

**Demerits of Irrigation**

- Water logging brought on by irrigation may lower crop output.
- Irrigation can occasionally result in the spread of infectious diseases like malaria, dengue, etc.
- It might also result in nitrates seeping into the groundwater table, which could have detrimental consequences including blue baby syndrome.

**Conclusion**

The process of supplying water to arid area in addition to rainfall is known as irrigation. Its main goal is to cultivate. In many regions of India, there are many kinds of water system hones. In India, wells, tanks, canals, eternal canals, and multipurpose river valley enterprises are used for irrigation. For the proper use of irrigation framework, the water system engineer should be knowledgeable about the type of soil moisture, irrigation water quality, and water system recurrence.

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