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Modern Methods of Irrigation and Drainage for Maintaining the Soil Health

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Abstract

In the short and long term, soil health can be improved and productivity and profitability can be increased by employing management strategies that take care of the soil. The greatest numbers of products are produced at the lowest cost in a fully functional soil. Profitability can only be maximised by optimising soil health. If soil is mistreated, it will not serve your needs. Managing soil health and enhancing its function primarily involves creating and maintaining an environment conducive to the diverse organisms that make up the soil food web. This can be accomplished by reducing soil disruption, growing a diverse range of plant species, keeping live plants in the soil as much as possible, ensuring the soil remains covered at all times, and employing modern irrigation and drainage methods.

Keywords: Drainage, Drip irrigation, Soil health, Sprinkler irrigation

Introduction

Water is applied to the soil artificially by irrigation. Irrigation is very useful in areas where there is very little rainfall and during dry seasons. Irrigation is crucial for boosting crop yield, increasing cropping intensity, and improving overall crop productivity. Crop yield from irrigated area far exceeds that from non-irrigated area (about 2.5 times). Irrigated croplands provide 33-40% of the world's food output and people utilize 70% of the water on earth for irrigation (Salmon *et al.*, 2015).

Carefully regulate irrigation to prevent runoff, erosion, and nutrient leaching. For crops reliant on irrigation, maintain soil moisture levels between 50% and 100% of field capacity by using soil moisture monitoring and techniques like mulching to retain moisture. In addition to helping farmers, irrigation development raises the pay rates and job prospects for agricultural landless labourers, both of which are essential for lowering poverty rates among these households.

There are two major classes of irrigation systems:

1. Gravity flow systems and

2. Pressurized distribution systems.

1. Gravity Flow Distribution Systems

Water is transported and distributed at the field level by gravity flow systems using an overland, free surface flow regime. In this case the water is moved to the start of the irrigation system and then gravity takes over. Additionally, there are divisions within these surface watering techniques based on operating and configuration features.

Surface irrigation can be generally categorized into four types: (1) basin irrigation, (2) border irrigation, (3) furrow irrigation, and (4) uncontrolled flooding. Two key characteristics define a surface irrigation system: (a) the water flow has an exposed surface that follows the gravitational gradient, and (b) the field surface itself is used for water conveyance and distribution.

2. Pressurized Distribution Systems

Pressurized irrigation systems encompass methods like sprinkler and drip irrigation, along with similar systems where water is transported and dispersed across the farm via pressurized pipe networks. Tremendous increase in population demands relatively more food production. There are limited land resources for food production. The water resources are also scarce. So it is required to use every drop

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of water judiciously to achieve maximum yield. More crops per drop of water are need of an hour. This is only possible through adoption of pressurized irrigation systems.

Pressurized Irrigation Systems

Water Delivery Method

The water delivery method refers to how water is distributed to plants. These systems can be categorized as below.

Drip Irrigation (Localized Irrigation)

This method involves delivering water directly to the crop's root zone via a network of pipes using emitters such as drippers, sprayers, bubblers, or microjets. Water is applied at low rates to a limited soil surface area around the plants, rather than being spread over the entire field. The type of water emitter and the water delivery method are key features of a piped irrigation system. These factors often determine other characteristics, such as the required pressure, type of installation, system flow capacity, and application duration.

Sprinkler (Overhead) Irrigation

This method disperses water into the air through nozzles, mimicking natural rainfall as the water breaks into small droplets and falls onto the field. It can be implemented in various ways based on factors such as the diameter and discharge coverage, the type of sprinkler mechanism used, and the height of the water jet above the ground, whether beneath the foliage or overhead.

Drainage

Drainage issues are brought on by an abundance of water, either on the surface of soil or in the crop root zone. Drainage, which also involves removing soluble salts from the soil, merely refers to the removal of excess surface and subsurface water from the land in order to promote crop development and production. When the water table is less than 2 m below the surface of the earth, a drainage issue known as water-logging occurs. In India, approximately 2.46 million hectares of land are documented to be affected by water-logging, while an estimated 7 million hectares are identified as containing salt-affected soils (Pandey *et al.*, 2013).

Need of Drainage

• To increase cultivable area, production, or productivity while maintaining yield over an extended duration.

• To provide favorable environment for the crop in order to maximize production of crop.

• In dry and semi-dry regions, drainage is essential for salinity-alkalinity control.

• To mitigate the health hazards associated with the proliferation of mosquitoes breeding in ponds.

Types of Drainage System

1. Surface Drainage Method.

2. Subsurface Drainage Method.

3. Mole Drainage.

1. Surface Drainage System

The process of eliminating surplus water from the soil's surface is referred to as a surface drainage system. It includes following subclasses.

• *Bedding Drainage System:* Applied to flat, inadequately drained soil with limited permeability, this method involves creating beds separated by shallow furrows aligned with the prevailing slope. Suitable for slopes of up to 1.5%, the length of these beds typically ranges from 100 to 300 meters. Field drains channel water into lateral drains, which then direct it to main drainage channels.

• *Parallel Field Drain System:* This system is used on flat, poorly drained areas with a lot of irregulation. This system is dependent on proper land formation to ensure proper row slope. These rows release their excess water into adjacent field drains strategically constructed across the field.

• *Random Field Drainage System:* Primarily utilized in fields with numerous small, dispersed depressions, this system's drains link these depressions, channeling water towards a suitable outlet.

• *Cross Slope Ditch System:* The cross-slope ditch system, also referred to as the Nichols terrace, is a graded terrace channel suitable for slopes up to 4%. Ideal for soils with inadequate drainage and multiple minor depressions, this system requires ditches to run parallel to the contour lines, featuring a consistent or varying grade of 0.1 to 1%. These ditches can have triangular or trapezoidal shapes, with side slopes ranging from 1:14 to 1:10.

• *Diversion or Interceptor Drain:* At the base of these elevated areas, diversion or interceptor drains can be constructed to shield low-lying areas from flooding induced by surface runoff from neighboring higher elevations. To prevent silt accumulation in diversion or interceptor drains, a filter strip can be established on the uphill side of the ditch.

2. Subsurface Drainage System

The extraction of surplus water from below the soil surface or the root zone is referred to as a subsurface drainage system. It includes following subclasses.

• *Random Drainage System:* In fields with isolated wet patches scattered throughout, the random or natural system of drainage lines is employed.

• *Herringbone Drainage System:* The herringbone system comprises parallel laterals that intersect the main line from both sides at an angle. It is implemented in narrow valleys where the main or sub-main lines are located. This system involves double drainage at the junctions of laterals and mains, which may not always be cost-effective.

• *Gridiron Drainage System:* The gridiron system, also referred to as the parallel system, resembles the herringbone system in that the laterals connect to the main from one side only. It is applied in flat, evenly shaped fields with consistent soil characteristics. Due to fewer junctions and areas with double drainage, it proves to be a more economical choice compared to the herringbone system.

• *Interceptor Drainage and Relief Drainage:* The interceptor or cutoff system gathers seeping water from hill slopes, where wet spots emerge due to water moving horizontally through permeable layers above an impermeable layer. Installing the interceptor drain along the base of the permeable layer captures the seepage responsible for any damage.

3. Mole Drainage

Mole drainage is a semi-enduring subsurface drainage system. Using special equipment known as a mole plough and mole plug, a continuous circular trench is excavated beneath the ground level in the soil. Mole drainage is best suited for specific types of soils because the channel's stability is crucial in this method of drainage. In general, clay soil is suitable for mole drainage. Mole drains have a lifespan of 10 to 15 years, depending on the structural strength of the subsoil. Mole drain depths range from 45 cm to 120 cm, depending on mole equipment. The size ranges from 7.5 cm to 15 cm.

Conclusion

Applying the modern methods of irrigation and drainage, we can improve the soil health by reducing or removing the salt accumulated in soil. The salinity of soil will be maintained by using proper irrigation and drainage methods.

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