

A 5-ha Cornfield Was Irrigated For 12 Hrs At A Discharge Of 250 Lps. If The Average Depth Of Water Stored

Introduction

A 5-ha Cornfield Was Irrigated For 12 Hrs At A Discharge Of 250 Lps. If The Average Depth Of Water Stored is a common problem encountered in agricultural engineering and irrigation planning. Understanding the relationship between discharge, time, area, and water depth is essential for efficient water resource management, crop health, and optimizing irrigation schedules. This article provides an in-depth analysis of how to calculate the average depth of water stored in a field, considering the given parameters, and explores the fundamental concepts, calculations, and practical implications involved in such irrigation scenarios.

Understanding the Basic Concepts

Definitions and Terminology

Before delving into calculations, it is essential to clarify some key terms:

- **Discharge (Q):** The volume of water flowing per unit time, usually expressed in liters per second (Lps) or cubic meters per second (m^3/sec).
- **Time (t):** Duration over which the irrigation occurs, measured in hours or seconds.
- **Area (A):** The surface area of the field being irrigated, expressed in hectares (ha) or square meters (m^2).
- **Depth of Water (h):** The height of water covering the field, typically expressed in millimeters (mm) or meters (m).

Understanding Discharge and Volume

Discharge indicates how much water is supplied per second, and when multiplied by duration, provides the total volume of water supplied. This total volume, when distributed

over the irrigated area, gives the average depth of water stored.

Calculating Total Volume of Water Supplied

Step 1: Convert Discharge to Cubic Meters per Second

Given:

- Discharge, $Q = 250$ Lps

Since 1 liter = 0.001 cubic meters,

$$Q = 250 \text{ Lps} = 250 \times 0.001 = 0.25 \text{ m}^3/\text{sec}$$

Step 2: Calculate Total Volume Over the Irrigation Duration

Given:

- Duration, $t = 12$ hours

Convert hours to seconds for consistency:

$$t = 12 \text{ hrs} \times 60 \text{ min/hr} \times 60 \text{ sec/min} = 12 \times 3600 = 43,200 \text{ seconds}$$

Total volume, $V = Q \times t$

$$V = 0.25 \text{ m}^3/\text{sec} \times 43,200 \text{ sec} = 0.25 \times 43,200 = 10,800 \text{ m}^3$$

Determining the Area of the Field in Square Meters

Given:

- Area, $A = 5$ hectares

Since 1 hectare = 10,000 m²,

$$A = 5 \times 10,000 = 50,000 \text{ m}^2$$

Calculating the Average Depth of Water Stored

Step 1: Use the Volume-Area Relationship

The average depth (h) of water stored is given by:

$$h = \text{Total Volume} / \text{Area}$$

Substituting the known values:

$$h = 10,800 \text{ m}^3 / 50,000 \text{ m}^2 = 0.216 \text{ m}$$

Step 2: Convert Depth to Millimeters

Since 1 meter = 1000 millimeters,

$$h = 0.216 \text{ m} \times 1000 = 216 \text{ mm}$$

Summary of Results

- Total volume of water supplied = 10,800 cubic meters
- Area of the field = 50,000 square meters
- Average depth of water stored in the field = 216 millimeters

Practical Implications of the Calculation

Water Management and Efficiency

Understanding the average depth helps in assessing whether the amount of water supplied is sufficient for crop needs. For example, 216 mm may be adequate for certain crops at specific growth stages but insufficient for others, depending on water requirements.

Design of Irrigation Systems

The calculation informs the design and capacity of irrigation infrastructure, such as canal dimensions, pipe sizes, and pump capacities, to ensure uniform water distribution and optimal crop yield.

Scheduling and Water Conservation

Knowing the volume and depth aids in scheduling future irrigation events, avoiding over-irrigation, and conserving water resources.

Additional Considerations

Uniformity of Water Distribution

While the average depth provides a general estimate, actual water distribution may vary due to soil type, topography, and irrigation method. Proper assessment of uniformity is essential for effective irrigation management.

Soil Infiltration and Percolation

Some water percolates into the soil or runs off, which may reduce the effective water stored. Soil properties and infiltration rates should be considered in practical applications.

Impact of Evaporation and Transpiration

During irrigation, some water is lost through evaporation and plant transpiration. Adjustments in water application rates may be needed to compensate for these losses.

Conclusion

Calculating the average depth of water stored in an irrigated field is a fundamental aspect of irrigation engineering. For the specified scenario—a 5-hectare cornfield irrigated for 12 hours at a discharge of 250 Lps—the total volume of water supplied is 10,800 m³, resulting in an average water depth of approximately 216 mm. This calculation aids in designing efficient irrigation systems, managing water resources effectively, and ensuring optimal crop growth. Proper understanding and application of these principles are vital for sustainable agriculture and resource conservation.

References

- Irrigation Engineering by S.C. Gupta
- Principles of Irrigation Engineering by R.K. Jain
- FAO Irrigation and Drainage Paper No. 24: Irrigation Scheduling

Frequently Asked Questions

How is the average depth of water stored calculated for a 5-hectare cornfield irrigated for 12 hours at 250 Lps?

The average depth is calculated by dividing the total volume of water applied by the area of the field. First, find the total volume: $\text{volume} = \text{discharge} \times \text{time}$; then, convert to consistent units and divide by the area in square meters to find the depth in meters.

What is the significance of knowing the average depth of water stored in irrigation practices?

Knowing the average depth helps in assessing whether the crop's water requirements are met, optimizing water usage, and ensuring efficient irrigation without over or under-watering.

How do you convert the discharge from liters per second to cubic meters per hour for calculation purposes?

Since 1,000 liters = 1 cubic meter, multiply the discharge in Lps by 0.001 to get cubic meters per second, then multiply by 3600 to convert to cubic meters per hour.

What is the total volume of water supplied to the 5-ha cornfield during the 12-hour irrigation period at 250 Lps?

Total volume = discharge (Lps) $\times$ time (seconds). For 250 Lps over 12 hours: $250 \text{ Lps} \times 12 \times 3600 \text{ seconds} = 10,800,000 \text{ liters}$ or 10,800 cubic meters.

How would you convert the field area from hectares to square meters for the calculation?

Since 1 hectare equals 10,000 square meters, 5 hectares equals 50,000 square meters.

What is the approximate average depth of water stored in the field based on the given data?

Using the total volume (10,800 m³) and the area (50,000 m²), the average depth = $10,800 \div 50,000 \approx 0.216 \text{ meters}$ or approximately 21.6 centimeters.

Additional Resources

A 5-ha Cornfield Was Irrigated For 12 Hrs At A Discharge Of 250 Lps. If The Average Depth Of Water Stored — this scenario presents a classic case study in irrigation

management, emphasizing the importance of understanding water application, flow rates, and storage capacities to ensure optimal crop growth. Whether you're a student, agronomist, or farmer seeking to refine your irrigation strategies, analyzing such parameters provides valuable insights into water utilization efficiency and resource planning. In this comprehensive guide, we'll break down the key concepts, calculations, and considerations involved in determining the average depth of water stored during a specified irrigation event.

Introduction to Irrigation Calculations

Irrigation efficiency depends heavily on understanding the relationship between the volume of water applied, the area irrigated, and the resulting water depth or application rate. When a specific discharge (flow rate) is used over a given time to irrigate an area, calculating the average depth of water stored becomes essential for assessing how much water is delivered per unit area.

In our scenario:

- Area of the field: 5 hectares (ha)
- Duration of irrigation: 12 hours
- Discharge rate: 250 liters per second (Lps)

The goal is to determine the average depth of water stored in the field after irrigation.

Fundamental Concepts and Definitions

1. Discharge (Flow Rate)

Discharge, often expressed in liters per second (Lps) or cubic meters per second (cms), indicates how much water flows through a pipe or channel at any given moment.

2. Irrigation Duration

The total time during which water is supplied to the field, here 12 hours, directly influences the total volume of water applied.

3. Area of the Field

Expressed in hectares (ha), where 1 hectare equals 10,000 square meters (m²). The area impacts the calculation of water depth.

4. Water Depth

The average depth of water stored (in millimeters or centimeters) is obtained by dividing the total volume of water applied by the area irrigated.

Step-by-Step Calculation Process

Step 1: Convert Discharge to Cubic Meters per Second

Since the discharge is given in liters per second, convert it into cubic meters per second for compatibility with area units:

- 1 cubic meter (m^3) = 1000 liters

Discharge in m^3/sec :

$$Q = 250 \, \text{Lps} \times \frac{1 \, \text{m}^3}{1000 \, \text{L}} = 0.25 \, \text{m}^3/\text{sec}$$

Step 2: Calculate Total Volume of Water Supplied

Total volume (V) (in cubic meters):

$$V = Q \times t$$

Where:

- ($Q = 0.25 \, \text{m}^3/\text{sec}$)

- ($t = 12 \, \text{hours}$)

Convert hours to seconds:

$$12 \, \text{hours} \times 3600 \, \text{seconds/hour} = 43,200 \, \text{seconds}$$

Now, compute total volume:

$$V = 0.25 \, \text{m}^3/\text{sec} \times 43,200 \, \text{sec} = 10,800 \, \text{m}^3$$

Step 3: Convert Area to Square Meters

Given area:

$$A = 5 \, \text{ha} = 5 \times 10,000 \, \text{m}^2 = 50,000 \, \text{m}^2$$

Step 4: Determine Water Depth

Water depth (d) (in meters):

$$d = \frac{V}{A} = \frac{10,800 \text{ m}^3}{50,000 \text{ m}^2} = 0.216 \text{ m}$$

Convert meters to millimeters for easier interpretation:

$$0.216 \text{ m} \times 1000 = 216 \text{ mm}$$

Final Result:

The average depth of water stored in the 5-hectare cornfield after irrigating for 12 hours at a discharge of 250 Lps is approximately 216 millimeters.

Implications and Practical Considerations

1. Water Application Efficiency

An application depth of ~216 mm indicates a significant water input, suitable for crops like corn which typically require 400-600 mm of water during the growing season. This single irrigation event covers roughly a third to half of that requirement, depending on crop stage and rainfall.

2. Irrigation Scheduling

Understanding the volume of water applied helps farmers plan subsequent irrigations, avoiding over- or under-watering. For example, if the crop needs 500 mm during the season, and this event provided 216 mm, additional irrigations are necessary.

3. Water Management and Conservation

Efficient irrigation involves matching water application with crop needs, soil retention capacity, and avoiding runoff or deep percolation losses. Knowing the average water depth aids in optimizing these factors.

Additional Factors to Consider

1. Soil Type and Water Retention

Different soils (sandy, loamy, clayey) have varying infiltration rates and water holding capacities, influencing how much of the applied water is available to plants.

2. Distribution Uniformity

Uniform water distribution across the entire 5-ha area ensures crops receive consistent moisture, affecting the actual depth of water stored.

3. Application Method

Methods such as sprinkler, drip, or flood irrigation influence the efficiency and uniformity of water application, impacting the effective depth.

4. Environmental Conditions

Evaporation, transpiration, and rainfall during or after irrigation can alter the actual water stored and its availability to crops.

Summary and Key Takeaways

- Total water supplied during irrigation can be calculated using flow rate and duration.
- Average water depth in a given area is obtained by dividing total volume by the area irrigated.
- In our scenario, irrigating 5 hectares for 12 hours at 250 Lps results in an approximate water depth of 216 mm.
- Understanding these calculations aids in irrigation planning, water resource management, and ensuring optimal crop growth.

Final Thoughts

Effective irrigation management hinges on accurate calculations and understanding of water application parameters. By mastering these fundamental concepts, farmers and agronomists can optimize water use, improve crop yields, and promote sustainable agricultural practices. Remember, precise measurement and monitoring are key to translating these calculations into successful real-world irrigation strategies.

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