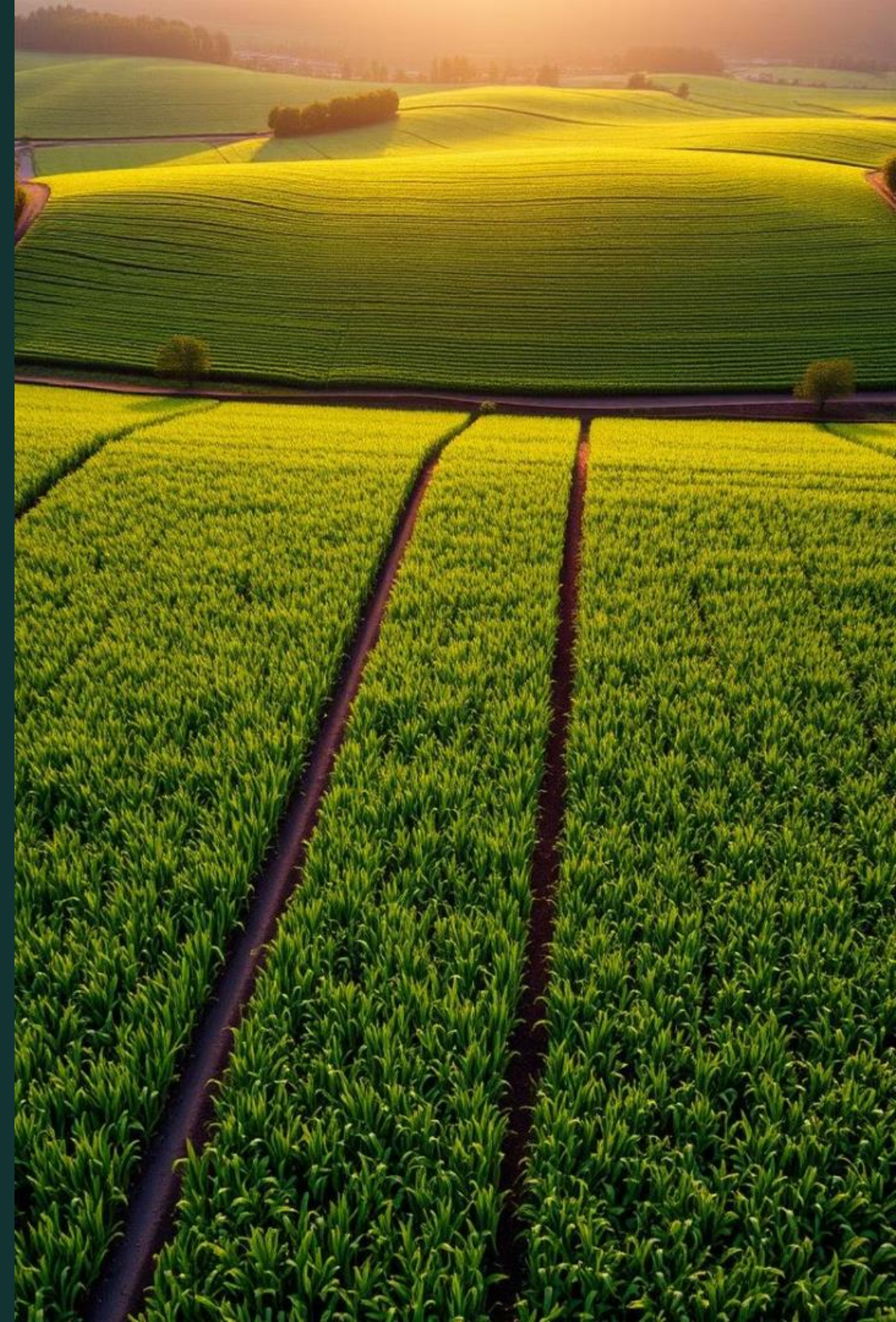


# Introduction to Soil Water Movement

Welcome to the fascinating world of soil water movement. This presentation will explore the critical role water plays in the soil, a complex three-phase system composed of solid particles, liquid water, and gaseous air. Soil water is essential for plant growth, ecosystem health, and various environmental processes. An ideal soil composition for plant growth consists of approximately 50% solid material, 25% water, and 25% air. We'll also discuss water retention, contrasting field capacity, the maximum amount of water the soil can hold after drainage, with the wilting point, the point at which plants can no longer extract water from the soil.



**by Sugitha Thankappan**



# Key Forces: Adhesion, Cohesion, and Gravity

## Forces at Play

The movement of water in soil is governed by several key forces: adhesion, cohesion, and gravity. Adhesion refers to the attraction between water molecules and soil particles, while cohesion is the attraction between water molecules themselves. Gravity pulls water downwards through the soil profile.

Understanding these forces is fundamental to understanding how water behaves within the soil environment, affecting everything from nutrient transport to plant water availability.

## Capillary Action

Capillary action, a combined effect of adhesion and cohesion, allows water to move upwards against gravity in small soil pores. Water always moves from areas of high water potential (more free water) to areas of low water potential (less free water).

# Types of Soil Water

## Gravitational Water

This water drains freely through the soil due to the force of gravity. It's generally not available to plants, as it moves too quickly through the soil profile.

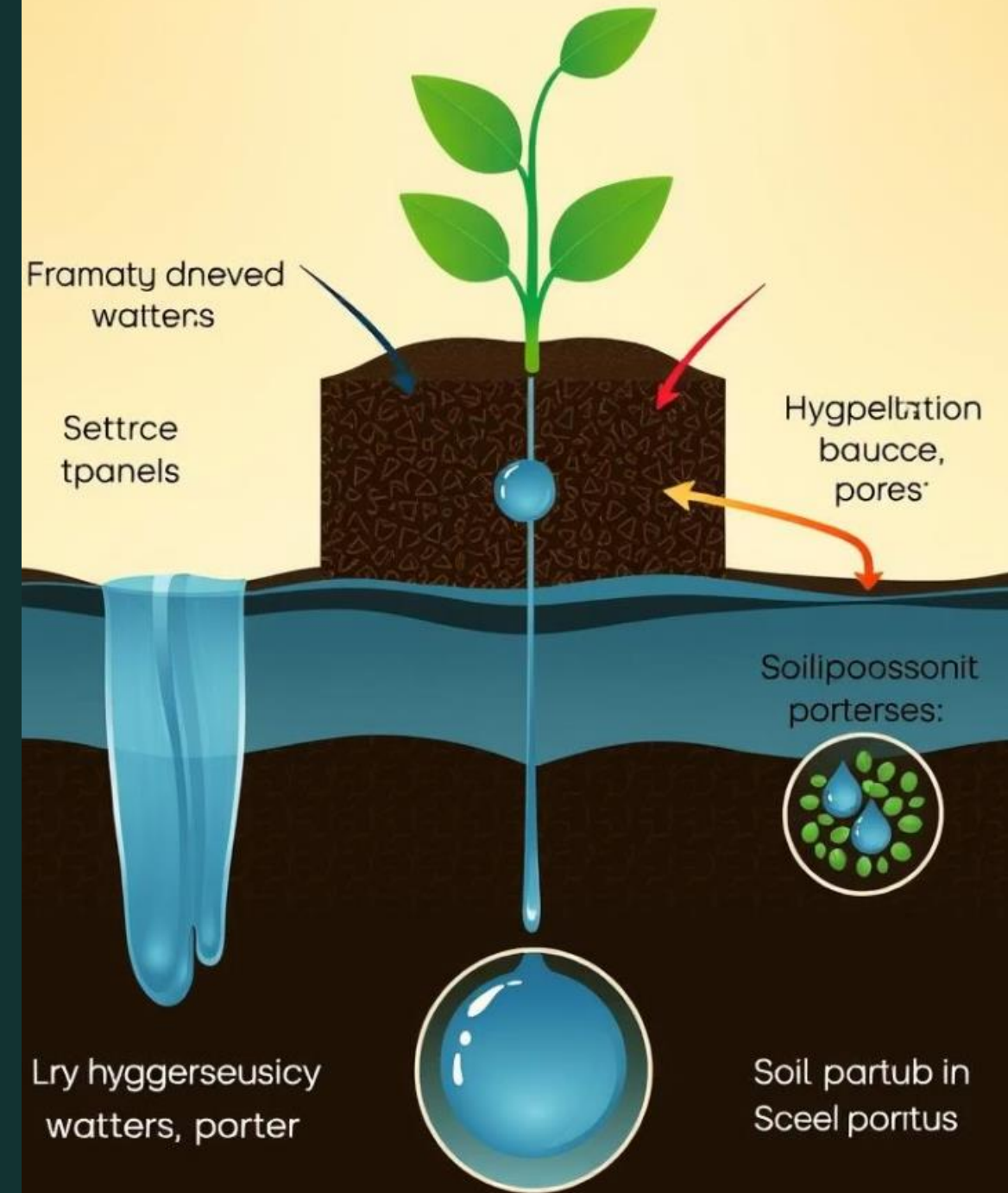
## Capillary Water

Held in small soil pores, capillary water is the primary source of water for plants. It's retained against gravity due to capillary forces.

## Hygroscopic Water

Tightly bound to soil particles, hygroscopic water is not available to plants. It's held at very high tensions (greater than  $-1500$  kPa), making it inaccessible.

The availability of water to plants depends on the type of water present in the soil. Managing soil moisture to maximize capillary water is crucial for healthy plant growth.



# Saturated vs. Unsaturated Flow



## Saturated Flow

Occurs when all soil pores are filled with water. This typically happens during heavy rainfall or irrigation. Described by Darcy's Law.

Darcy's Law ( $Q = -KA(dh/dl)$ ) relates flow rate ( $Q$ ) to hydraulic conductivity ( $K$ ), cross-sectional area ( $A$ ), and the hydraulic gradient ( $dh/dl$ ). Richards' equation is a more complex model accounting for unsaturated conditions.



## Unsaturated Flow

Occurs when water moves through partially filled pores. This is a more complex process, described by Richards' equation.



# Infiltration

1

## Definition

Infiltration is the process of water entering the soil from the surface. It's a key component of the water cycle and essential for replenishing soil moisture.

2

## Factors

Soil texture, structure, organic matter content, and initial moisture content all influence infiltration rates. Compacted soils have significantly reduced infiltration.

3

## Horton's Equation

Infiltration rate typically decreases over time, as described by Horton's equation. This is due to saturation of the surface layer.

Compaction can reduce infiltration rates by up to 90%, highlighting the importance of soil management practices that promote good soil structure and porosity.



# Factors Affecting Hydraulic Conductivity

## Soil Texture

Coarse-textured soils (sands) have higher hydraulic conductivity (K) than fine-textured soils (clays) due to larger pore spaces.

## Soil Structure

Well-aggregated soils have higher K due to increased macroporosity, allowing for easier water flow.

## Organic Matter

Increases K by improving soil structure and porosity, creating more pathways for water movement.

Hydraulic conductivity is a measure of the ease with which water flows through soil. Temperature also affects hydraulic conductivity, with higher temperatures decreasing water viscosity and increasing K.

# Practical Applications

1

## Irrigation Management

Optimize water use for crop production.

2

## Drainage Systems

Remove excess water from waterlogged soils.

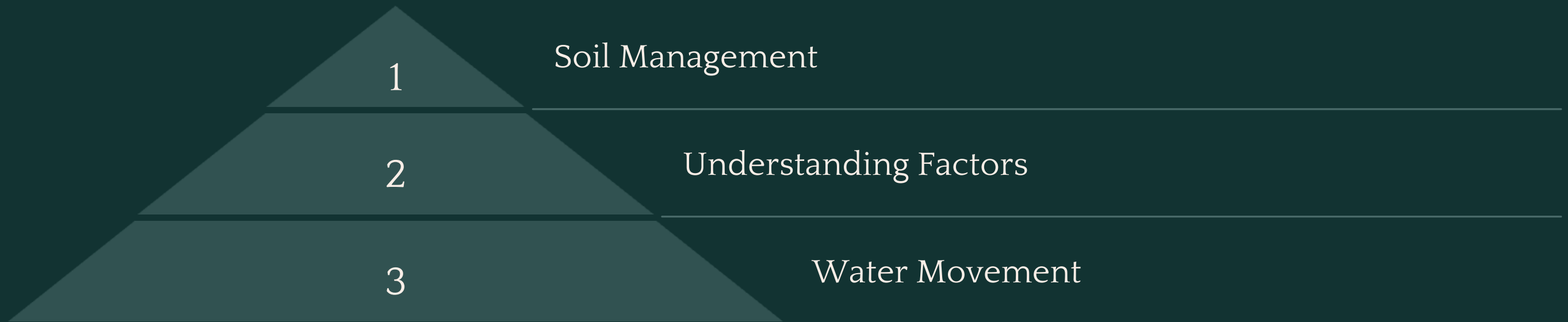
3

## Erosion Control

Maintain soil structure to prevent water erosion.

Effective soil water management has numerous practical applications. Drip irrigation, for example, reduces water waste by up to 60% compared to traditional sprinkler systems by delivering water directly to plant roots.

# Summary and Conclusion



Soil water movement is a critical process for plant growth, ecosystem health, and sustainable agriculture. Understanding the forces and factors that govern water movement is essential for effective soil management. Proper soil management practices can enhance water infiltration and retention, leading to improved crop yields and environmental sustainability. Future research will focus on developing sophisticated soil water models for accurate prediction of water movement and availability.

# Quiz Time!

Test your knowledge of soil water movement. Answer the following questions to reinforce your understanding of the key concepts covered in this presentation.

- What are the three types of soil water?
- Describe the difference between saturated and unsaturated flow.
- What is Horton's equation?
- How does organic matter affect hydraulic conductivity?

# Further Learning

Dive deeper into soil water movement with these resources:

- [NRCS Soil Health Resources](#)
- [Nature Soil Science Journal](#)
- [Soil & Tillage Research Journal](#)

Thank you for your attention! We hope this presentation has provided you with a comprehensive understanding of soil water movement and its importance for our world. Remember, understanding and managing soil water effectively is key to sustainable agriculture and a healthy environment.