

Course: Basics of Environmental Engineering (Climatology)



Main topic: Evaporation

Lecturer : RUTAYISIRE Theoneste



1. Introduction to Evaporation
2. Factors Affecting Evaporation
3. Evaporation in Agriculture
4. Measuring Evaporation
5. Impacts of Evaporation on Crop Growth and Yield
6. Measures of Reducing Evaporation and Other Techniques Used in Agriculture

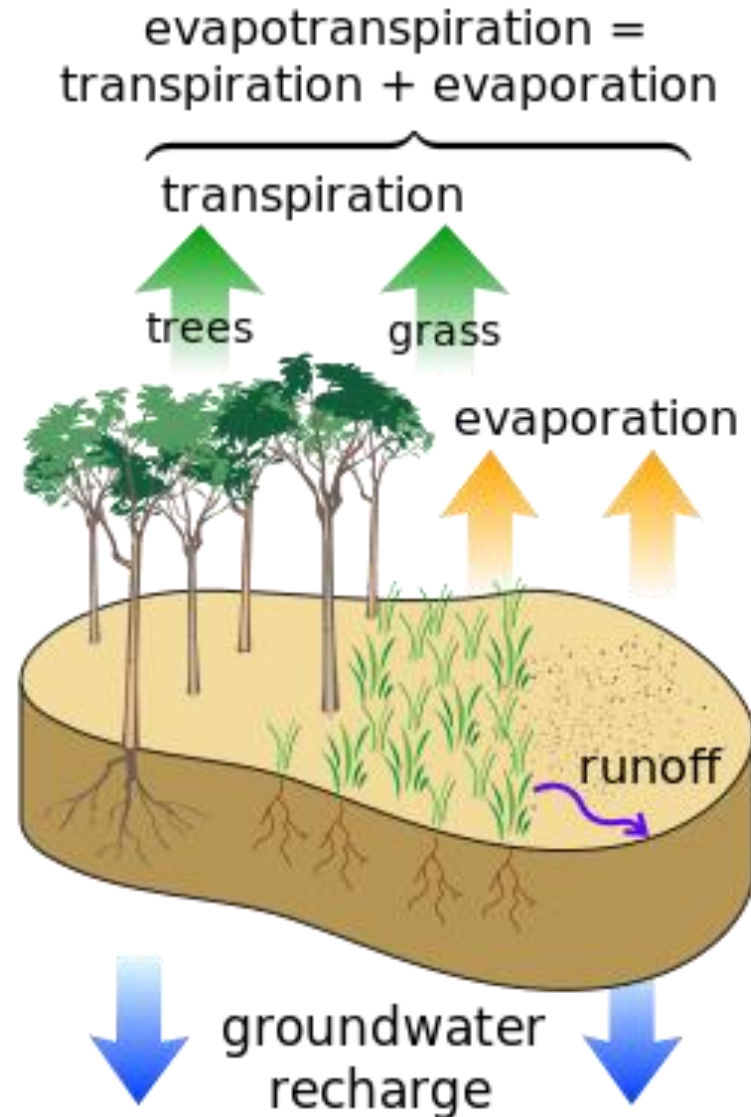
Interactive activity

1. Which of the following is NOT a key factor affecting evaporation rates in agriculture?
 - a) Temperature
 - b) Humidity
 - c) Wind speed
 - d) Soil moisture
 - e) Crop yield
2. Which of the following is a common technique used to reduce evaporation losses in crop production?
 - a) Drip irrigation
 - b) Planting deep-rooted crops
 - c) Applying chemical mulches
 - d) All of the above
 - e) None of the above
3. How can farmers use evaporation data to improve irrigation management?
 - a) Scheduling irrigation to match peak evaporation periods
 - b) Reducing irrigation during times of high evaporation
 - c) Adjusting irrigation amounts based on measured evaporation rates
 - d) b and c
 - e) All of the above
4. What is the primary method used to measure evaporation in agricultural settings?
 - a) Evaporation pans
 - b) Soil moisture sensors
 - c) Satellite remote sensing
 - d) Plant sap flow meters
 - e) Weather station data
5. Excessive evaporation can lead to which of the following impacts on crop growth?
 - a) Wilting and reduced photosynthesis
 - b) Increased disease susceptibility
 - c) Reduced nutrient uptake
 - d) All of the above
 - e) a and b only

Introduction to evaporation

Water changes states during evaporation, going from a liquid to a gaseous form called water vapor.

In agricultural terms, evaporation is an essential part of the water cycle and affects crop growth and development greatly.



Introduction to evaporation

Mechanisms of Evaporation

- Evaporation: Water molecules escape from the soil surface, water bodies, and surface of plant leaves into the atmosphere.
- Transpiration: Water movement from plant roots, through the plant, and released as vapor through leaf stomata.
- Evapotranspiration: The combined process of surface evaporation and plant transpiration.

Introduction to evaporation

Distinction between Evaporation and Transpiration

- Evaporation is the direct physical process of water transitioning from liquid to gas on surface.
- Transpiration is the biological process by which water moves through plants and is released as vapor through the leaves.

Factors Affecting Evaporation

Metrological factors

- ❖ **Temperature:** Higher temperatures increase the kinetic energy of water molecules, accelerating their transition to a gaseous state.
- ❖ **Humidity:** Lower humidity levels in the air increase the evaporative demand because there is more capacity for the air to hold water vapor.
- ❖ **Wind speed:** Faster wind speeds remove water vapor from the surface, increasing the rate of evaporation.

Factors Affecting Evaporation (cont'd)

- ❖ **Solar radiation:** Higher solar radiation provides additional energy to drive the evaporation process

Plant Factors

- ❖ **Leaf area:** Plants with larger leaf areas have higher transpiration rates, which contribute to overall evapotranspiration.
- ❖ **Stomatal behavior:** The opening and closing of stomata on leaves regulates the rate of transpiration.

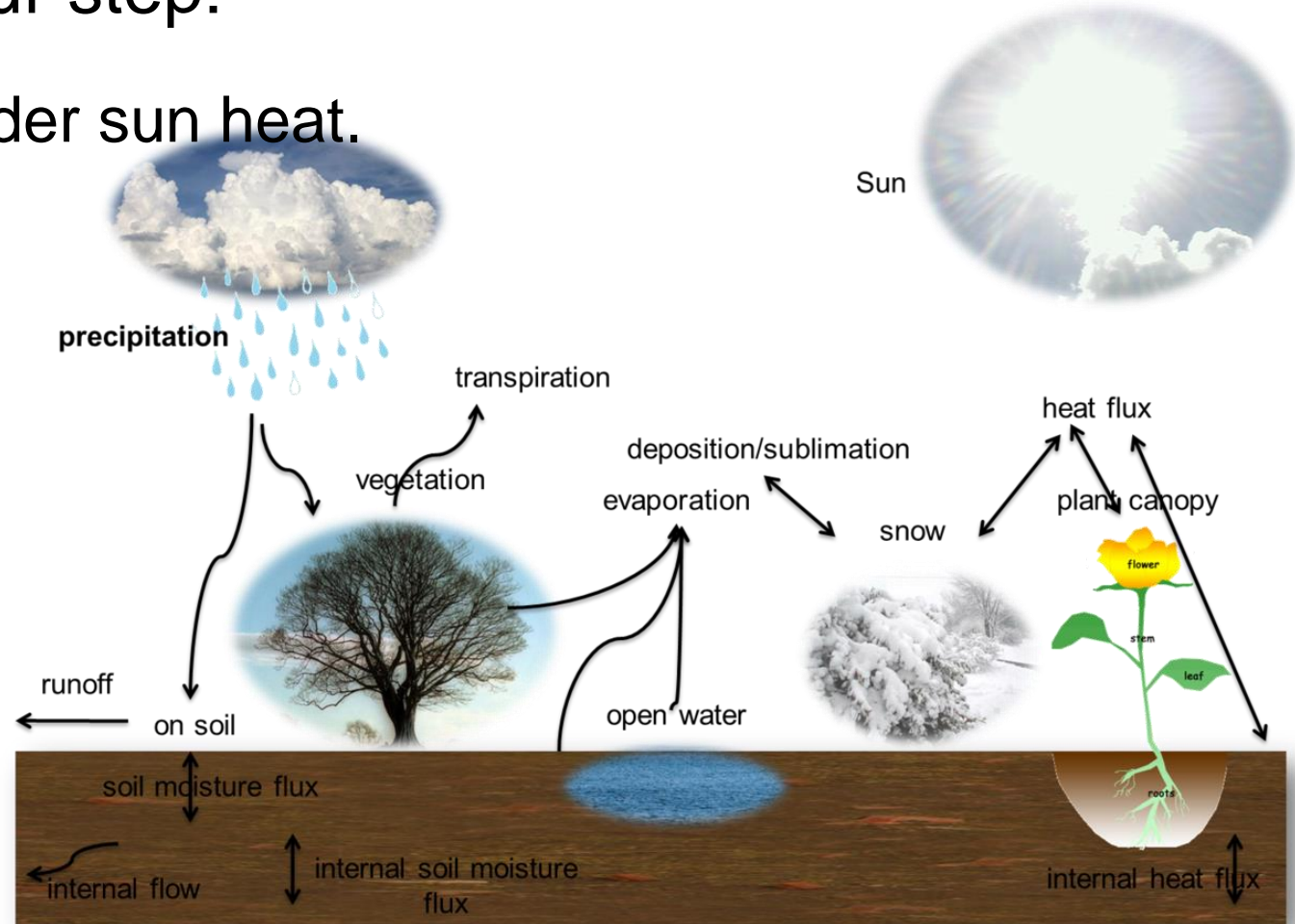
Factors Affecting Evaporation (cont'd)

- ❖ **Crop type and growth stage:** Different crops and their growth stages have varying evapotranspiration requirements
- ❖ **Rooting depth:** deeper root systems can access deeper soil moisture, reducing the impact of surface evaporation.

Factors Affecting Evaporation (cont'd)

Evaporation process include in four step:

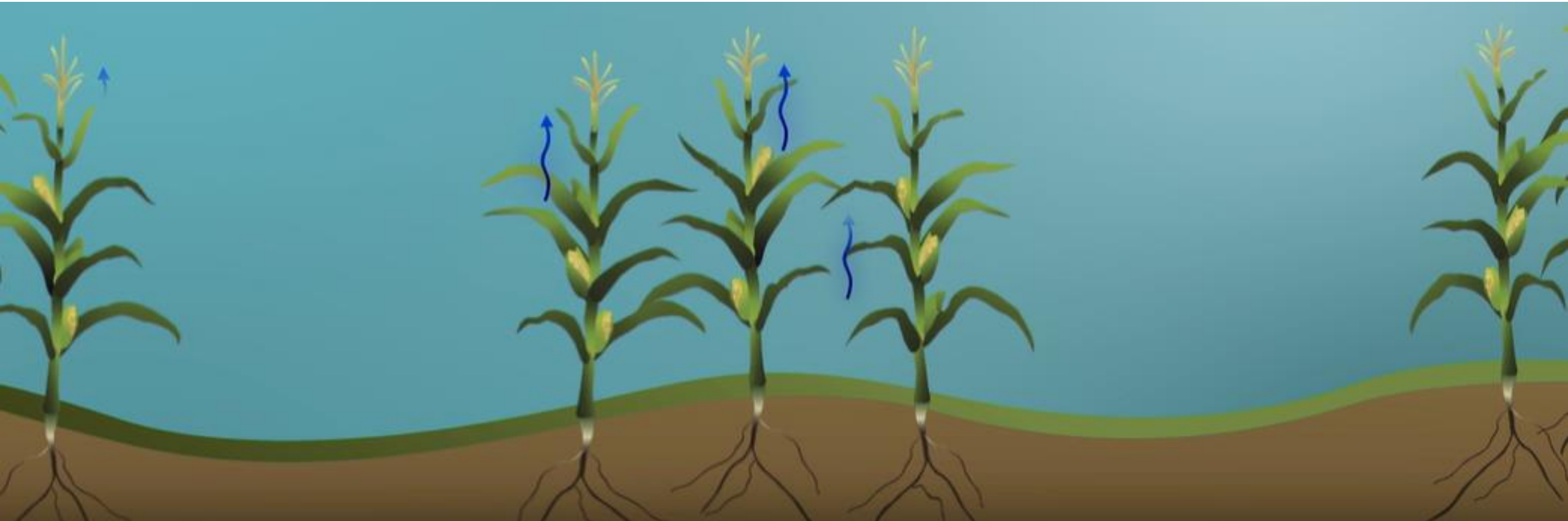
1. Evaporation: Water evaporates under sun heat.
2. Condensation: Water condenses in atmosphere to form cloud
3. Precipitation: Water is released from the cloud
4. Collection: Water are collected and held in different area



(Chen et. al., 1996, 1997; Chen and Dudhia, 2001; Ek et. al., 2003; Koren et. al., 1999)

Evaporation in Agriculture (cont'd)

Evaporation in crops is the conversion of water from plants and soil into vapor that is then released into the atmosphere.



Evaporation in Agriculture (cont'd)

Evaporation's significance in agriculture



Facilitating effective water management and timing of irrigation



Preserving the ideal level of soil moisture for increased crop yield



Encouraging the wise use of scarce water resources



Improving irrigation effectiveness and cutting energy expenses



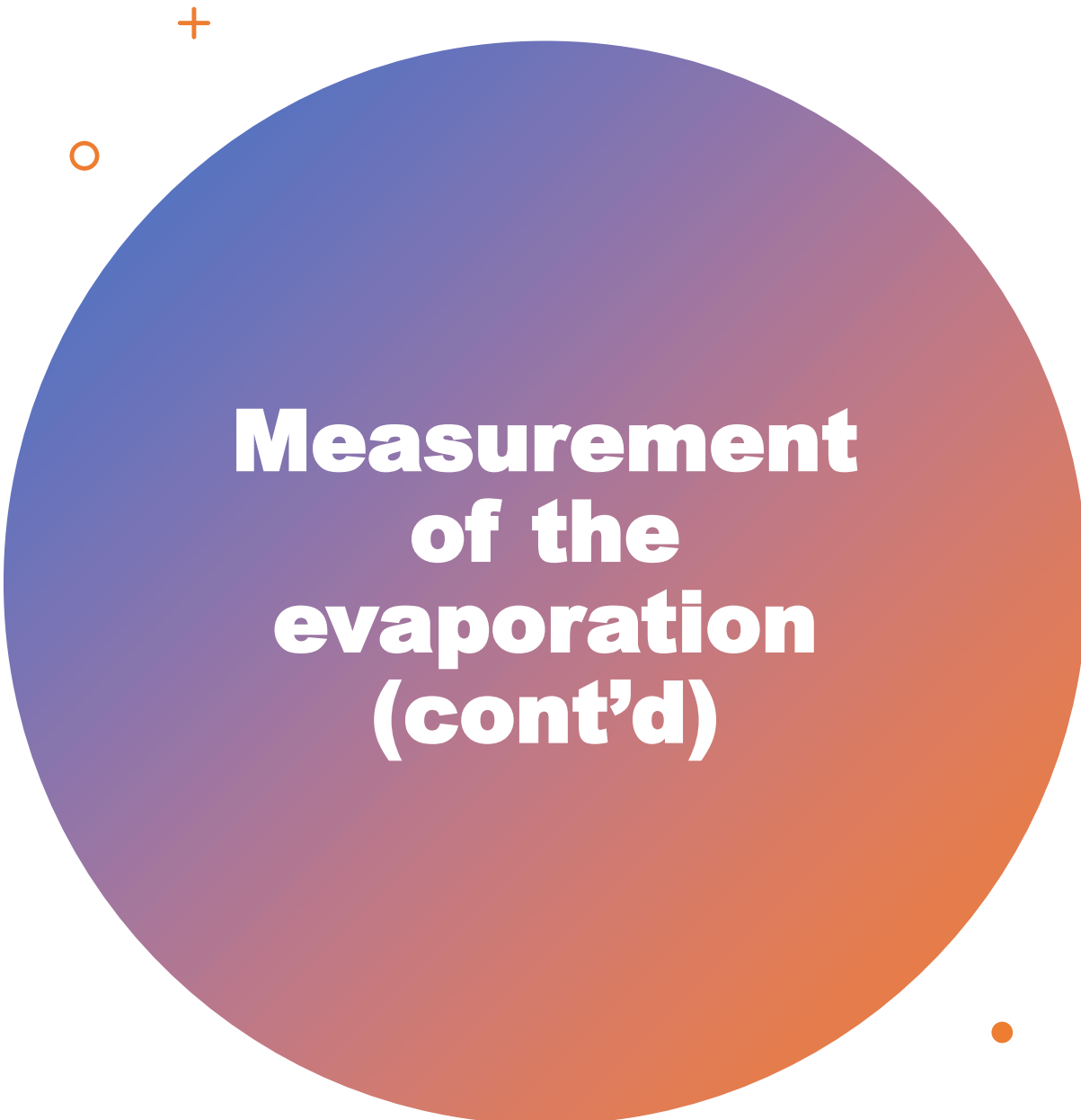
Enhancing agricultural planning and modeling to facilitate improved agricultural decision-making

Measurement of the evaporation




Evaporation pans and other measurement techniques are commonly used in agriculture to quantify the rate of evaporation.

1. Floating Pans
2. Pans placed above the ground
3. Sunken Pans

A large circle with a blue-to-orange gradient is positioned on the left side of the slide. To its top-left is a small orange plus sign, and to its top-left is a small orange circle. To its bottom-right is a small orange circle. The text "Measurement of the evaporation (cont'd)" is centered within the circle in white, bold font.

Measurement of the evaporation (cont'd)

Float pans are a necessary equipment for leveling and polishing concrete. They are essential for producing level and smooth concrete surfaces and are made to accommodate a variety of power floats. Usually constructed from sturdy materials like steel, these pans can resist the rigors of concrete work.

A thin vertical line on the right side of the slide, colored blue at the top and orange at the bottom.

Measurement of the evaporation (cont'd)

Float pans



Measurement of the evaporation (cont'd)

Key Features of Float Pans

1. Material:

Float pans are produced from 3mm thickness steel, ensuring durability and longevity.

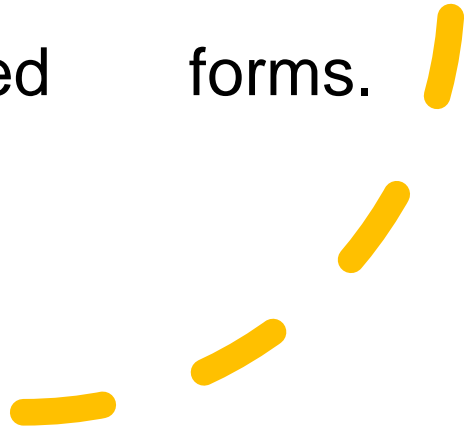
2. Curvature:

The curvature of the pan ranges from 3mm to 8mm at the dead center, minimizing suction to the slab and allowing for maximum movement of the concrete during the finishing process.

Key Features of Float Pans

3. Brackets: To ensure adaptability in use, they come with 4, 8, or 10 brackets that are made for both walk-behind and ride-on machines.

4. Paint Options: To accommodate a range of tastes and requirements, float pans are offered in painted and unpainted forms.



Measurement of the evaporation (cont'd)

Pans placed above the ground

When it comes to measuring evaporation, pans placed above the ground are commonly used for observations.

This pan is a cylinder with specific dimensions - a diameter of 47.5 inches and a depth of 10 inches. It is placed on a leveled wooden base and typically enclosed by a chain link fence to prevent animals from drinking from it.



Measurement of the evaporation (cont'd)

The Sunken Colorado pan is a square pan with a depth of 0.46 meters (18 inches) and a side length of 0.92 meters (3 feet). Conversion constants may be used to compare the evaporation from a Sunken Colorado Pan with a Class A pan.



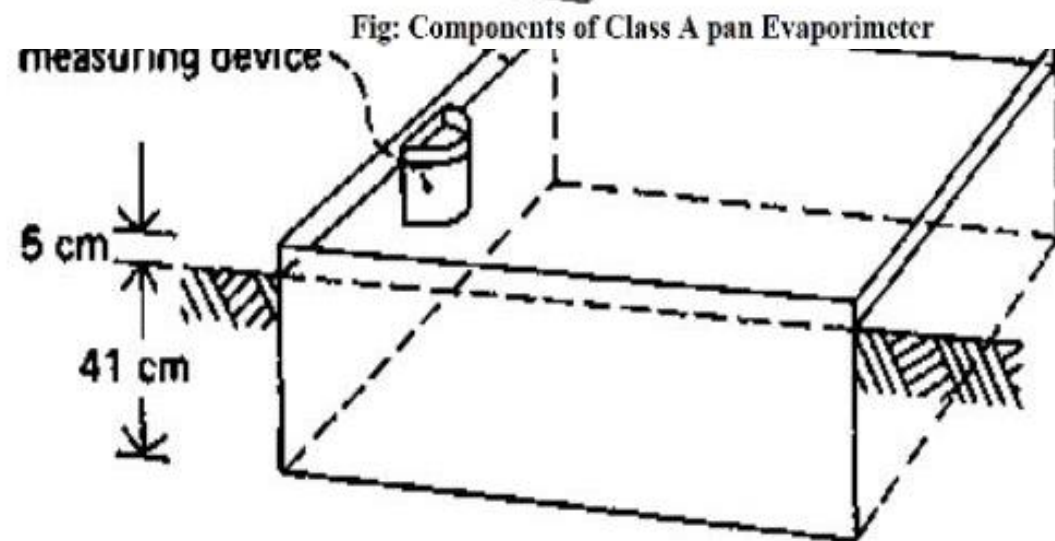
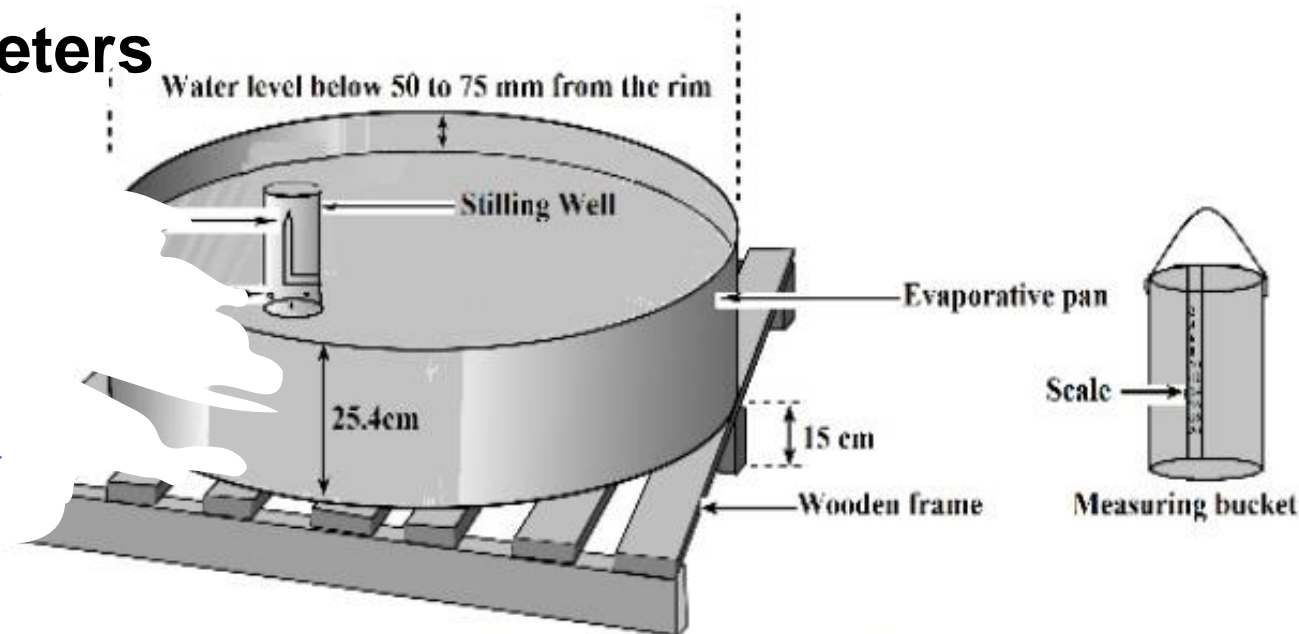
Measurement of the evaporation (cont'd)

Most common used Evaporimeters

Class 'A' open pan evaporimeter (U.S.W.B.) in Rwanda

The Class A evaporation pan (circle pan) and the Sunken Colorado pan (square pan) are the most well-known pans.

The water is left to evaporate for a certain amount of time, often 24 hours. For instance, a measurement is made every morning at seven o'clock.



Measurement of evaporation (cont'd)

- **The following is the evaporation pan's working principle:**
 - 1. In the field, the pan is installed.**
 - 2. A known amount of water is added to the pan; the water's depth is measured and the pan's surface area is known.**
 - 3. Concurrent measurement is made of any rainfall that occurs.**
 - 4. The amount of water left behind, or the water depth, is measured after a day.**

Positive Impact of Evaporation on Agriculture

❖ Water Management

Evaporation affects irrigation and crop water needs, thus influencing agricultural productivity.

❖ Soil Health

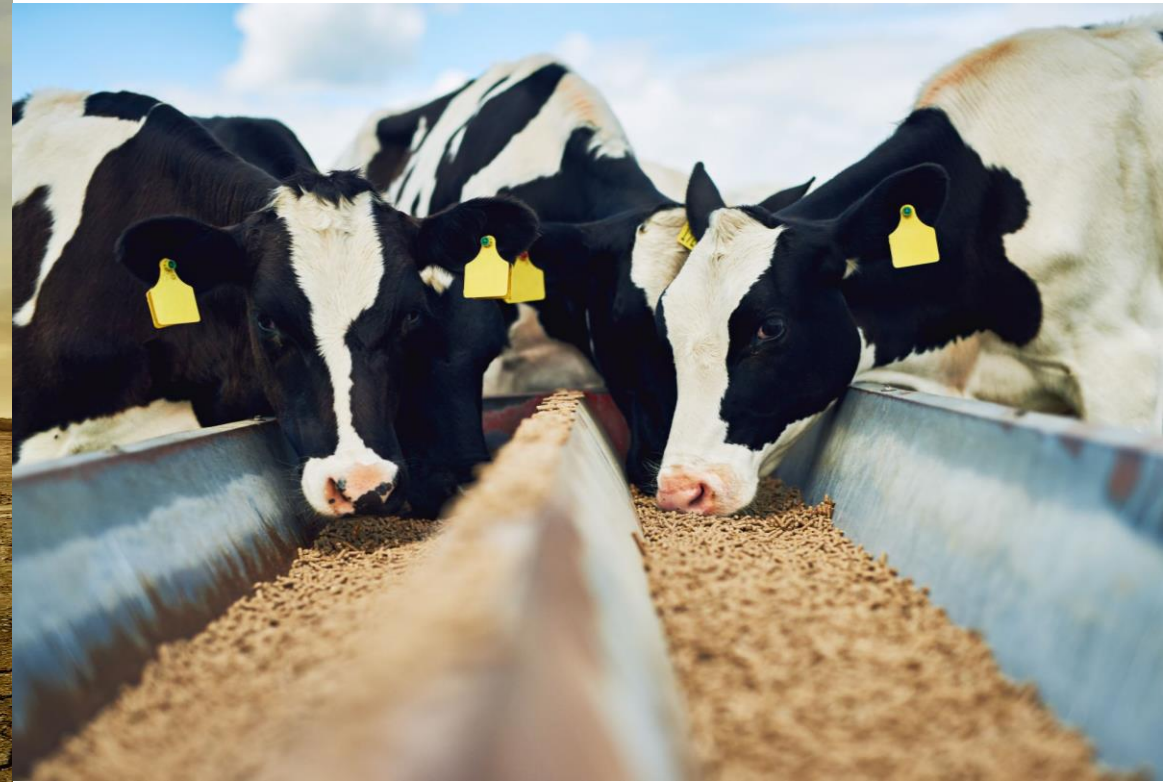
Regulation of evaporation can prevent soil salinity and preserve soil fertility.



Negative Impact of Evaporation on Agriculture production



Decreased Crop Yield : High evaporation rates can result in decreased crop yields, affecting food production.



Water scarcity due to evaporation affects the hydration and health of livestock and other animals.



Impact of Evaporation on Climatology



Weather Patterns (Evaporation)



contributes to the formation of clouds and precipitation, thereby affecting the regional



Global Water Cycle



Evaporation is a key component of the water cycle and influences global weather events.

Methods that farmers employ to minimize evaporation and maximize water use

Mulching is the process of applying synthetic or organic materials to the soil's surface to form a barrier that inhibits weed development, lowers evaporation, preserves soil moisture, and controls temperature.



Methods that farmers employ to minimize evaporation and maximize water use

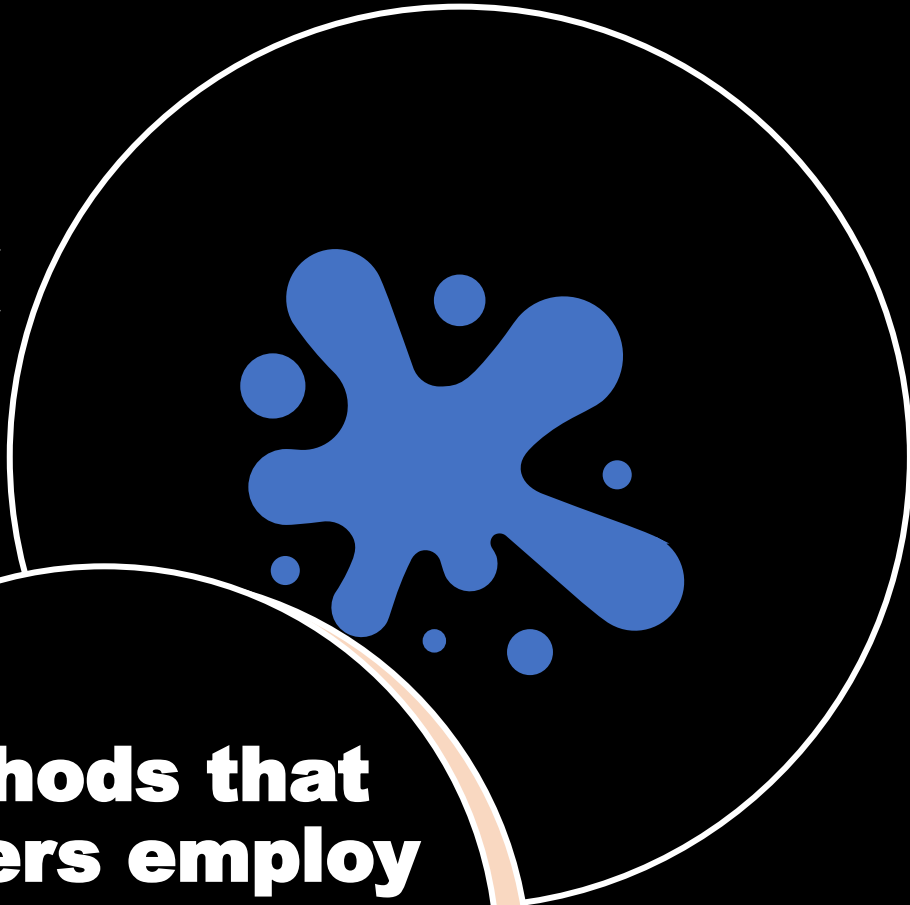
Installing sensors in the soil to track moisture levels in real-time enables farmers to accurately modify irrigation schedules, ensuring that water is only sprayed where and when it is required, hence reducing evaporation losses.



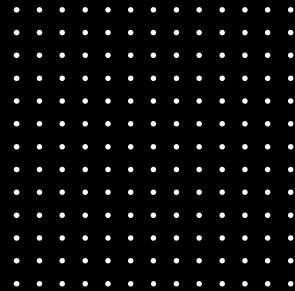
Methods that farmers employ to minimize evaporation and maximize water use

Planting cover crops between cash crops or during fallow seasons helps to maintain soil health, prevent weed growth, and retain moisture in the soil—all of which lower evaporation and conserve water.





Methods that farmers employ to minimize evaporation and maximize water use



By using a network of tubes or emitters to deliver water straight to the base of plants, drip irrigation reduces water loss from evaporation and runoff in comparison to conventional overhead sprinkler systems.



Methods that farmers employ to minimize evaporation and maximize water use

Gathering Rainwater: Rainwater collection and storage helps preserve water by lowering dependency on freshwater sources for irrigation.

Simple rain barrels to intricate storage tanks and ponds are examples of several types of rainwater collection systems.



Conclusion

Evaporation affects a number of industries, including environmental management, weather forecasting, and agriculture.

- ❖ Evaporation affects crop growth, irrigation tactics, and water consumption efficiency in agricultural contexts.
- ❖ Farmers may increase crop output by reducing water waste, timing irrigations more efficiently, and using evaporation data.
- ❖ Comprehending the principles of evaporation is crucial for environmentally friendly methods of managing water in several domains, including agriculture.

Solutions to individual assessment

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Bibliography of image

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