Nexus Labs

PRIMA
PARTNERSHIP FOR RESEARCH AND INNOVATION IN THE MEDITERRANEAN AREA

This project is part of the PRIMA programme supported by the European Union.

SMART IRRIGATION GUIDE FOR FARMERS

5 Steps to Efficient Water Use

for Healthy Crops and Sustainable Agriculture

TECHNICAL UNIVERSITY OF CRETE

GLOBAL WATER PARTNERSHIP MEDITERRANEAN

Why Smart Irrigation Matters

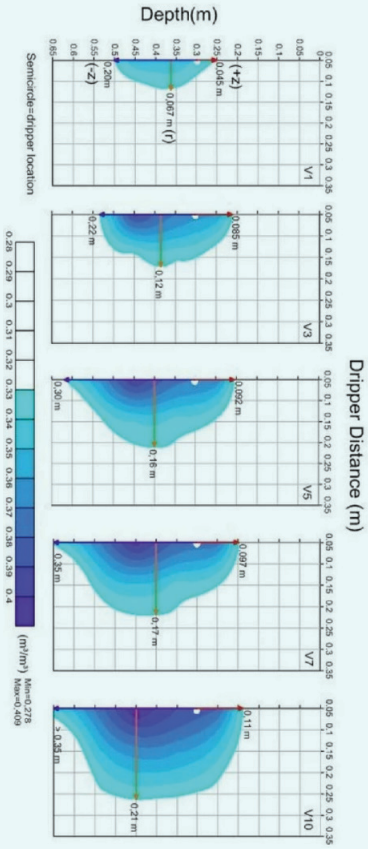
Water is becoming increasingly scarce, especially in Mediterranean regions. Traditional irrigation practices often lead to water waste, higher costs, and reduced crop performance.

Smart irrigation means:

- Applying water based on **plant needs**
- Using **soil moisture information**
- Improving **crop yield and quality**
- Saving **water, energy, and money**

Key principle:

"*Water the **plant**, **not** the **field**.*"

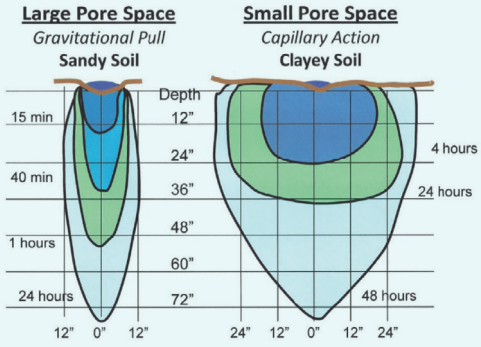


UNDERSTANDING THE MOVEMENT OF WATER IN SOIL

Water in the soil is stored in spaces between soil particles (pores). Different soils behave differently:

- **Sandy soils** → drain quickly, need frequent irrigation.
- **Clay soils** → retain water longer, and need less frequent irrigation.

Knowing your soil type helps you decide **how much and how often to irrigate**.



1 Understand your field's soil moisture limits

There are four key soil moisture levels:

Saturation – Soil is fully filled with water, no air remains → *harmful for plant roots*

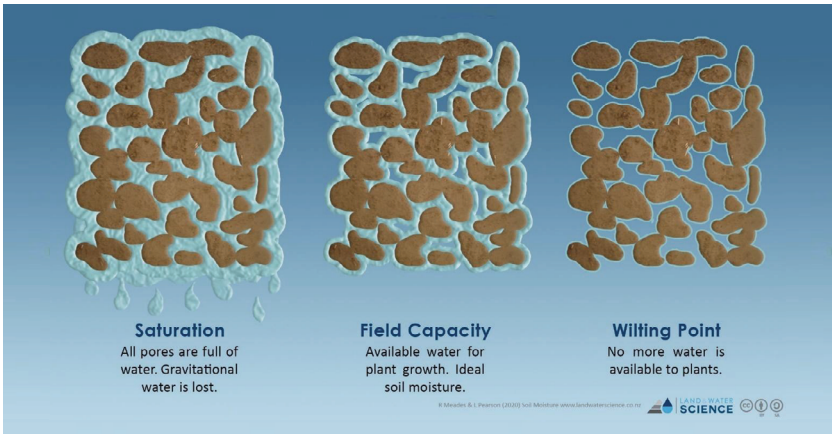
Field Capacity - The maximum usable water for plants that the soil can hold, after excess water has drained away

Available Water – The range between field capacity and wilting point - the water that plants can actually use

Wilting Point - Soil is too dry → *plants cannot recover*

After irrigation, soil moisture increases and may exceed field capacity. Excess water then drains away, bringing the soil back to field capacity. From that point, soil moisture gradually decreases as plants use water and some evaporates (evapotranspiration).

Keep soil moisture **between field capacity and wilting point**



WHEN SHOULD YOU IRRIGATE?

When soil moisture has dropped below field capacity, but before plants begin to show stress (wilting point). Overwatering to saturation wastes water and damages roots, while underwatering reduces yield.

2 Focus irrigation on the root zone

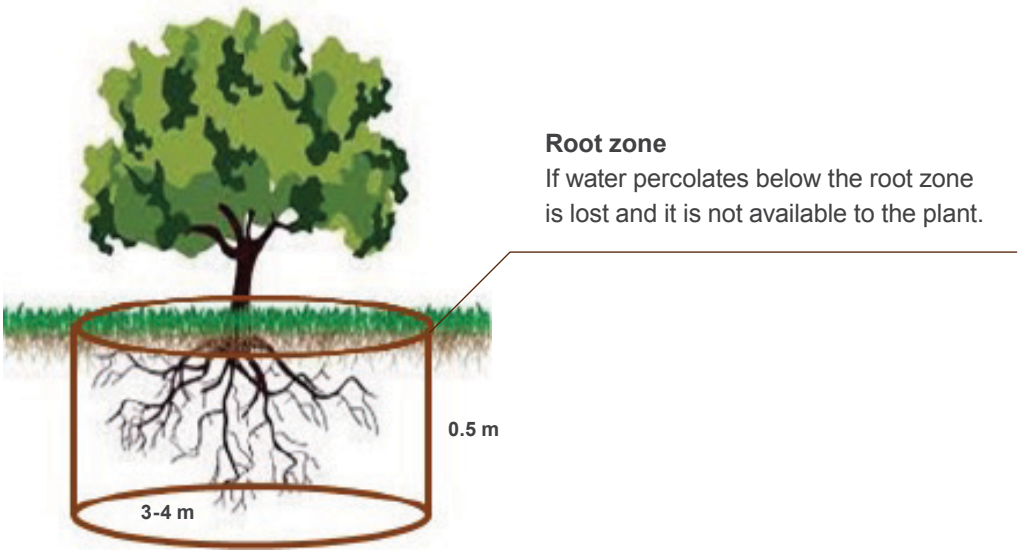
Most crops absorb water from a specific soil depth (root zone).

Example: Typical root depth: ~0.5 meters

Irrigation should target this zone, not deeper layers.

WHY?

- Water below root zone is **lost**
- Efficient irrigation = water stays where roots can use it



3 Know how long to irrigate

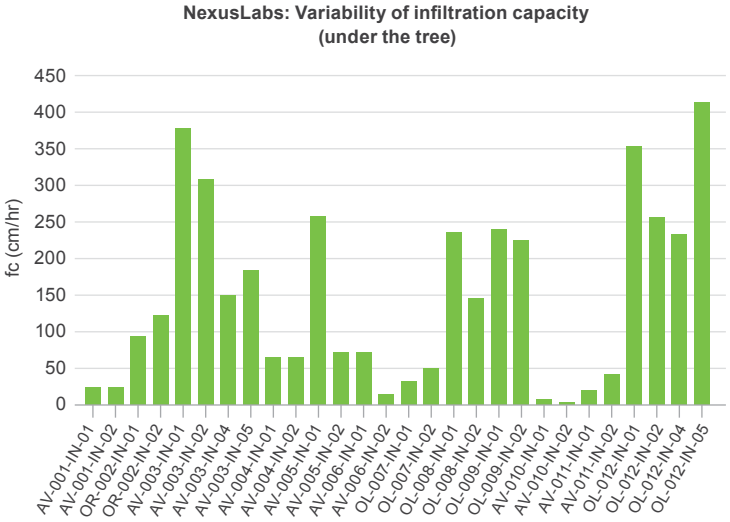
Water enters and moves through the soil at different speeds depending on soil conditions.

Infiltration	Capillary rise	Drainage
(water entering soil)	(water moving upward)	(water moving downward)

Field experiments show that:

- Water distribution is not uniform
- Soil variability affects irrigation efficiency

Adjust irrigation based on your field's conditions.



Infiltration experiments in your field help estimate how quickly water moves downward and how long it takes to reach the root zone.

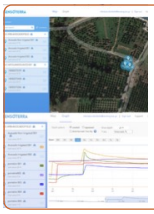
Use this information to decide how long to irrigate, so water stays in the root zone and is not lost to deeper layers.

4 Use soil moisture data to decide when to irrigate

Modern irrigation systems use:

Sensors
(soil moisture, climate)

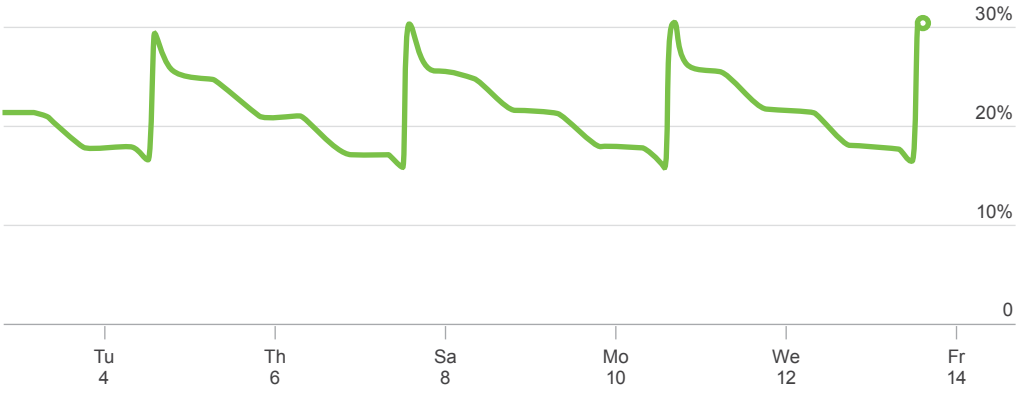
Wireless networks
(e.g. LoRaWAN)



Data platforms for monitoring

BENEFITS:

- Reduced water use = reduced energy consumption and costs
- Better crop performance



Data from soil moisture sensors can be viewed on mobile phones. After irrigation, you can observe soil moisture increasing, before starting to drop as water is absorbed by plants and transpires through the soil (evapotranspiration). It remains constant in the evening (when we do not have photosynthesis) and starts dropping again the next day.

When the soil moisture reaches the level that it was prior to irrigation event, you need to irrigate again.

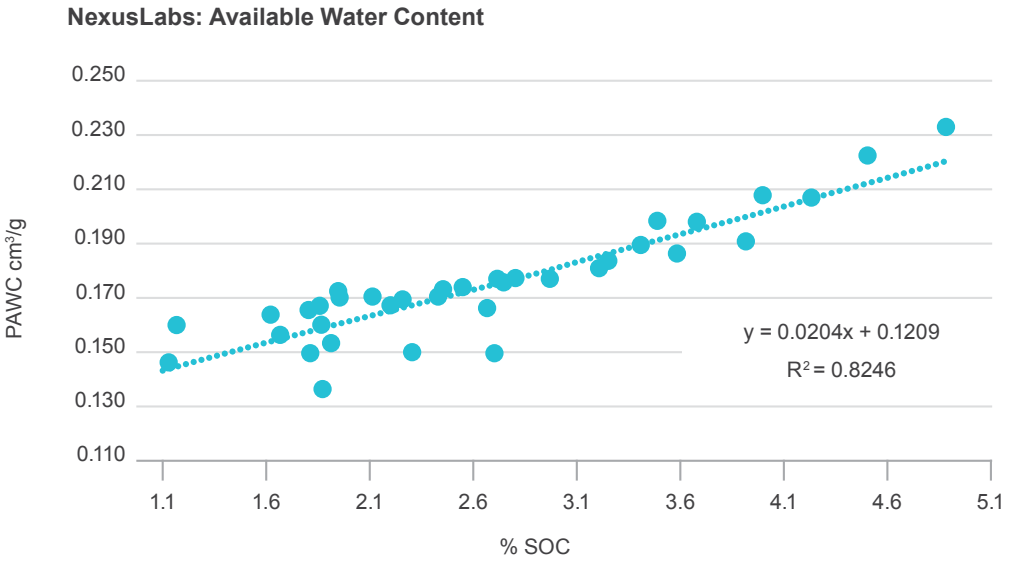
5 Improve your soil to retain more water

Agroecological practices and Nature-based solutions help reduce water and costs by:

Increasing soil organic matter	Improving water retention	Reducing evaporation losses	Enhancing soil structure

EXAMPLES:

• Cover crops • Mulching • Reduced tillage



Healthy soil = better water use

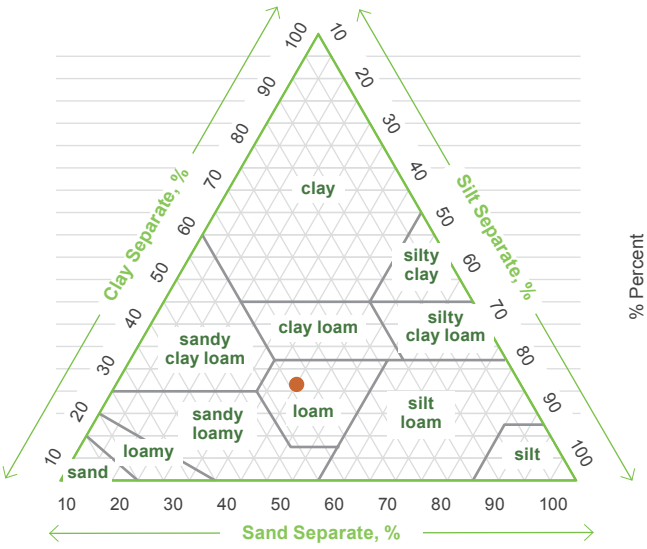
Soil organic matter increases the soil water retention capacity. For example, 1% increase in soil organic carbon increases soil moisture by 0.02 cm^3/g or the equivalent of 44 m^3/ha additional moisture, **delaying the onset of irrigation by several weeks**.

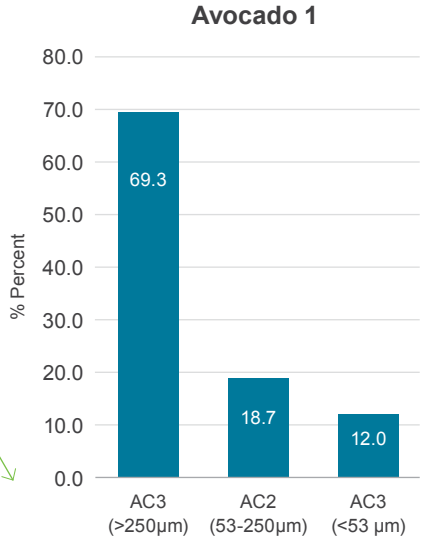
AN EXAMPLE

Irrigation of an Avocado Plantation

Soil structure

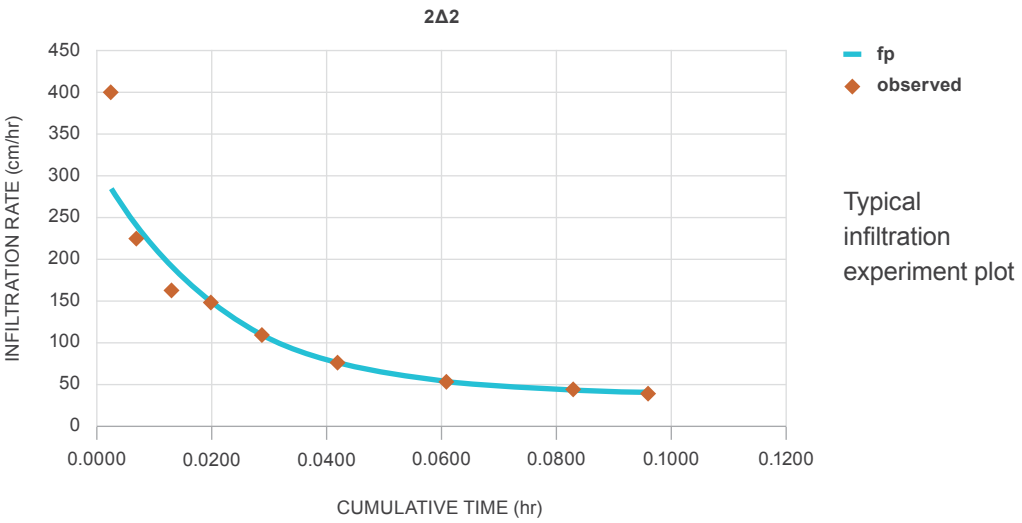
We measure the key parameters of soil structure that allow us to determine when, how much, and how long to irrigate: (Sand 47%, Silt 31.0%, Clay 22%; Soil Texture – Loam, Average porosity = 37%, Field capacity = 31.5%, Wilting point = 14.5%.)





Soil texture is Loam and the water stable macroaggregates is 69%, indicating a fertile soil.

Infiltration rate measurements



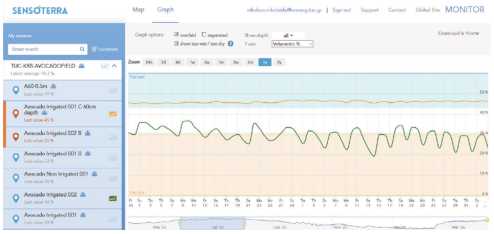
Typical infiltration experiment plot

INFILTRATION EXPERIMENT RESULTS		
Location	**Old trees – Infiltration rate**	**Younger trees – Infiltration rate**
Under the tree measurement	341cm/hr	165 cm/hr
Middle of field measurement	13 cm/hr	22 cm/hr

- Within the root zone, water can move fast (faster with older trees and dense roots), but it slows down below the root zone.
- The average infiltration rate for the avocado plantation ranges between 13 and 22 cm/hr which means that **the water covers the 50 cm root zone in about 2-3 hours**.
- **Recommended duration of irrigation 2-3 hours**. Irrigating longer than this will push water below the root zone, where it is lost.

Check and adjust your irrigation to minimize losses

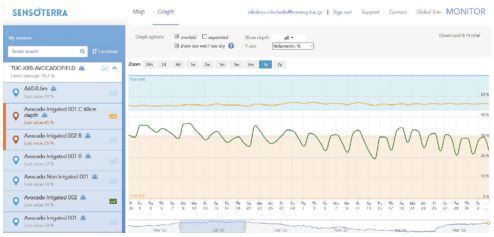
Check soil moisture measurements: if the 60 cm depth soil moisture level increases during irrigation events, it means water has moved below the root zone, and is wasted.



Soil moisture time series at 30 cm (green line) and 60 cm (orange line) depths during the period July 1st to August 31st, 2025.

RECORDED SOIL MOISTURE (@ 30 cm)

MAXIMUM 37% **MINIMUM** 19%



Soil moisture time series at 30 cm (green line) and 60 cm (orange line) depths during the period April 2025 to March 2026.

RECORDED SOIL MOISTURE (@ 30 cm)

MAXIMUM 37% **MINIMUM** 15%

Soil moisture @ 60 cm depth – Stable soil moisture content, percolated water did not increase the moisture level → ***losses to groundwater were minimal***.

The maximum soil moisture recorded during irrigation was the same as the porosity, suggesting that the soil at 30 cm was saturated.

Irrigation for up to 3 hours minimizes the losses to groundwater.

What This Means for You:

Determine the duration of irrigation based on the infiltration rate experiment, so you do not waste water below the root zone.
(in our Avocado example, 3-hour duration)

A

Learn the key soil moisture levels for your soil: field capacity (upper limit) and wilting point (lower limit).

B

Irrigation should start when the soil moisture is between field capacity and wilting point.
(In this example about 20%)

C

Determine the required amount of irrigated water for each tree.
This depends on the volume and water holding capacity of the root zone, and the desired soil moisture level.
In this example, this corresponds to about 250L per tree.

D

Determine the number of drips required to provide the irrigation volume.
In this example, the irrigation volume of 250L should be provided in 3 hours, which equals 84L/hr per tree.
If the **drip rate is 4L/hr**, then you would need **21 drips per tree**.

E

Check soil moisture measurements at 30 and 60 cm depths, to ensure no water is lost.
If the 60 cm depth soil moisture level increases during irrigation events, it means water is wasted below the root zone, and you need to reduce the amount of irrigation.

F

Following these guidelines, you can significantly reduce the amount of water you use and ensure a healthy yield by giving the plants exactly the amount of water they need.

In our avocado example, assuming the irrigation period lasts 5 to 6 months and on average irrigation every 4 days, then we will have 30 to 40 irrigation events, and the **total irrigation will be 200 to 260 m^3/dunum** which is significantly less than the usual practice (typical range 500 – 700 m^3/dunum).

KEY TAKEAWAYS FOR FARMERS

- ✓ **Irrigate based on plant needs, not routine**
- ✓ **Monitor soil moisture regularly**
- ✓ **Focus on the root zone**
- ✓ **Avoid over- and under-irrigation**
- ✓ **Use simple or advanced tools to guide decisions**
- ✓ **Apply agroecological practices to improve soil**

Smart irrigation is not just about saving water - it is about **increasing productivity, reducing costs, and building resilience to climate change**.

Small changes in irrigation practices can lead to **big benefits for your farm**.

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