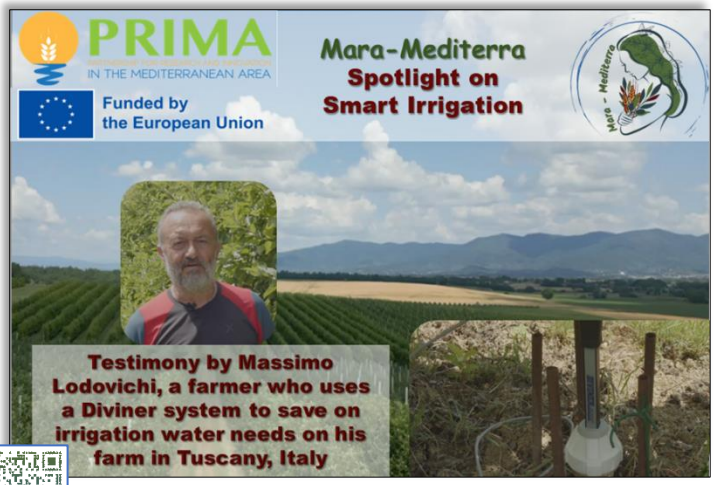
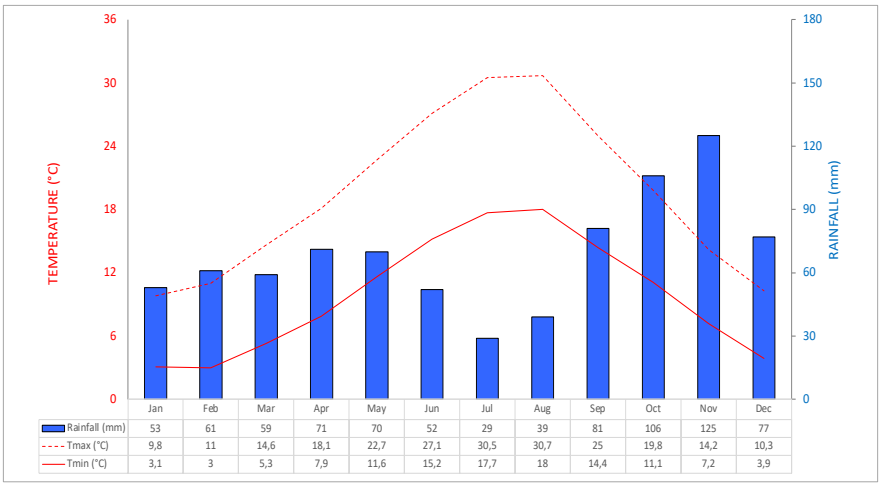
Testimonial video and associated training material

6. Smart irrigation



Massimo Lodovichi is the manager of the farm Illuminati GMM. His farmland is located in two different Municipalities of Valdichiana, Castiglion Fiorentino and Foiano della Chiana, in the Arezzo province of Central Italy. The farmland consists of 200 hectares, half of which is cultivated as orchards of apple (54 hectares), pear (26 ha), plum (5 ha), peach (11.5 ha) and vineyards (6 ha).

Ever since Massimo started working on the farm in 1987, he faced problems with the scarcity of water for irrigation, particularly in the hilly part of the farm. This explains his motivation to have been continuously looking for strategies to optimize irrigation efficiency and thereby save water. The adoption of smart irrigation systems, supported by experts of the University of Florence, has proven to be an efficient water-saving strategy, allowing the farm to roughly half their consumption.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	53	61	59	71	70	52	29	39	81	106	125	77
Tmax (°C)	9,8	11	14,6	18,1	22,7	27,1	30,5	30,7	25	19,8	14,2	10,3
Tmin (°C)	3,1	3	5,3	7,9	11,6	15,2	17,7	18	14,4	11,1	7,2	3,9

The climate in Foiano della Chiana is warm and temperate. Rainfall is higher in autumn and winter compared to spring and summer. The temperature averages around 13°C and the annual rainfall is around 800 mm.

Soil in this area is mainly clay and silty, with gentle hilly topography. The main cultivations are fruit orchards, but also cereals such as wheat and barley.

Smart irrigation: what is it?

Smart irrigation is an advanced approach that makes use of technology and data to optimize water use and improve irrigation efficiency. It is conceived to address the challenges of traditional irrigation systems, such as overwatering, leaching, and inefficient scheduling. Basically, the main components of a smart irrigation system typically include sensors, controllers, agrometeorological weather stations, and communication devices. However, the technological level greatly varies: from single sensors directly used by the farmer, to the integration of ground sensors with remote sensing data, short-term weather predictions, water balance models and GIS-based systems delivering different kinds of maps (i.e. water balance, crop irrigation requirements, soil texture etc.) coupled with specific recommendations for irrigation scheduling.

- ***Sensors***

  Soil moisture sensors are placed in the ground to measure the moisture content in the soil, at various depth. Among the various types of soil moisture sensors, capacitance sensors and frequency domain reflectometry (FDR) sensors are commonly used operationally in smart irrigation systems. These sensors offer practical benefits in terms of accuracy, ease of use, and compatibility with different soil types.

Capacitance Sensors
They provide continuous measurements of soil moisture by analyzing changes in electrical capacitance. Capacitance sensors can be easily installed in the soil, and many models offer wireless connectivity, allowing seamless integration with smart irrigation systems. They are compatible with various soil types and offer relatively accurate readings.

Frequency Domain Reflectometry (FDR) Sensors
They measure soil moisture by analyzing changes in the frequency response caused by the dielectric soil properties. FDR are known for their accuracy and can provide reliable and consistent measurements over time. They are suitable for different soil types and are often used in agricultural and research applications where precise monitoring is required. The diviner device used by Massimo is a typical FDR sensor.

- ***Controllers***

  Smart irrigation controllers are the engine of the system. By dynamically adapting irrigation based on real-time information, smart controllers contribute to efficient water management. They receive data from sensors and agrometeorological weather stations, and based on a prediction model for crop water requirements, they determine when and how much to irrigate. These controllers can be programmed with specific plant types, soil conditions, and other variables, allowing for customized irrigation schedules.

⌀ ***Agrometeorological weather stations***

Agrometeorological weather stations provide local real-time weather data such as temperature, humidity, wind speed, solar radiation, and rainfall. This information is crucial because it helps the smart irrigation system to adjust irrigation schedules based on current weather conditions. In many cases, weather data are used to estimate crop evapotranspiration, which is the most significant water loss from the system.

⌀ ***Remote sensing***

Satellites play a significant role in smart irrigation by providing valuable data and insights that help optimize water use and improve irrigation.

WEATHER MONITORING

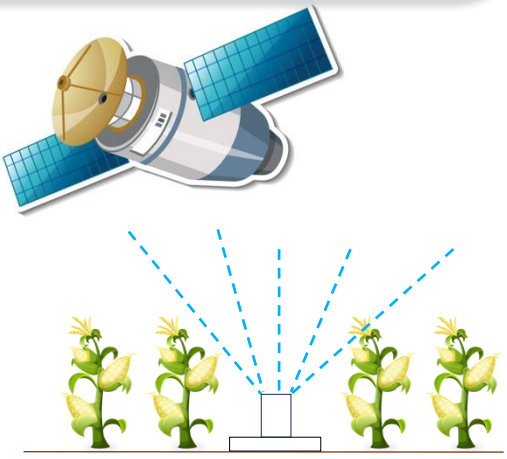
Satellites provide accurate and up-to-date weather information, including rainfall patterns, temperature, humidity, and evapotranspiration rates. This data helps smart irrigation systems adjust watering schedules based on actual water needs.

SOIL MOISTURE MONITORING

Satellites with microwave sensors can measure soil moisture content over large areas. These sensors can penetrate cloud cover and provide soil moisture data regardless of weather conditions.

CROP MONITORING

Satellites can capture imagery of fields and monitor crop parameters such as vegetation indices, crop stress levels, and biomass. This data allows to identify field plots that may require different irrigation volumes or detect signs of stress early on, allowing for timely interventions.



Benefits of smart irrigation systems

- ✓ **Water conservation**: smart irrigation systems use data-driven approaches to deliver the right amount of water at the right time, avoiding overwatering and reducing water wastage. Compared to traditional management based on experience or rule of thumb adopted by farmers, it has been estimated that the adoption of smart irrigation systems can result in a reduction of 20-30% of irrigation volumes, yet, based on the technology used and the scale of application, such reduction can reach up to 50%.
- ✓ **Increase crop productivity**: by monitoring soil moisture levels and adjusting irrigation schedules accordingly, smart irrigation systems ensure that plants receive adequate water, leading to an optimized yield.
- ✓ **Time and labour savings**: with automated scheduling and remote-control capabilities, smart irrigation systems minimize the need for manual intervention and maintenance. This saves time and labour associated with traditional irrigation methods.

✓ **Environmental sustainability**: by reducing water consumption and minimizing runoff, smart irrigation contributes to environmental sustainability and helps protect water resources. Additionally, avoiding overwatering and consequent deep percolation, nutrient leaching and transport to groundwater is strongly reduced.

Different approaches to smart irrigation

The most common smart irrigation systems are based on three different approaches; ***evapotranspiration*** (ET), which relies on calculated ET rates and weather data; ***soil moisture*** that directly uses soil moisture measurements; and satellite-based which uses ***remote sensing*** technology to provide broader insights on vegetation and soil moisture conditions.

ET-based irrigation relies on calculating the crop ET rate. It considers factors such as weather conditions, solar radiation, and crop type to estimate water requirements.

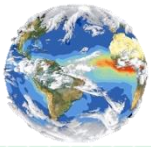
Main features:

- It requires accurate and up-to-date weather information to calculate the ET rate and adjust irrigation schedules accordingly.
- It provides a generalized estimation of water requirements for a specific crop. It does not account for variations in soil types or microclimates within an area.
- It operates on a predetermined schedule based on calculated estimations and weather data. It may not provide real-time information on the actual soil moisture conditions.

Soil moisture-based irrigation directly measures the soil moisture using real-time sensors placed in the soil.

Main features:

- It takes into account the specific soil type, plant types, and microclimate.
- By directly measuring soil moisture levels, it offers real-time feedback on the actual water content in the root zone. This enables a more precise irrigation scheduling.
- It is less reliant on weather data as compared to ET-based irrigation. It focuses on the actual moisture conditions in the soil, which can vary from the general weather conditions in the area.



Satellite-based irrigation uses remote sensing to gather information on vegetation, soil moisture, and other parameters. It provides a bird's eye view of large-scale agricultural areas.

Main features:

- It covers large areas and monitors vegetation and soil conditions across wide territories, making them suitable for large-scale agricultural operations.
- It involves data analysis and modelling techniques to interpret the data collected.
- It offers large-scale insights into vegetation and soil moisture conditions across a broad geographic area. This can help identify regional patterns, trends, and anomalies related to irrigation needs.

Based on the modern digital agriculture approach, it is possible to integrate the different irrigation systems to create a comprehensive, precise and efficient irrigation solution.