

PRECIMED PROJECT: INTRODUCTION AND OVERVIEW

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Abstract

The project “Precision irrigation management to improve water and nutrient use efficiency in the Mediterranean Region” (PRECIMED) is an R&I project co-funded under the PRIMA 2018 programme (Partnership for Research and Innovation in the Mediterranean Area) section II, for a period of 3 years starting from October 2019. PRECIMED consortium is led by CEBAS-CSIC and is composed of a multidisciplinary team of five partners (CEBAS-CSIC, ODINS, UTH, INRAA and OPTIM) from four countries (Spain, Greece, Algeria and Tunisia). PRECIMED seeks to improve water and nutrients use efficiency in the Mediterranean Region. The research will allow the project consortium to launch a data-based irrigation management tool, integrating knowledge about fertilizers and irrigation water management with Information and Communication Technologies (ICTs).

New technologies to improve water and nutrients use efficiency in agriculture

In recent years, some problems like water quality degradation, soil salinization process, underground water depletion or demographic unbalances between rural and urban areas has become evident in arid and semiarid areas (WWAP, 2015). Some of these problems are especially relevant in the Mediterranean Region, where agriculture is one of the most dynamic and productive sectors, but also the most vulnerable to water scarcity. Under this problem, it is important to carry out adequate irrigation management as one of the most effective solutions to promote the economic development of this region. In this sense, there is a need to look for different deficit irrigation strategies and new technologies that increase water use efficiency and make available additional water sources for fertigation, decreasing water scarcity and the discharge of water and nutrients to the environment.

Precision irrigation is technologically feasible through the use of environmental sensors, probes, and decision support systems (NEEA, 2015). Nowadays, there is a wide variety of possible solutions available on the market that range from the simplest based on hand sensing to the more complex that uses satellite imagery (Photo 1).



Photo 1. Leaf temperature and soil moisture sensors, and Satellite images generated by Sentinel 2

In addition, the “Internet of Things” (IoT) is a highly promising family of technologies which can offer many solutions towards the modernization of agriculture. The management and analysis of IoT data (“Big Data”) can be used for the interpretation and valorization of the collected data, automate processes, predict situations and improve different activities at farm level remotely, even at real-time. The agricultural sector was highly affected by the Wireless Sensor Network (WSN) technologies and is expected to be equally benefited by the IoT (Tzounis et al., 2017). It is time to find out how to transfer scientific findings on water and nutrients conservation to water end-users.

A new decision support system (DSS) as PRECIMED solution

For these reasons, the main objective of PRECIMED is the development, validation and transfer of a data driven irrigation management system, to improve Water and Nutrient Use Efficiency, integrating the knowledge about fertilizers and irrigation water management with Information Communication Technologies (ICTs), aiming to be respectful with the environment and socioeconomically profitable.

The solution proposed by PRECIMED is a Decision Support System that uses the information provided by different sensors at farm level, with cloud technology and big data analysis, to send recommendations in real time to the farmers regarding fertigation, through an app or on in a web-based platform (Figure 1).

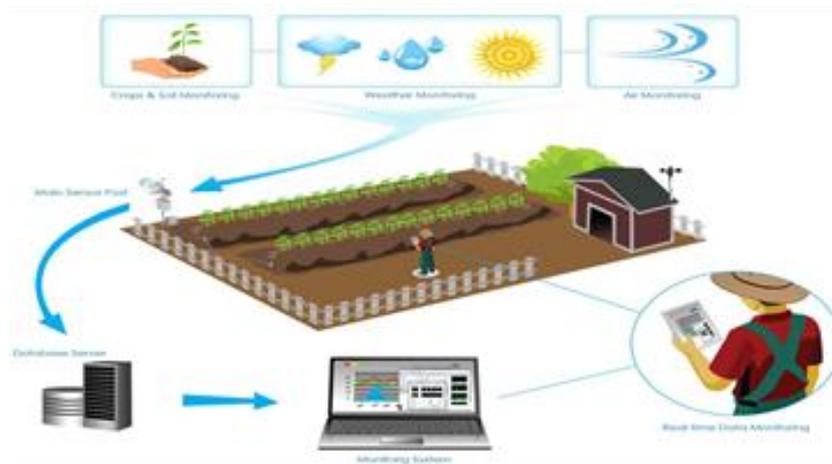


Figure 1. Decision Support System concept

There are solutions available on the market covering a range of individual operations in the agriculture sector to optimizing irrigation, spraying, tree pruning, pest management etc. On their own, these solutions are providing value to farmers, either by enabling reduction of costs or more efficient execution of targeted operations. However, most of these solutions are built around proprietary protocol and are the so-called point solution, i.e., addressing a single farm operation and implemented as an isolated solution, despite using modern cloud-based technologies as the IoT concept. The main consequence of this situation on the market is that a single farm must use multiple solutions. The DSS that we propose, will alleviate these problems by validating the real-life potential and market readiness of advanced interoperability between agricultural devices, for different

production sectors like the greenhouses and outdoor crops. The DSS data-driven, standards-based approach, with its emphasis on existing and emerging standards will ensure interoperability and ease of integration across the agricultural sector. It will bring together heterogeneous types of IoT devices and infrastructures – from field and plant sensors, weather stations, monitoring and control devices, actuators, and remote sensors, connected in various configurations present on the market today.

PRECIMED impacts

The main impact of PRECIMED is to improve the farm productivity through the reduction of costs and the increase of the crop yield with a solution that minimises the environmental impact due to the sustainable use of resources, and to reduce the human laborious tasks while feasible business models are generated for the different farming scenarios. PRECIMED is allowing the consortium to reach a useful system, tested, and validated by supporting farmers in the different participating countries, and therefore to reduce the gap between application developers and agricultural players. PRECIMED is also creating stronger bridges between the two shores of the Mediterranean basin, which is composed of EU and non-EU countries.

PRECIMED aims to lead the Digital Transformation of the European Agri-Food Sector based on the rapid adoption of advanced IoT technologies, data science and smart irrigation assuring the viability and sustainability of the sector long term. Uncertainty regarding which technology and standards should be applied act as a barrier to IoT adoption and any envisaged domain services within the agricultural domain. PRECIMED gravitates towards accessibility and value generation of open data and analytics to ensure across the sector to support new business opportunities for a viable and sustainable agriculture industry. PRECIMED considers an essential building block of impact will be to ensure that data is available to those who can create a value from it. PRECIMED will impact a range of stakeholder groups along the agro-food ecosystem: farmers, businesses, citizens/society, public authorities, and external communities, from the EU Mediterranean and non-EU Mediterranean countries, to build capacity and support innovation in precision irrigated agriculture. PRECIMED is formulated to present a professional irrigation scheduling expert system (soil and plant sensors) associated to a set of results coming up from real case studies on fruit trees and hydroponic crops.

PRECIMED Development-Implementation of a new DSS

The project began in October 2019 and is currently in its last year. First, PRECIMED focused its approach on the selection of the pilot farms available in the four countries belonging to the consortium (Spain, Greece, Tunisia, and Algeria) (Table 1). For this, the necessary requirements of the experimental plots under study were identified, the management of fertigation in the context of existing climate change was analyzed and an intensive review of the previous scientific results obtained in works and projects of I+D+I related to agricultural conditions in the Mediterranean Region was carried out. In this way we could know the challenges to consider in the design of the DSS and define the most appropriate system for each one of the pilot farms included in the evaluation, as well as the type and number of sensors necessary for precise irrigation management in each case study.

Table 1. PRECIMED farming scenarios

Country	Farming scenario	Crop	Localization
Greece (UTH)	Farming scenario 1	Cucumbers	Larissa, Greece
	Farming scenario 2	Tomatoes	Volos, Greece
Algeria (INRAA)	Farming scenario 1	Citrus	Algiers (humid area), Algeria
	Farming scenario 2	Potatoes	Tiaret región (semiarid area), Algeria
Spain (CSIC)	Farming scenario 1	Pomegranate trees	Murcia (semiarid area), Spain
	Farming scenario 2	Pear trees	Murcia (semiarid area), Spain
Tunisia (OPTIM)	Farming scenario 1	Olive trees	Tunisia

Once the pilot farms were selected in each of the participating countries, the climate, plant and soil sensors in the crops were deployed and connected to an IoT platform. Specifically, in some open field farms, volumetric humidity probes were installed that provide temperature, humidity, and electrical conductivity of the soil which, thanks to the use of CPS gateways with LPWAN wireless communication, were connected to the IoT platform developed and deployed by ODINS. This platform takes advantage of the BigData models that are identified in greenhouse and open fields. In the case of greenhouse has been identified a model in which, based on inputs, such as temperature, solar radiation, irrigation volume and drainage volume that generally are readily available inputs to growers and advisors we obtain the simulate fraction of intercepted PAR from thermal time, the crop total dry matter accumulation, the critical crop nutrient content uptake, the evapotranspiration, and recommendations for the nutrient solution in the PRECIMED DSS. In open field, in addition to predictive models based on soil moisture and climate data, a model exclusively on soil moisture measurements obtained from capacitive sensors is being validated, which is also connected to the platform.

The deployment and validation of PRECIMED DSS prototypes in the different scenarios is underway. We aim to evaluate a wide range of crops to build successful showcases for the Mediterranean area that will be fully functional and may encourage business opportunities in the exploitation of project results. For it, PRECIMED is developing an innovative business model called Software as a Service. This software uses recent web technologies adapted to any mobile devices that allow the application access by end-users from anywhere with Internet using mobile phones, tablets and PCs.

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