

Deliverable

Project Acronym: PRECIMED

Project full Name: Precision Irrigation Management to Improve Water and Nutrient Use Efficiency in the Mediterranean Region

1st Annual EC report

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Summary

This report aims to review the tasks that are being carried out in these first twelve months. As described in detail in the following sections, the project is being implemented correctly with some changes due to the situation the world is suffering from the pandemic and some other changes that do not affect the proposed objectives. The consortium is in continuous contact and two meetings have been held for the sharing of all the progress and decision making.

1. Explanation of the work carried out by the beneficiaries and Overview of the progress

1.1 Objectives

PRECIMED project will research, develop and validate a Standards-based Decision Support System (DSS) including Irrigation/Fertirrigation Models for a massive analysis of real-time crop and meteorological status data to improve the efficient use of water, nutrients and energy. For this, the consortium will integrate the knowledge on fertilizers and irrigation of Mediterranean crops with innovative information and communication technologies (ICTs) to develop a solution that will be respectful with the environment and economically profitable. In the PRECIMED project, the DSS will be developed for the end user that can easily access and manage water and fertilizers through web interfaces from anywhere with an Internet connection using their mobile phones, tablets or PC. The DSS platform will be able to collect a large amount of crop and environmental data, which will be processed and analyzed in order to provide recommendations in real-time to farmers regarding the best irrigation and fertilization practices. The DSS will offer management services and remote actuations to improve the lives of Mediterranean farmers and also save water and fertilizers in a region with significant problems of water stress and soil pollution. The challenge is to create stronger bridges between the two areas of the Mediterranean basin, which is made up of EU and non-EU countries: Tunisia, Algeria, Spain and Greece. In this sense, the consortium is made up of SMEs, research centers and end users that will collaborate to validate the solution for subsequent commercialization.

The main objectives are presented in table 1.

Table 1: PRECIMED project objectives

Objective number	Measurability	WP	Period for accomplishment					
			M6	M12	M18	M24	M30	M36
O1	To Improve Water and Nutrient Use Efficiency (WUE and NUE) in the Mediterranean Region by using intensive ICT solutions	2,3,4,5	X	X	X	X	X	X
O2	To facilitate the interchange of technology and best goods practices between EU and non-EU Mediterranean countries in order to improve the water and nutrient use efficiency in all the Mediterranean Region	2	X	X	X	X	X	X
O3	To develop and validate (in different demonstration farms) a Standards-based Decision Support System for data-driven irrigation/fertilization management that evaluates the medium-term evolution of crop nutritional status, soil salinity, yield and fruit quality and safety, optimizing the water and fertilizers needs and the energy costs at farm level.	3,4	X	X	X	X	X	X
O4	To ensure that the project activities and outcomes reach the relevant target groups , especially end-users (farmers), thus enhancing the market uptake of PRECIMED's solutions.	5	X	X	X	X	X	X

1.2 Explanation of the work carried per WP

The activities to be carried out during the project have been carefully designed to achieve the project goals and most importantly, to deliver maximum socioeconomic impacts, transfer of knowledge, and deal with challenges in the agricultural sector. PRECIMED project is organized in 5 work packages.

1.2.1 WP1 Project Management

The aim of WP1 is to enable an efficient coordination and guide the project partners for achieving the overall project objectives while following the directives set by the EC in the PRIMA grant agreement and the consortium regulation provisions set by the consortium agreement.

The WP leader is CSIC

T1.1 Team and project coordination.

A general coordination has been proposed with the objective to, effectively, coordinate the project. This includes the project management by the Project Coordinator (PC), assuring technical coordination on the level of subproject leaders, assuring interaction between the different WPs and the quality of intermediate project results. Furthermore, this coordination also covers tasks such as, the preparation, organization, administration, minutes and follow-up of scheduled meetings:

- Management of the consortium: legal, contractual, ethical and administrative matters.
- Organization of the Kick-off meeting (19/11/2019) and First year annual meeting (15/10/2020).
- Perform day-to-day management as efficient administrative support
- Overall management and coordination of the project, ensuring that the project stays focused and that there is a good cooperation and coordination between all work packages.

All communication with the PRIMA Secretariat has been performed by the PC. The PC is running the day-to-day project coordination with the support of the PMT (Project Management Team).

Within this task, during the first year of the project, deliverables 'D1.1 Project Management Procedure' and 'D1.2 Quality Assurance Plan' has been revised and submitted by the PC to the PRIMA Secretariat via PRECIMED Smartsheet, and distributed among the consortium partners. The PC with the support of PMT has been actively involved with all management and technical parts with respect to the submissions of the deliverables.

T1.2 Management of activities between the consortium members

This task is led by the Quality manager (QM), and the activities are:

- Development of a Quality Assurance Plan (QAP). This has been reflected in the deliverable D1.2
- Quality monitoring of the execution of WPs and tasks.
- Managing any quality issue with respect to the project and establishing actions (preventive or corrective) when necessary

T1.3 Project Progress reports's technical coordination

This task comprises the technical coordination at project level, supervising all the deliverables carried out during this year and the flow of technical information.

T1.4 Financial and Administrative coordination CSIC

In this project there is no financial coordination by CSIC, as each partner is funded directly by its own national funding agency. It is therefore up to each partner to meet the financial objectives set out in the project for each year and for each task. Each partner will be responsible for the justification with its own country entity as appropriate. The Administrative Manager is in charge of the necessary actions for the achievement of a fair and effective internal administration within the consortium to meet EC requirements. In this sense, the actions carried out during the first year have been:

- Designing and maintaining partner specific templates for the deliverables and the presentation of the meetings.
- Implementing and maintaining the internal platform (dropbox) for information exchange and email lists.
- Administrative support to all partners on an individual level for any needs that may arise.

This first year the coordinator had to communicate with the Project Officer to request changes in delivery dates and other issues that arise in the day-to-day running of the project.

1.2.2 WP2 Establishment of end-user's requirements

The aim of WP2 is to establish what are the characteristics and issues related to the agricultural crop production in the Mediterranean basin and the requirements that must be recognized.

The WP Leader is UTH

T2.1 Identification of farmers participating in the project and establishment of experimental approach in the pilot farms.

The assessment of pilot farms for the design of the PRECIMED DSS has been focused, by identifying the requirements of the farms and the farmers, analyzing nutrients' and water availability management in the context of climate change, taking into account the impact of irrigation technologies on the productivity of water and fertilizers use efficiency, and defining the most interesting system suitable for each one of the pilot farms

included in the assessment, concerning the type and the number of sensors required to manage water and fertilizers in each case study.

To carry out this task, meetings at the start of the project have been held with the owners of the farms where the pilot farms are installed, cooperatives and agricultural players based in the Mediterranean basin with the main characteristics of erratic rainfall, mild temperatures, irregular topography, and nearness to large water bodies. In this area, farming is intensive, highly specialized, and varied in the kind of crops raised. PRECIMED will develop the pilot activities in the main Mediterranean farm types (orchard/vegetables/fruits trees/viticulture and greenhouse/open fields farming) counting with farmers from the design phase with different size, soil, and climate conditions of holdings. Farmers need to improve the holdings' resource efficiency.

The most important requirements identified in the pilot farms are the following:

- Need a weather station in each pilot farm for the monitoring of climate conditions (air temperature and relative humidity, solar radiation, leaf wetness and cloud coverage in all cases. Additionally, rainfall, wind speed and ETo are required in open field).
- Need devices for the monitoring of soil water content. In addition, soil parameters as soil water content at field capacity and at permanent wilting point, the total availability water and the readily availability water, the hydraulic conductivity, soil texture, rooting depth, electrical conductivity, pH, etc.
- Improving the application rates and the timing of fertilizers.
- Defining an irrigation scheduling program for field crops and crops in greenhouses.

T2.2 Analysis of nutrients and water availability and management in the context of climate change.

An intensive review of previous scientific results and information obtained from previous R&D work and related projects on agricultural conditions in the Mediterranean Region has been carried out. In this sense, the following factors have been taken into account: soil, substrate, plant material, atmosphere, water resources and quality (surface water, underground resources, etc..), irrigation systems (agronomic design, application efficiency and distribution uniformity), irrigation-related performances (irrigation scheduling, failures in the irrigation system, economic losses, water use efficiency, etc..) and fertilizers application. So we get to know the challenges to be considered in PRECIMED DSS.

In the frame of this task and Deliverable 2.2, WP2 leader has proposed to contact an Editor for the development of a special issue in a scientific Journal. All partners will be then able to submit a manuscript for peer review and the synthesis of the manuscripts will be D2.2. Although this deliverable will be elaborated and presented at the end of the project (M36), during this year the partners have presented a summary of our future work. Also, the following three scientific papers in scientific journals have been published to date:

- Nikolaou, G., Neocleous, D., Kitta, E., Katsoulas, N., 2020. Implementing sustainable irrigation in water-scarce regions under the impact of climate change. *Agronomy*, 10(8):1120. <https://doi.org/10.3390/agronomy10081120>
- Nikolaou, G., Neocleous, D., Kitta, E., Katsoulas, N., 2021. Advances in irrigation /fertigation techniques in greenhouse soilless culture systems. *Advances in horticultural soilless culture* (ed. Prof Nazim Gruda, University of Bonn, Germany). ISBN (pdf): 978-1-78676-438-6.
- Bañón, S., Ochoa, B., Bañón, D., Ortuño, M.F., Sánchez-Blanco, M.J. 2020. Assessment of the Combined Effect of Temperature and Salinity on the Outputs of Soil Dielectric Sensors in Coconut Fiber. *Sustainability* 2020, 12, 6577; doi:10.3390/su12166577.

1.2.3 WP3 Decision Support System Development

The aim of WP3 is to perform the Decision Support System development. The goal of these activities is to deliver a demonstration prototype at the end of the project that fits perfectly the farmers needs assessed throughout the project.

The WP Leader is ODIN

T3.1 Design and Development of IoT-data management platform with cost-effective devices for optimized irrigation scheduling.

This task addresses the cost-effective data acquisition and remote actuation with wireless gateways connected to an IoT-standards-based platform through Internet. The task leads to develop a FIWARE-based platform supporting edge/cloud computing and the integration of three subsystems (i.e. data acquisition, data processing and end-users services) in the context of precise irrigation and fertilization. Moreover, the FIWARE-based platform employs standardized IoT-data protocols (i.e. MQTT, REST and NGSI) to facilitate the acquisition, integration and exchange of massive data with CPS gateways and also BigData techniques that will be provided in T3.3.

Currently, climate, soil and plant sensors are deployed and connected with CPS gateways with wireless LPWAN communication developed. Indices derived from these sensors are being considered to be integrated in the platform. Concerning climate parameters, in the case of greenhouses (UTH and INRAA), air temperature, relative humidity, solar radiation and vapour pressure deficit (VPD) are considered to be integrated in the platform. In addition to these, the cloud coverage, rainfall, the wind speed and ETo are also considered for open field scenarios. From soil sensors, humidity and the electrical conductivity (EC) of the substrate and soil are indices of importance. Concerning the indices related to the crop, transpiration of the plants, root and leaves temperatures and leaf wetness must be taken into account in greenhouse climate and fertigation control. Furthermore, it is a matter of major importance for the indices of the quantity – expressed as a percentage concerning the amount of nutrient solution given to the crop – and the EC of the runoff to be included in the DSS.

All the CPS gateways are connected to the platform thanks to the use of lightweight protocols such as 6LoWPAN and LP-WAN technologies (Low-Power Wide Area Network). In this architecture, low level operations that require minimum latency and high reliability in the communication with legacy sensors/actuators will be executed at CPS gateways. The intermediate management level is the edge computing plane, which will include a set of NFV-powered monitoring and control modules in charge of orchestrating the CPS gateways in the same crop. At this layer, data fusion and aggregation is carried out to offload BigData analytics performed in the cloud. The edge plane will enable the cloud part of the DSS platform to serve multitude of heterogeneous crops. The edge control modules are virtualised through NFV techniques that allow their instantiation at the field or at the cloud. These modules communicate with CPS gateways using IoT communication protocols such as MQTT or CoAP. MQTT is especially considered, given that it is more addressed to the management of industrial processes, however, CoAP is also supported for particular non-critical monitoring tasks not involving control.

An IoT system for the data transfer from UTH to ODIN has been developed (www.precimed.eu).

T3.2 (Models to determine fertirrigation management in greenhouse and in open air.

Data recorded in the field and in the greenhouses related to soil and crop status and the weather forecast (see task 3.1.) is used to develop irrigation/fertilization scheduling models with the goal to develop an optimum

irrigation/fertilization scheduling programs to improve water and fertilizers use efficiency. In this sense, a group of equations needed for the models to be developed has been organized and the integrated models for enhancing irrigation and fertilization in both open air and greenhouses are being developed.

1.2.4 WP4 Validation and Demo of Decision Support System

The aim of WP4 is to test the PRECIMED performance in field conditions to evaluate its performance and versatility for different agricultural conditions, and to see the aspects that can be improved so that the precision irrigation is more accurate.

The WP Leader is OPTIM. This WP starts on M13 so is out of the scope of this deliverable.

1.2.5 WP5 Communication, Dissemination and Exploitation

The aim of WP5 is to increase the impact of the project through the wide dissemination of project outcomes. Communication activities will also actively support the involvement of end-users in particular for iterative design and development process and business model formulation

The WP Leader is INRAA

T5.1 Communication and Dissemination activities

The following communication and dissemination actions have been carried out during the first year:

- Design the logo of the project (INRAA).
- Design the official website for the PRECIMED project (INRAA). So far, the official registration of the sub domain name is: <https://www.precimed.inraa.dz>, nevertheless the consortium agreed to change this subdomain to <https://www.precimed.org>
- Create a social medias and update (Facebook) (UTH)
- Create a Forum (LinkedIn) (UTH)
- Leaflet for the Project (UTH)
- Two Newsletters for the Project (UTH)
- Workshops

In the frame of this tasks, the two following deliverables have been delivered this year:

- D5.1 Communication and Dissemination Plan. This deliverable focuses on the development of a dissemination strategy, including the design and production of necessary material, the development of communication tools (logo, website, social media, LinkedIn, Brochures, newsletters, leaflets, posters and Banners) and the organisation and implementation of various communication activities (main events).
- D5.2 Data Management Plan. This deliverable focuses on how to manage the data and information created during the project, in order to describe all procedures for keeping and disseminating PRECIMED results.

1.3 Impact

The main impact foreseen by 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 (water, fertilizers and energy consumption) and reduce the human laborious tasks while feasible business models are generated for the different farming scenarios.

In this first year of the project there are no defined indicators to analyse the impact of the project. The impact will be analysed at the end of the project as set out in the proposal. Nevertheless, it could be noted that the consortium is interacting with the relevant stakeholders from the very beginning in order to aid in the Digital Transformation of the European Agri-Food Sector based on the rapid adoption of advanced IoT technologies, data science and smart irrigation. The farm digitalisation started already in the pilot farms where sensors and IoT devices are installed to transfer in real time data to PRECIMED platform so that the process of data analysis and decision support is effectively developed. In this way PRECIMED will impact a range of stakeholder groups along the agro-food ecosystem: farmers, businesses, citizens/society, public authorities and external communities.

In the frame of PRECIMED, 7 pilots are already deployed and 9 stakeholders are engaged. In addition, 10 direct employments have taken place already Update of the plan for exploitation and dissemination of result (if applicable).

This section is not applicable in this report of the first year of the project development. It will be taken into account in future annual reports.

2. Update of the plan for exploitation and dissemination of result (if applicable)

This section is not applicable in this report of the first year of the project development. It will be taken into account in future annual reports.

3. Update of the data management plan (if applicable)

During this first year of the project, no cases have been identified that are subject to changes in the management plan.

4. Follow-up of recommendations and comments from previous review(s) (if applicable)

During the period covered by this report, no comments or reviews have been received from the official bodies overseeing the implementation of the project. This section will be applicable in future reports.

5. Deviations from the proposal submitted (if applicable)

Some partners have exposed some deliverables should be delayed and other changes from the proposal.

5.1 Tasks

Deviations due to COVID-19 pandemic:

- A first draft of the deliverable D2.1 is already available between the partners and thus the work related to the relevant WPs can continue without significant effects. In addition, a first draft of D3.2 is planned to be delivered on-time so that all relevant deliverables that need D3.2 as input will continue working. However, due to the limitations forced for the restriction of the COVID-19 pandemic, complete interaction with stakeholders is restricted and delayed. In addition, the different meetings planned to

be held between the owners of the farms where the pilots will be installed and the development team are also restricted and delayed. The above restrictions affected the delivery of D2.1. Furthermore, due to the restrictions forced especially to the Public Organizations and Universities participating in the consortium and the force for application of work from distance, the employment of new personnel was delayed. The above restrictions affected the delivery of all the above mentioned deliverables for which an extension is requested. PRIMA accepted the extension requested and the delivery date of the final versions of D2.1 is M22 and of D3.2 is M24.

- A first draft of D5.3 is already available between the partners and to PRIMA if needed for preliminary submission. However, we request the extension in order to consider alternative Dissemination and Exploitation plans, which will take into account the restrictions imposed by the COVID-19 pandemic and the measures taken for its control. Thus, in the final deliverable, we would like to present potential mitigation measures that will be taken in order to present a complete plan that could be compatible with the restrictions due to COVID-19 and will present more alternative strategies. Finally, it has to be noted that more or less, all partners faced the restrictions imposed by the pandemic, which causes some delays in the implementation of the project activities. Thus, priority has been given to field/experimental and modelling activities which are important to be completed as they will be used as input in the next steps of the project. PRIMA accepted the extension requested and the delivery date of the final version of D5.3 is M22.

5.2 Use of resources

Deviations on the pilot farms:

- The farming scenario 4 will be tested in UTH pilot greenhouse instead in the greenhouse described in the proposal since it is not operational anymore.
- INRAA change in their pilot farm 2, adding a glass greenhouse dedicated to the hydroponic production of potato seeds.
- CSIC has changed the crops that were indicated in the initial proposal. At present, pomegranate and pear trees will be worked on in the field.
- OPTIM have had to discard the proposed pilot farm, as it is located in a lockdown region (due to COVID-19) and talked about the problems finding another pilot farm with similar characteristics, due to limitations forced for the restriction of the pandemic.

Other deviations:

- INRAA specified that it's possible to use other soil water sensors (not available currently at his level) for an online access like the use of Drill and Drop system for the measurements of soil water content, soil temperature and salinity.
- The delivery dates of some of the deliverables referred in table 3.1c of the proposal are wrong. The correct delivery dates are those referred in table 3.1b of the proposal.
- Deliverable's "due dates" of WP2 in the table that summarizes all of them in the original proposal are incorrect (not in the rest of the proposal).
- Due to the pandemic, the annual consortium meeting scheduled to take place in Greece has had to be held virtually.

5.2.1 Unforeseen subcontracting (if applicable)

Not applicable for this first year of the project

5.2.2 Unforeseen use of in-kind contribution from third party against payment or free of charges (if applicable)

Not applicable for this first year of the project.