

INNOVATIVE GREENHOUSE SUPPORT SYSTEM IN THE MEDITERRANEAN REGION: EFFICIENT FERTIGATION AND PEST MANAGEMENT THROUGH IOT BASED CLIMATE CONTROL — IGUESSMED

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Deliverable 5.8. Training courses

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D5.8 – Training courses

Abstract

The objective of this deliverable is to collect information about the training courses held in the project. This deliverable is a part of Task 5.2 Demo and dissemination of iGUESS-MED support system performance. The aim of this task was to demonstrate the innovations, technical requirements and results achieved by the iGUESS-MED project to interested end users and stakeholders in the field.

The deliverable is divided into four chapters covering the training courses held in each country. A total of 10 training courses were held, divided into 2 training courses in Spain, Italy, and Turkey, and 4 in Tunisia. The training courses were attended by growers, technical advisors, agricultural vocational training students, technology companies, researchers, computer scientists, agritech start-ups, agronomy students.

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1 Introduction



The iGUESS-MED project aims to develop a Decision Support System (DSS) able to effectively manage fertigation and prevent plant diseases and pests in tomato crops grown in soil and soilless in commercial greenhouses of the Mediterranean region. This innovative greenhouse DSS will be developed to (i) help greenhouse farmers to improve the management of fertigation in areas with low (saline) quality waters (ii) to reduce the use of chemicals by a sustainable and integrated pest and disease control and (iii) to improve the climatic efficiency in the existent greenhouse by low-cost climate actions. The DSS will allow obtaining healthier and higher quality productions and higher yields, while reducing water use and the loss of nutrients and chemicals to the environment. iGUESS-MED will be able to manage efficient fertigation, to forecast diseases and pests, and improve the climatic efficiency in tomato greenhouses, using only climate data acquisition and basic information on cropping systems. The DSS will provide feedbacks and alerts about crop needs and real-time recommendations to the farmers through friendly portable real-time data visualization tools as PC, tablets or smartphones. To achieve this objective, new models for calculating crop evapotranspiration will be performed by integrating sensor data from plant, soil, and climate, and forecasting models for assessing disease and pest risks will be developed by using Integrated Pest Management.

The project consortium (research centers, SMEs, and end-users of EU and non-EU countries belonging to the Mediterranean basin) will collaborate from the beginning to make the DSS marketable involving, end-users and stakeholders to validate the system in own greenhouses, reducing gaps between research, application developers and farmers. The application of DSS will benefit the workers and the consumers, providing better working conditions, crop healthiness and reduction of environmental impact.

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1.1 Summary of the deliverable

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The deliverable is divided into four chapters, each one covering the open days held in each country.

The target for this deliverable was to organize at least eight training courses, two per country, while the total training courses organized at the end of project were ten. During these training courses, the viability and potential of iGUESS-MED was demonstrated, and its adoption was promoted.

The audience for the training courses was broad and diverse, including growers, technical advisors, agricultural students, technology companies, researchers, computer scientists, agritech start-ups, and agricultural vocational training students.

2 Training courses held in Spain



2.1 Use of iGUESS-MED DSS for the irrigation and fertilization recommendations for greenhouse tomato crops.

Date: 17/05/2023

Location: Anecoop farm, Almería, Spain

Type of audience: Agricultural vocational training students

Number of attendees: 51

Highlights:

The University of Almeria (UAL), in collaboration with the Group CAJAMAR Foundation, organised a training course to show the use of the iGUESS-MED DSS for irrigation and fertilisation recommendations in greenhouse tomato crops. The event was aimed at the students of the Escuela Agraria Vícar, the largest agricultural vocational training centre in Almería.

After visiting the pilot farm where iGUESS-MED DSS was tested, the students attended a training course on the use of the iGUESS-MED DSS as a tool to recommend irrigation and fertigation of a greenhouse tomato crop. The training course was run by Dra. María Dolores Fernández (CAJAMAR) and Prof. Marisa Gallardo (UAL). María Dolores Fernández talked about irrigation management with the iGUESS-MED DSS whereas Marisa Gallardo's talk focused on the management of fertigation nutrient solution concentration by using the DSS.

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Link: <https://drive.google.com/file/d/1920M5ITh6KcCV8lnFQvyXrU1pHBlj9gZ/view?usp=sharing>

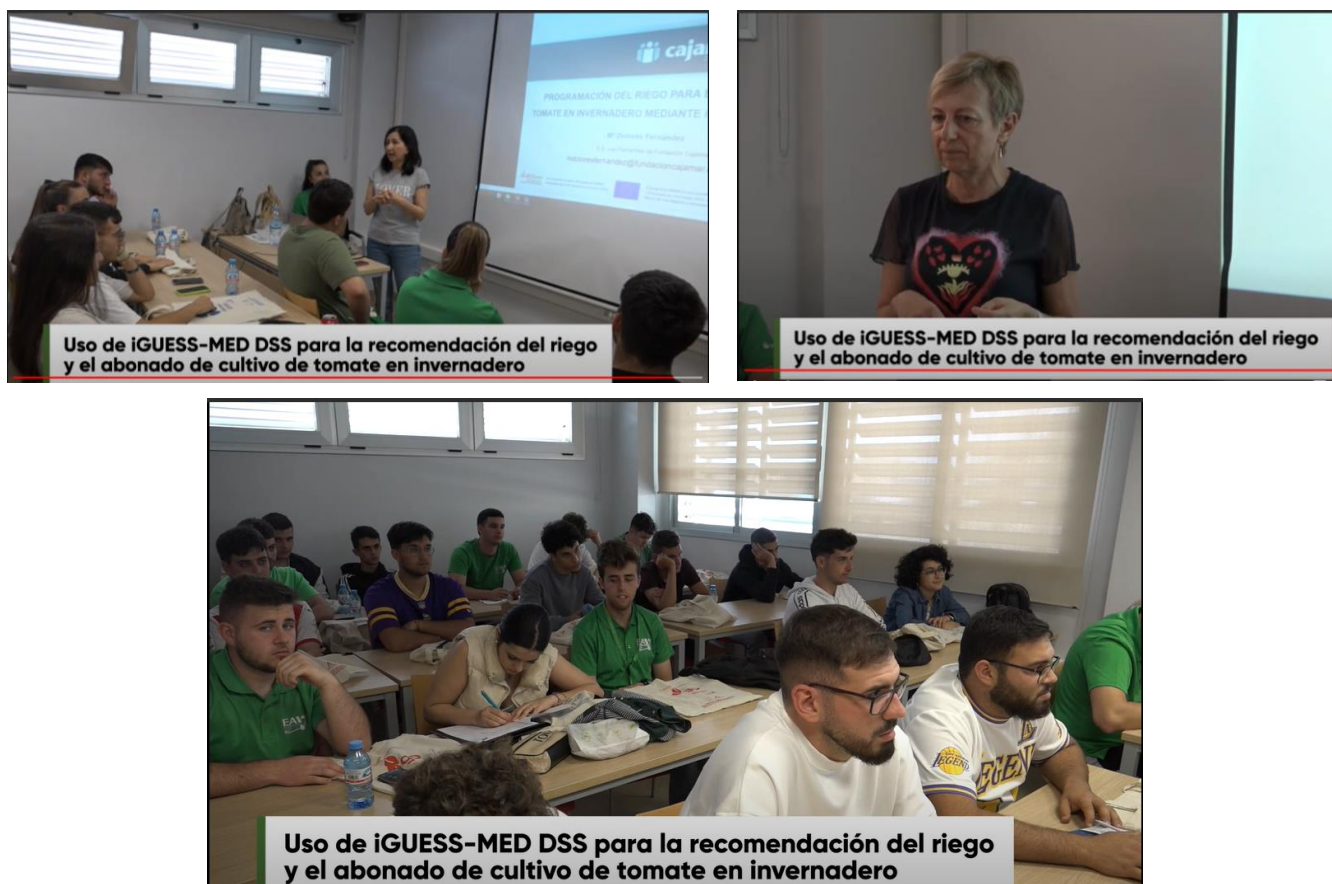


Figure 1: Training course held on 17/05/2023 at the Anecoop farm, Almeria (SP).

2.2 Efficient irrigation and fertilisation management of greenhouse tomato crops using iGUESS-MED DSS

Date: 26/04/2024

Location: Las Palmerillas Research Centre, Almería, Spain

Type of audience: Agricultural vocational training students

Number of attendees: 15

Highlights:

Students from the VÍCAR Agricultural Vocational School attended the course organized by the Group Cajamar Foundation in collaboration with the University of Almeria. In this event, the students learned about the models included in the iGUESS-MED DSS for providing irrigation and fertilization recommendations for greenhouse tomato crops.

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The irrigation dose calculation with the iGUESS-MED DSS was explained by M^a Dolores Fernández, while the fertigation nutrient concentration calculation with the iGUESS-MED DSS was shown by Jenifer Salinas. Francisco Padilla and Teresa Peña talked about the different monitoring tools, such as sap analysis and optical sensors, to determine the nutritional status of crops. At the end of the event, the students took part in a hands-on demonstration of the different monitoring tools.



Figure 2: Training course held on 26/04/2024 at the Las Palmerillas Research Centre, Group CAJAMAR Foundation, Almeria (SP).

3 Training courses held in Tunisia



3.1 Sensors used to optimize irrigation in greenhouses

Date: 02/06/2022

Location: CRRHAB, Chott-Mariem, Sousse, Tunisia

Type of audience: Students and professors from CIHEAM Bari (IT), and tunisian experts

Number of attendees: 18

Highlights:

In the framework of the iGUESS-MED project dissemination activities, the Regional Research Centre on Horticulture and Organic Agriculture (CRRHAB) organized a training course on June 2, 2022, for a team from CIHEAM Bari-Italy (students, professors) and Tunisian experts. The training course was focusing on the use of sensors and related monitoring devices to manage irrigation in greenhouses. A classroom session covering different methods of determining crop water requirements and the use of the decision support systems (DSS) for optimizing irrigation schedules was delivered by Imed BEN AISSA and Mohsen MANSOUR. The visitors were although introduced to the importance of using models and DSS to enhance water saving and irrigation efficiency in greenhouses. Then, they visited the the iGUESS-MED trial at the CRRHAB experimental station.

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Figure 3: Training session held on 02/06/2022 at CRRHAB, Chott Mariem-Sousse (TN).

3.2 Enhancing greenhouse irrigation management

Date: 16/06/2022

Location: CRRHAB, Chott-Mariem, Sousse, Tunisia

Type of audience: Agricultural vocational trainers

Number of attendees: 12

Highlights:

The CRRHAB organized a training session on June 16, 2022, focused on enhancing greenhouse irrigation management techniques. The training was designed for the benefit of a **group of trainers from various agriculture training Centers**. The aim was to present the different methods and equipment for best management and control of irrigation under greenhouses.

Led by Mohsen Mansour, the training included a comprehensive field visit to the project's trial plots. Trainers were introduced to various sensors installed in the greenhouse. They received detailed explanations on the operation and uses of these sensors for effective irrigation control. This was followed by a classroom session covering different methods of determining crop water requirements and the use of DSS for optimizing irrigation schedules.

By learning these trainers the latest irrigation management knowledge and tools, the iGUESS-MED project sought to disseminate this expertise to a wider network of agricultural professionals. This will ultimately enhance sustainable water usage and crop productivity in greenhouse operations across the region.

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Figure 4. Training course held on 16/06/2022 at CRRHAB, Chott Mariem-Sousse (TN) to agronomic trainers.

3.3 The use of sensors to manage irrigation in greenhouses

Date: 12/12/2022

Location: CRRHAB, Chott-Mariem, Sousse, Tunisia

Type of audience: Graduation-year Engineer students (Engineering of Horticultural Systems speciality)

Number of attendees: 13

Highlights:

The CRRHAB) organized an on-field training course on December 12, 2022, focused on the use of sensors and related monitoring devices to manage irrigation in greenhouse cropping systems. The training was designed for the benefit of engineer students in their graduation year (Horticultural Systems Engineering Speciality) belonging to the Higher Agricultural Institute of Chott-Mariem (ISA-CM).

Led by Imed BEN AISSA, demonstrated to the students the various sensors installed in the greenhouse and the climate station. He explained them the use and the operation of these different sensors and devices to schedule and manage irrigation in the greenhouse. The students were although introduced about the importance of using models and DSS to enhance water saving and irrigation efficiency in greenhouse cropping systems and about the targeted goals of the esompted the iGUESS-MED DSS.

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Figure 5: Training session held on 12/12/2022 at CRRHAB, Chott Mariem-Sousse (TN) to engineer students belonging to the Higher Agricultural Institute of Chott-Mariem (ISA-CM).

3.4 Training session on iGUESS-MED integrated pest management protocols

Date: 13/12/2023

Location: “Maison de l’oasis”, Gabes, Tunisia

Type of audience: engineers, technicians, and qualified workers

Number of attendees: 20

Highlights:

CRRHAB organized a training course about insect and pest management in tomato greenhouses developed within the iGUESS-MED project for engineers, technicians, and qualified workers of demopilot commercial greenhouse “Maison de l’Oasis”, a Tunisian-Dutch tomato exporting company. Prof. Asma Laarif presented a summary of the iGUESS-MED project to the participants and then explained the principles and components of iGUESS-MED integrated pest management program. Then, Dr. Thameur presented the main tomato insect pests and the means of their control. Subsequently, samples of tomato leaves and fruits were shown to the participants to know the symptoms of the beginning attacks and how intervene in time. Certificates of participation were distributed to the participants.

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Figure 6: Training course held on 13/12/2023 at “Maison de l’oasis” (Tunisian-Dutch tomato exporting company), Gabes (TN).

4 Training courses held in Italy



4.1 Training course of iGUESS-MED project at CREA, Pontecagnano (IT).

Date: 12/07/2023

Location: Pontecagnano-Faiano (SA), Italy

Type of audience: Agronomists, technicians, growers, university Phd students and researchers

Number of attendees: 66. In presence and online

Highlights:

From 14:30 till 19:00 p.m. of 12 July, a training course was organized by CREA (Research Centre for Vegetable and Ornamental Crops Council for Agricultural Research and Economics), to present the user manuals of the protocols, models and softwares involved in iGUESSMED Decision Support System. The event was aimed at technicians, agronomist, and growers of Salerno province (high concentration of protected crops), and for this main reason presentations were made in Italian. University students and researchers were also present in the audience.

After a brief introduction explanation of the iGUESS-MED project by Dr. Alejandra Navarro Garcia, coordinator of iGUESSMED, training course presentations in Italian started as follow:

- “Protocolli dedicati per prevedere l'insorgenza di patologie e parassiti, aumentando i livelli di controllo biologico nelle coltivazioni di pomodoro delle serre mediterranee”

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This session consisted in 3 presentations, first one regarding tomato diseases, IDM, and biocontrol titled: “Protocolli dedicati per prevedere l'insorgenza di patologie e parassiti, aumentando i livelli di controllo biologico nelle coltivazioni di pomodoro delle serre mediterranee” by Dr. Catello Pane (CREA). After this, two presentations regarding tomato pest, IPM, biocontrol, and climate influence in IPM, where Dr. Marco Mosti (BIOPLANET) and Dr. Valeria Zeni (UNIFI) presented “Integrated Pest Management protocols” and finally Dr. Asma Laarif and Dr. Thameur Bouslama (CRRHAB) presented “The importance of climatic parameters in integrated pest management.”

- “Gestione efficiente della fertirrigazione nelle coltivazioni di pomodoro IN SUOLO delle serre mediterranee attraverso i software VEGSYST (nutrizione) e PrHo (Irrigazione)”

Here were shown and explained the models to determine precise irrigation and nutrition management in low-tech MED greenhouses with conventional and low-quality waters in soil systems. VEGSYST user manual (nutrition) was presented by Prof. Marisa Gallardo (UAL) and PrHo (irrigation) user manual by Dr. Maria Dolores Fernández (CAJAMAR).

- “Gestione efficiente della fertirrigazione nelle coltivazioni di pomodoro in FUORI SUOLO nelle serre mediterranee attraverso il software SIMULHYDRO”

In the third session, SIMULHYDRO user manual was presented by Prof. Luca Incrocci (UNIFI) and Dr. Daniele Massa (CREA-OF) to explain soilless cultivation and the models used to determine precise fertigation (nutrition and irrigation) management in low-tech MED greenhouses with conventional and low-quality waters in soilless systems.

- “Semplici interventi per migliorare il clima nella serra mediterranea”

The last presentation was made by Dr. Esteban Baeza (FUTURE FARM Solutions) and Prof. Luca Incrocci (UNIFI) dealing the greenhouse climate control by adding small modifications or improving existing techniques in the MED greenhouses.



Figure 7: General views of attendees in presence and online in the lecture hall of CREA at Pontecagnano (SA), Italy.

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Figure 8: Session dedicated to tomato pests and diseases, biocontrol and integrated disease and pest management. Dr. Catello Pane (CREA), Dr. Marco Mosti (BIOPLANET), Dr. Valeria Zeni (UNIFI), and finally Dr. Asma Laarif and Dr. Thameur Bouslama (CRRHAB).



Figure 9: Dr. Maria Dolores Fernández (CAJAMAR) and Prof. Marisa Gallardo (UAL), during the presentations of VEGSYST and PrHo user manuals.

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Figure 10: Prof. Luca Incrocci (UNIFI) during the presentation of SIMULHYDRO user manual and Dr. Esteban Baeza (FUTURE FARM Solutions) presenting greenhouse climate control by adding small modifications in the MED greenhouses.

4.2 Training course on iGUESS-MED DSS held at the Association of Producer Organizations “C.S.C.” at Fondi (IT).

Date: 05/07/2024

Location: Association of Producer Organizations “C.S.C.” at Fondi (province of Latina, Lazio, Italy).

Type of audience: Growers, stakeholders, agronomists,

Number of attendees: 20 in presence

Highlights:

On the afternoon of 5th July 2024, a training course was held at the Association of Producer Organisations "C.S.C." at Fondi (province of Latina, Lazio, Italy), in collaboration with the EVJA, University of Pisa and CREA - Vegetable and Ornamental Crops.

In the afternoon, from 14:30 to 17:00, a training course on the practical utilization of the iGUESS-MED PRIMA DSS was held. Dr. Simone Scarpa and Dr. Paolo Iasevoli (EVJA) presented an overview of the dashboard of an OPI station, highlighting the climate graphs and the alert functionality. Dr. Catello Pane (CREA) explained the forecasting models developed for Botrytis and Alternaria diseases and illustrated how works the alert system in the DSS, Dr. Alejandra Navarro Garcia (CREA) showcased the output of the VEGSYS model applied to soil tomato cultivation, while Prof. Luca Incrocci (UNIFI) illustrated the outputs of the SIMULHYDRO model for a soilless tomato cultivation. Following the presentations, a discussion was held with the participants to address any remaining technical queries. The event was attended by 20 persons, most of them were agronomists, growers and stakeholders.

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Figure 11: Training course on the practical utilization of the iGUESS-MED DSS with the attendance of agronomists, growers and stakeholders held on 4/07/2024 at the Association of Producer Organisations "C.S.C." at Fondi (IT).

5 Training courses held in Turkey



5.1 Irrigation management in Mediterranean type low technology greenhouses.

Date: 10/08/2023

Location: Akdeniz University, Antalya, Turkey

Type of audience: Students

Number of attendees: 30

Highlights:

As part of the iGUESS-MED Project, the first training event was held on August 10, 2023, with the participation of undergraduate and graduate students. During the event, comprehensive information

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about the project was provided, and university greenhouses were visited. In these tours of Mediterranean-type low-tech greenhouses, detailed explanations were given on how irrigation and fertilization practices are carried out and how the amounts of water and fertilizer to be applied are determined. In addition, the sensors and devices used in the project were introduced, and information was provided on how decisions were made regarding irrigation timing and amounts.



Figure 12: First training event in the framework of the Iguess-MED project held on 10/08/2023 at the greenhouses of the Akdeniz University, Antalya Antalya (Turkey).

5.2 Introduction of models used for irrigation and fertilization, and presentation of the DSS.

Date: 09/08/2024

Location: Akdeniz University, Antalya

Type of audience: Growers, students

Number of attendees: 11

Highlights:

As part of the iGUESS-MED project, the second training event was held on August 9, 2024. The event was attended by undergraduate and postgraduate students, as well as technical staff involved in cultivation in the University's research greenhouses. During the training, comprehensive information was provided on the models used for irrigation management within the project, and a sample irrigation simulation was conducted using climatic data from inside the greenhouse.

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Figure 13: Second training event in the framework of the iGUESS-MED project held on 09/08/2024 at the Akdeniz University, Antalya (Turkey).

6 Conclusions



The viability and potential of iGUESS-MED DSS have been wide demonstrated and its adoption promoted in 10 training courses in all the belonging countries of the project. The target for this deliverable was to hold at least eight training courses, so all the KPIs proposed in the project have been met and achieved.

The training courses have increased the visibility of the project among growers, technical advisors, agricultural vocational training students, technology companies, researchers, computer scientists, agritech start-ups, and agronomy students.

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