

isUP-AgrO

WORK PACKAGE: 3

DELIVERABLE: D3.1 – Staff exchange vs. 1

Date: 31/08/2025



**Funded by
the European Union**

The project, isUP-AgrO (number 101159644), is funded by the European Union. Views and opinions expressed are, however, those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.

WORK PACKAGE	3
TASK	Task 3.2: Crop ecophysiology and abiotic stresses research techniques Task 3.3: Smart crops irrigation technologies and strategies
DUE DATE	M14
SUBMISSION DATE	31/08/2025 (M14)
DELIVERABLE LEAD	UNIPR
DISSEMINATION LEVEL	PU
DOCUMENT NATURE	<input checked="" type="checkbox"/> R-Report <input type="checkbox"/> O-Others
AUTHORS	Carla Ragonezi

Revision history

REVISION	DATE	AUTHOR	ORGANISATION	DESCRIPTION
V.0	12/08/2025	Gianni Galaverna, Carla Ragonezi	UNIPR UMa	Table of Contents
V.1	14/08/2025	Carla Gouveia	UMa	Draft
V.2	20/08/2025	Carla Gouveia	UMa	Complete Draft
V.3	28/08/2025	Ana Branco	SAT	Review
V4	29/09/2025	Enrique Fernández, Gianni Galaverna	CSIC-INRAS UNIPR	Final Review
V.5	31/08/2025	Carla Ragonezi	UMa	Final

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Executive Summary

The deliverable outlined the staff exchanges organized within the framework of WP3 of the isUP-AgrO project. Two staff exchanges, structured as a 14-day program of scheduled activities, were held at the Institute for Natural Resources and Agrobiological Sciences (IRNAS) in Seville, Spain. The training was conducted by a multidisciplinary team from IRNAS, coordinated by the ECOVER – Plant Ecophysiology and Irrigation Group, under the leadership of Dr. Enrique Fernández.

The first staff exchange, focused on Crop Ecophysiology and Abiotic Stress Research Techniques (Task 3.2), was implemented during two crop developmental phases to assess distinct morphological traits and plant growth responses across different periods of the year. The first session took place from **9 to 20 September 2024** and involved **3 participants from ISOplexis**. The second session was conducted from **24 March to 4 April 2025** and engaged an additional **3 participants from ISOplexis**.

The second staff exchange, dedicated to Smart Crop Irrigation Technologies and Strategies (Task 3.3), was carried out from **23 June to 4 July 2025**, with the participation of **2 ISOplexis researchers**.

These exchanges significantly enhanced the participants' scientific and technical expertise, reinforced collaborative networks with the IRNAS team, and established a strong foundation for the effective implementation of the subsequent research activities foreseen under WP6.

1. Introduction

The isUP-AgrO project aimed to establish ISOPlaxis as a center of excellence in agriculture through strategic twinning with leading research institutes in Italy and Spain, supported by an innovation expert to improve research management practices and foster sustainable development.

Within this framework, Work Package 3 – Staff Exchange – was designed to promote mobility and hands-on training, thereby strengthening ISOPlaxis staff with advanced knowledge and practical skills in agrosystems, agrodiversity, and bioresources for sustainable food production and resource management.

Work Package 3 (WP3) focused on promoting staff exchange among project participants to provide practical, hands-on training. Its primary objective was to strengthen the knowledge and skills of ISOPlaxis staff in key research domains, namely agrosystems, agrodiversity, and bioresources. These competencies supported sustainable food production and improved resource management. WP3 was designed to complement the theoretical training delivered under WP2 by enabling its application in real-world research environments.

The staff exchange (WP3) will operate alternately with the training schools (WP2), being the topics of both WPs complementary, aiming to deepen research knowledge and skill, improving the practical and research training of the ISOPlaxis team in specific topics, methodologies, and techniques. There have been early established or detected gaps during the execution of WP2. These interactions will be realized in Sevilla (Spain) and Parma (Italy), and supervised by each local partner, allowing ISOPlaxis researchers to have access to laboratory and field facilities, advanced equipment, and research platforms held by these institutions. As an outcome, we expect to get accelerated training in ISOPlaxis research in specific techniques and methodologies, making it possible to implement new research strategies related to agrodiversity and agrosystem studies in Madeira, during the research project.

This deliverable focuses on the staff exchanges performed during the first year

2. Staff exchange

3. Staff Exchange: Crop ecophysiology and abiotic stresses research techniques (Task 3.2)

Leader: IRNAS-CSIC

IRNAS-CSIC oversaw the staff exchanges, which took place in Seville, Spain. The trainers consisted of a multidisciplinary team from IRNAS, coordinated through the ECOVER – Plant Ecophysiology and Irrigation Group, under the leadership of Dr. Enrique Fernández.

Two staff exchanges were conducted within Task 3.2: the first in month 3 and the second in month 9, each lasting 14 days. The exchanges were scheduled during different phenological stages of crop development, allowing participants to study a variety of crops throughout the year.

Participants: ISOPlaxis-UMa

The program engaged **6 participants from ISOplexis, 3 in each phase**. Participants enhanced their knowledge and practical skills regarding the interaction of environmental factors—such as climate, nutrients, and water—with crop physiological processes. They received training in advanced tools and techniques employed in agricultural breeding programs related to crop development and productivity.

Scope/Description: The program focused on tools and methods that enabled participants to understand crop responses to water scarcity and the physiological processes and strategies involved in plant adaptation to stress. This was achieved through in-field screening (phenotyping) and crop quality evaluation. The staff exchanges coincided with different phenological stages, providing the opportunity to assess diverse morphological traits and behaviors throughout the growth cycle.

The program was highly interactive, with participants actively engaged throughout the training. It was structured to facilitate the transfer of knowledge and best practices, promote learning from shared experiences, and develop new practical skills.

The topics addressed included:

1. Field and laboratory deep phenotyping techniques.
2. Crop quality evaluation techniques.

3.1. 1st phase of the Staff Exchange to IRNAS, Seville, Spain (M3)

The first phase of the staff exchange comprised a structured agenda of activities, such as field visits and discussion sessions focused on crop ecophysiology and abiotic stress research techniques. This stage was carried out over 14 days, from **9 to 20 September 2024**.

The **trainers** were comprised of a multidisciplinary team from IRNAS, throughout the ECOVER Group, through the leading of **Enrique Fernández** (PhD in Agricultural Engineering, ECOVER Group leader, Director of IRNAS), and with **Antonio Diaz Espejo** (PhD in Biology, Senior Scientist), **Jaime Sebastian** (PhD in Forest Ecology and Management, Postdoctoral researcher), **José M. Torres Ruiz** (PhD in Biology, Senior Scientist), **Rafael Romero** (PhD in Systems Engineering and Automation, Senior Scientist), and **Virginia Hernandez** (PhD in Plant Ecophysiology, Senior Scientist).

ISOplexis team members who attended the staff exchange:

- **Fabricio Macedo** – Invited Researcher at ISOplexis, holding a PhD in Agronomy. Role: Remote Sensing and Agroclimatologist. Expertise: remote sensing and vegetation indices, biomass estimation, agricultural productivity, agroclimatology, genetic diversity, sustainability and ecological modeling, and geotechnologies applied to agriculture and natural resources.
- **Gregório Freitas** – Senior Technician at ISOplexis, holding a bachelor's degree in Biology. Role: Crop Supervisor/Evaluator. Expertise: prospecting, inventory, georeferencing, and characterization/agronomic evaluation of the germplasm collection based on specific descriptors.
- **Sofia Valente** – Research Fellow at ISOplexis, holding a master's degree in Applied Biochemistry. Role: Environmental Microbiologist specializing in Soil Biochemistry and Microbial Ecology. Expertise: environmental biochemistry, microbiological activity, physico-chemical and enzymatic activities of soil, and soil diversity and microbiota.

Staff exchange program:

Hour	Monday 9th	Tuesday	Wednesday	Thursday	Friday	Monday 16th	Tuesday	Wednesday	Thursday	Friday		
9 - 10	Arrival & Introduction to the IRNAS (E.F.)	Field trip to La Hampa research station (E.F.): monitoring eco-physiological and agronomic variables					Field trip to the Orán commercial orchard (E.F.)	Field trip to La Hampa (V.H.): Role of turgor pressure in plant growth limitation in response to water deficit: implications for irrigation management	Chat on Irrig. Scheduling (E.F.)			
10 - 11						Chat on Plant hydraulics (J.M.T.)				Chat on Irrigation strategies (E.F.)		
11 - 12				Chats on the use of scientific language and on fundamentals of irrigation (E.F.)	Chat on fundamentals of irrigation and on irrigation scheduling (E.F.)	Chat on the use of plant sensors in precision agriculture (ADE)					Chat on the Watchplant experiment (J.S.)	Chat on irrigation strategies and on perspectives of irrigation (E.F.)
12 - 13			Administrative matters								Chat on electronics & software (R.R.)	
13 - 14												
14 - 15	Lunch											
15 - 16		The use of the Scholander chamber (E.F.)					Practice with the Scholander chamber (E.F.)					
16 - 17												
E.F. = Enrique Fernández V.H. = Virginia Hernández R.R. = Rafael Romero J.S. = Jaime Sebastian A.D. = Antonio Diaz Espejo J.M.T. = José M. Torres Ruiz												

Summary of the activities:

- ✓ Conducted **greenhouse experiments** to study the impact of different ozone concentrations on crop transpiration.
- ✓ Performed plant hydraulics **laboratory experiments**, including measurements of residual nocturnal stomatal conductance, leaf turgor pressure, and assessments using the Scholander chamber, among other techniques.
- ✓ Undertook **field trips** to the *La Hampa* Research Station and the *Orán* commercial orchard to observe and apply sensors and techniques for crop monitoring and data collection.

Description of the activities:

The field trips included visits to the *La Hampa* Research Station and the *Orán* commercial orchard, where participants observed and learned various methods for monitoring different fruit crops, with a particular focus on testing different irrigation treatments. The trainers explained the use of sensors and techniques for data collection, including internode length measurement, shoot growth, trunk diameter variations, canopy dimensions, Plant Sens dendrometers for monitoring trunk diameter changes, ZIM probes for measuring leaf turgor pressure, and the compensation heat-pulse technique for sap flow measurements. Participants also received hands-on training in the use of the Licor LI-6400 portable photosynthesis analyzer to measure stomatal conductance and photosynthesis rates. Additional information was provided on data transmission systems, agrometeorological stations, irrigation components, and soil moisture measurement using the Profile Probe (Delta-T) device.

During fieldwork, special attention was given to proper handling techniques, such as collecting leaves at specific times and storing them carefully for subsequent measurements in the Scholander pressure chamber. On the same day as sample collection, participants conducted practical sessions using the Scholander chamber to measure water potential in olive leaves. These sessions covered the principles of equipment operation and proper techniques for obtaining accurate measurements.

The activities also included a visit to the plant hydraulics laboratory at IRNAS, where the team demonstrated an instrument developed by the group to measure residual nocturnal stomatal conductance. Additionally, participants visited a greenhouse where an experiment was conducted to study the impact of different ozone concentrations on tomato plant transpiration.

The group also presented various sensor technologies, including the development and testing of new low-cost sensors, data loggers, and systems for data transmission and processing. Discussion sessions addressed the fundamentals of irrigation, encompassing soil physics, plant ecophysiology, and water management in agriculture. These sessions included an overview of different irrigation strategies, scheduling methods, and future perspectives on water use in agriculture.

Photographic images of the activities are presented below, illustrating the group participants (Figure 1), the main laboratory (Figures 2 and 3), the greenhouse (Figure 4), and field activities (Figures 5 and 6).

Photographic records of the Task 3.2 Staff Exchange (M3) to IRNAS, Seville – 1st phase

GROUP PHOTOS



Figure 1 Group photo – IRNAS-CSIC and ISOPlexis-UMA

MAIN LABORATORY ACTIVITIES



Figure 1 Images from the training practice with Scholander pressure chamber. The principles of the equipment were explained (A), and the measurements were made with olive leaves (B).

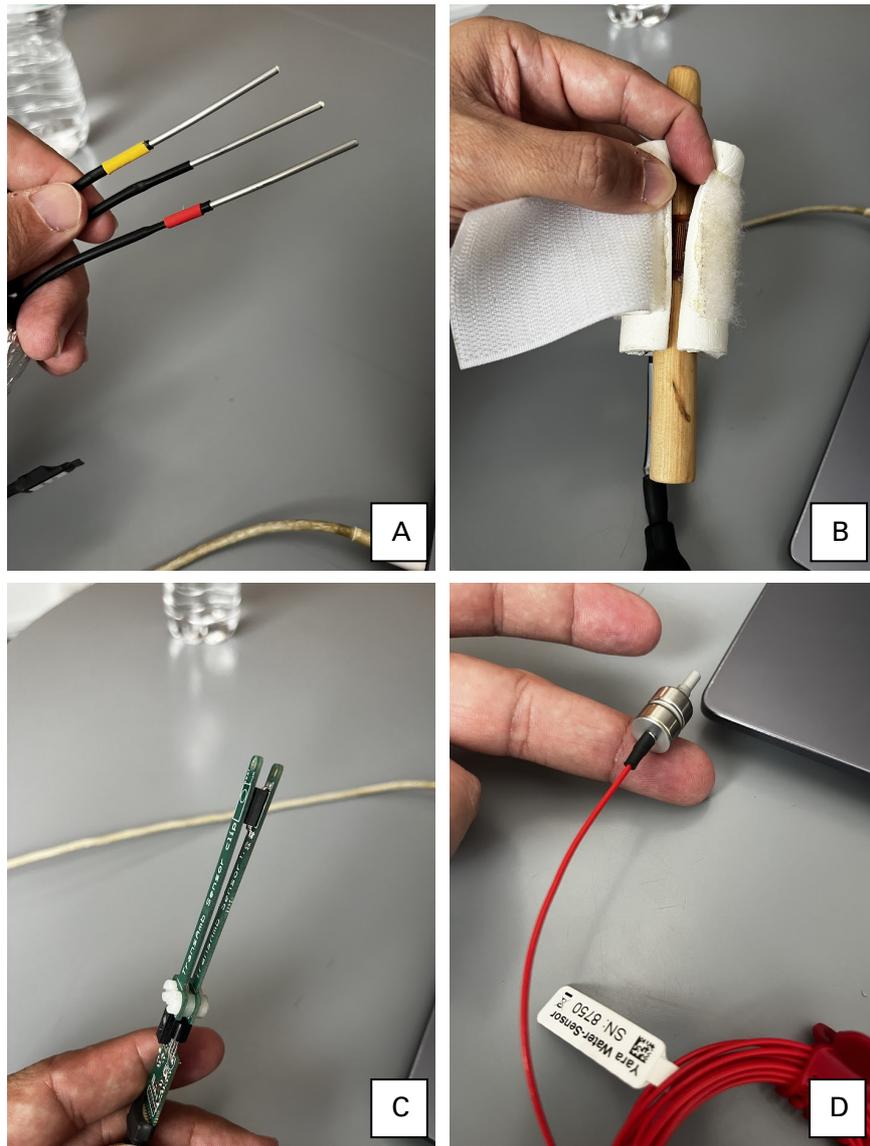


Figure 2 Demonstration of the sensors in one of the chat sessions, for stem (A and B) and leaves (C and D).

MAIN GREENHOUSE ACTIVITIES

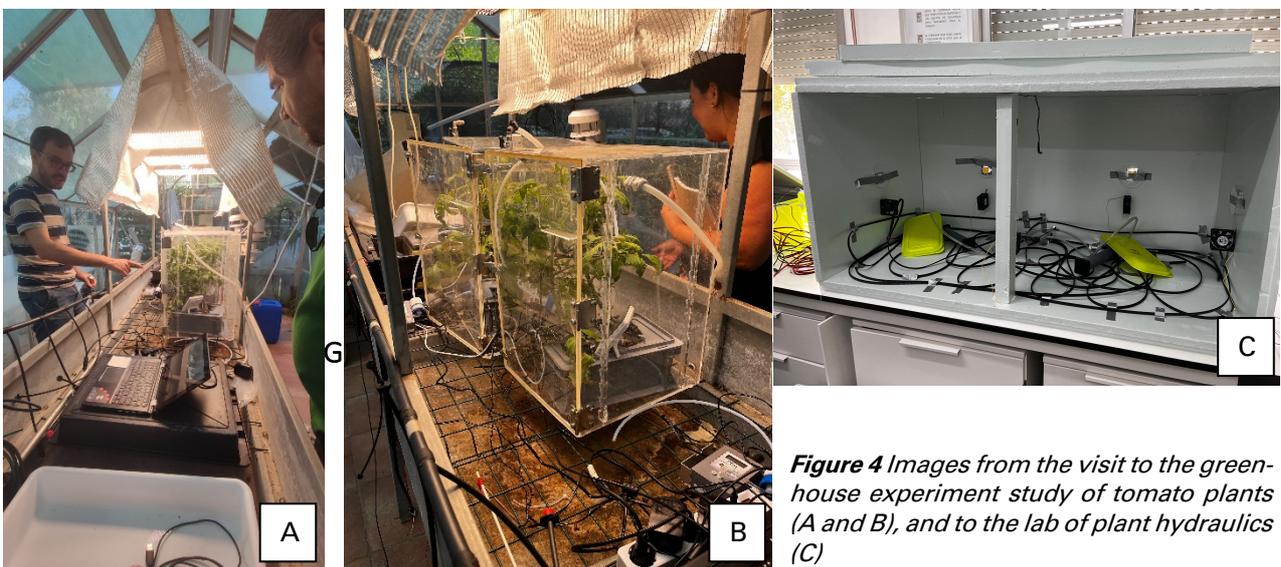


Figure 4 Images from the visit to the greenhouse experiment study of tomato plants (A and B), and to the lab of plant hydraulics (C)

MAIN FIELD ACTIVITIES



Figure 5 Images from the Fieldtrip to La Hampa research station (A). In this activity it was presented the experimental design and strategies of study implemented with olive trees (B), being explained and demonstrated the technologies of monitoring (C), such as the leaf ZYM probes (D), and stem dendrometers (E).

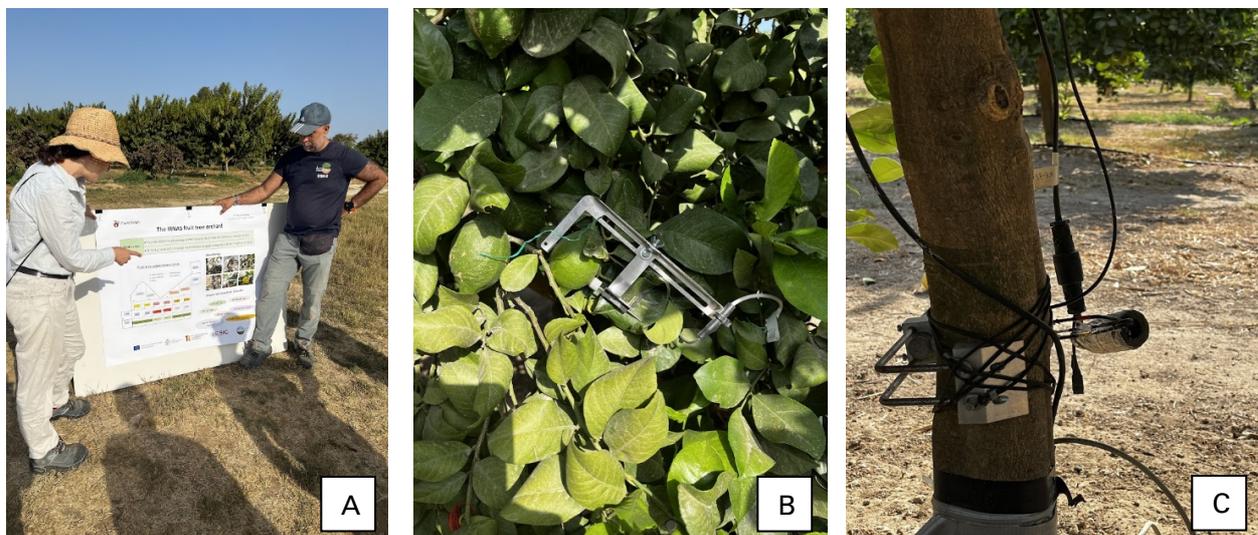


Figure 6 Images from the fieldtrip to La Hampa research station with introductory and explanation approach (A), and demonstration of the monitoring sensors, such as fruit dendrometer (B), and stem probes for sap flow measurements (C).

3.2. 2nd phase of the Staff Exchange to IRNAS, Seville, Spain (M9)

The second phase of the staff exchange was followed by a program that combined fieldwork and technical discussions addressing crop ecophysiology and approaches to abiotic stress research. This stage took place from **24 March to 4 April 2025**, also spanning 14 days.

The **trainers** for the second phase were built on the **same core team and additionally** involved **Celia Rodriguez** (PhD in Biology, Senior Scientist), **María Muñoz** (PhD student), **Saray Gordillo** (PhD in Natural Resources and Environment, Postdoctoral Researcher), and **José Manuel Colmenero** (PhD in Biotechnology, Leader of the RIH Group – *Regulación Iónica e Hídrica en Plantas*, and Deputy Director of IRNAS).

ISOplexis team members who attended the staff exchange:

- **Carla Gouveia**, isUP-AgrO Invited Researcher at ISOplexis with a **PhD degree in Biological Sciences**. Acts as: Plant Physiology and Food Analysis Researcher focusing on Crop Nutritional Value and Stress Adaptation. Skills and expertise: agricultural plant science, food analysis, food composition, nutritional assessment, plant abiotic stress tolerance, plant biochemistry, plant environmental stress physiology, and plant physiology.
- **Gregório Freitas**, Senior Technician at ISOplexis, with a **bachelor's degree in Biology**. Acts as: Crop Supervisor/Evaluator. Skills and expertise: prospecting, inventory, georeferencing, characterization/agronomic evaluation of the germplasm collection, based on specific descriptors.
- **Miguel Carvalho**, **Full Professor** with Aggregation in Biochemistry and Biotechnology at the Faculty of Life Sciences at the University of Madeira. Acts as: **Coordinator of ISOplexis**. Skills and expertise: coordinates the Agriculture, Food, and Biochemistry Regional Priority Domain Platform; research activities including agriculture, biochemistry, and biotechnology.

Staff exchange program:

Hour	Monday 24th	Tuesday	Wednesday	Thursday	Friday	Monday 31st	Tuesday	Wednesday	Thursday	Friday
9 - 10	Arrival & introduction to the IRNAS (E.F.)	The TurGRO* Project: description and visit to related experiments (V.H.).	Experiment to quantify minimum leaf conductance and leaf thermal tolerance (J.M.T.y J.S.)	Trip to the Doñana National Park, to see experiments on tree mortality (J.M.T.)	Project Irriwell (A.D.)	The ISADORA+: a decision support system to manage irrigation (R.R.)	Procedures to schedule irrigation (M.M. y S.G.)	Visit of the Orán commercial orchard (E.F.)	Chat on the ISADORA Project and installation of sensors (E.F.)	Definition of experiments for the project (E.F.)
10 - 11					Project WatchPlant (A.D.)					
11 - 12					Visit to the greenhouse experiments. Sensors (A.D.)					
12 - 13	Administrative matters	Use of the psicrometer (C.R.)	Visit to the labs of the RIH group. Experiments on the role of Cl- in plants (J.M.C.)				Unse of microlysimeters to determine soil water evaporation (M.M.)	Project Limgro, on carbon fluxes and fruit growth (S.G.)		
13 - 14										
14 - 15					Lunch					
15 - 16		Analysis of related literature		Lunch with the ECOVER group and discussion of experimental approaches			Training on excel files to schedule irrigation		Analysis of data related to the ISADORA project	
16 - 17										
Participants from IRNAS:		Details on the used acronyms related to the research projects:								
E.F. = Enrique Fernández		TurGRO: Role of turgor pressure in plant growth limitation in response to water deficit								
V.H. = Virginia Hernández		Irriwell: A novel plant-based approach to estimate irrigation water needs of orchards for an optimal water management								
R.R. = Rafael Romero		WatchPlant: Smart biohybrid phyto-organisms for environmental in situ monitoring								
J.S. = Jaime Sebastian		Osmoroot: Characterization of Root Ionic Readjustment in Dry soil: a Key Mechanism for Plant Drought Adaptation (OsmoRoot)								
A.D. = Antonio Diaz Espejo		ISADORA: Irrigation Scheduling Approaches in Digital fruit tree Orchards for Sustainable Intensive Agriculture								
J.M.T. = José M. Torres Ruiz										
C.R. = Celia Rodríguez										
J.M.C. = José Manuel Colmenero										
M.M. = María Muñoz										
S.G. = Saray Gordillo										

Summary of the activities:

Theoretical sessions on:

- **TurGRO:** Role of turgor pressure in plant growth limitation in response to water deficit
- **Irriwell:** A novel plant-based approach to estimate irrigation water needs of orchards for optimal water management
- **WhatchPlant:** Smart biohybrid phyto-organisms for environmental *in situ* monitoring
- **Osmoroot:** Characterization of Root Ionic Readjustment in Dry soil: a Key Mechanism for Plant Drought Adaptation (OsmoRoot)
- **ISADORA:** Irrigation Scheduling Approaches in Digital Fruit Tree Orchards for Sustainable Intensive Agriculture

Description of the Activities:

The theoretical and discussion sessions began with an introduction to innovative methodologies applied in both greenhouse and field environments. Through expository lectures, participants explored the practical applications of advanced sensors and technologies and engaged in discussions with the IRNAS team on the planning of the isUP-AgrO project's research experiment (Work Package 6). These discussions focused on the two selected vineyard agrosystems, where the ISOplexis team would later implement sensorization to evaluate irrigation requirements and selected crop traits related to water use.

Participants attended demonstrations on psychrometer installation in stems and leaves to determine osmotic potential and observed simulations of sensor functionality under both laboratory and greenhouse conditions. The participants also had the opportunity to work hands-on with other equipment, specifically the Scholander chamber, to measure the water potential in plant leaves. They have also done scheduled irrigation exercises, allowing them to navigate on a daily basis the data system collected from the crop, weather stations, and soil, and program the water irrigation needs of a crop.

The activities further included visits to several laboratories:

- **RIH Group laboratories** – *in vitro* collection and crop genetic identification.
- **ECOVER Group laboratories** – demonstrations with psychrometers, the Scholander chamber, and micro-lysimeters.
- **Greenhouse experiments** – use of leaf sensors, dendrometers, and thermocouples.

Field trips provided additional practical training opportunities. Participants visited the **La Hampa experimental olive orchard**, where they observed data logger calibration for weather stations; the **Orán commercial olive orchard**, where they learned about the caudalimeter system for irrigation; and the **Doñana National Park**, where they studied experiments on tree mortality in *Pinus* and *Juniperus* species, with a focus on techniques and sensors applied to monitor premature tree death in real time.

Through these activities, participants gained direct exposure to the sensor technologies used by the IRNAS group, including the development and testing of low-cost sensors, data loggers, and systems for data transmission and processing.

Photographic records of the activities are provided below, including group participants (Figure 7), main laboratories (Figures 8 to 12), greenhouse (Figures 13 and 14), and field activities (Figures 15 to 17).

Photographic records of the Task 3.2 Staff Exchange (M9) to IRNAS, Seville – 2nd phase

GROUP PHOTOS



Figure 7 Group photos – IRNAS-CSIC and ISOPlaxis-UMa

MAIN LABORATORY ACTIVITIES

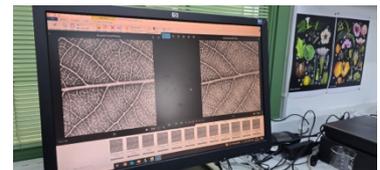


Figure 8 Leaf cavitation– Celia Rodríguez (IRNAS-CSIC)



Figure 9 Stem Psicometer – Celia Rodríguez (IRNAS-CSIC)



Figure 10 Scholander chamber – Antonio Diaz (IRNAS-CSIC)



Figure 11 Micro-lysimeters – Maria Muñoz (IRNAS-CSIC)



Figure 12 Residual conductance - Jaime Sebastián (IRNAS-CSIC)

MAIN GREENHOUSE ACTIVITIES



Figure 13 Leaf Psicometer – Leonardo and Celia Rodríguez (IRNAS-CSIC)



Figure 14 Leaf dendrometer – Virginia Hernandez (IRNAS-CSIC)

MAIN FIELDTRIP ACTIVITIES



Figure 15 La Hampa research station – Rafael Romero (IRNAS-CSIC)



Figure 16 Research station of Orán, a commercial olive orchard – Enrique Fernandez (IRNAS-CSIC)



Figure 17 Experiment on tree mortality (Doñana National Park) – José Manuel Torres and Enrique Fernandes (IRNAS-CSIC)

Conclusions/expected outcomes:

The first staff exchange at IRNAS aimed to advance the research capabilities of the ISOplexis Centre at the Universidade da Madeira by providing a solid foundation in irrigation principles, crop ecophysiology, and water stress management. The exchange enhanced the team's scientific and technical expertise, strengthened their practical skills, and offered hands-on experience with advanced monitoring

techniques. It also deepened research understanding and reinforced collaboration between the partners.

Expected outcomes included the initiation of planning for the acquisition of sensors relevant to the project's experimental work under Work Package 6. Future cooperation was considered essential for the proper assembly, calibration, and maintenance of these sensors in subsequent project activities.

4. Staff Exchange. Smart crops irrigation technologies and strategies (Task 3.3)

Leader: IRNAS-CSIC

IRNAS-CSIC oversaw the staff exchange, which took place in Seville, Spain, in month 12, for 14 days, from **23 June to 04 July 2025**, throughout the ECOVER group multidisciplinary team from IRNAS, under the leadership of Enrique Fernández.

Participants: ISOPlexis-UMa

The program engaged **2 participants from ISOPlexis**. Participants in this staff exchange program gained practical training in new approaches and techniques related to smart irrigation strategies and crop monitoring, with innovative methods for water resource management in agricultural systems. The staff exchange accommodated 2 participants.

The **trainers** consisted of a multidisciplinary team from IRNAS, within the ECOVER Group, led by **Enrique Fernández** (PhD in Agricultural Engineering, ECOVER Group Leader and Director of IRNAS). The team included **Celia Rodriguez** (PhD in Biology, Senior Scientist), **Jaime Sebastian** (PhD in Forest Ecology and Management, Postdoctoral Researcher), **José M. Torres Ruiz** (PhD in Biology, Senior Scientist), **Rafael Romero** (PhD in Systems Engineering and Automation, Senior Scientist), **Virginia Hernandez** (PhD in Plant Ecophysiology, Senior Scientist), **María Muñoz** (PhD student), Saray Gordillo (PhD in Natural Resources and Environment, Postdoctoral Researcher), and **José Manuel Colmenero** (PhD in Biotechnology, Leader of the RIH Group – *Regulación Iónica e Hídrica en Plantas*, and Deputy Director of IRNAS).

ISOPlexis team members who attended the staff exchange:

- **Humberto Nóbrega**, Senior Technician at ISOPlexis, with a **bachelor's degree in Biology**. Acts as: Curator of the Germplasm Collection of the ISOPlexis Seed Bank of the University of Madeira. Skills and expertise: management of the genebank documentation systems (ISOPex and ISOPlexis GRIN-Global), phenotyping of genetic resources, evaluation of the germplasm collection based on specific descriptors, analysis, and statistical treatment of data.
- **Nuno Nunes**, isUP-AgrO Invited Researcher at ISOPlexis with a **PhD degree in Biological Sciences**. Acts as: Research Scientist specializing in Antioxidant Activity and Biorefinery Applications. Skills and expertise: antioxidant evaluation, nutraceutical analysis, bioactivity assessment, biorefinery.

Scope/Description:

The program focused on providing participants with practical training in innovative approaches and techniques related to smart irrigation strategies and crop monitoring. In response to the growing challenges of climate change, the efficient use of water resources in agricultural systems has become an increasingly important priority. The staff exchange was highly interactive, with participants actively

engaged in training activities. It was structured to promote the transfer of knowledge and best practices, encourage learning from shared experiences, and strengthen practical skills

The key topics addressed included:

1. Precision irrigation methods and strategies.
2. Digitalization of irrigation.
3. Sensor and index-based vegetation moisture monitoring.
4. Sensor and index-based soil moisture monitoring.

Staff exchange program:

Hour	Monday 23th	Tuesday	Wednesday	Thursday	Friday	Monday 30th	Tuesday	Wednesday	Thursday	Friday	
9 - 10	Arrival & introduction to the IRNAS (E.F.)	Irrigation scheduling (M.M)	Visit to La Hampa experimental orchard (R.R.) to show dataloggers and comms			Measurements at La Hampa and Oran orchards (M.M.)			Measurements at La Hampa experimental orchard (E.F.)	Overview of the data and experiments of the WIDERA project (E.F.)	
10 - 11					Plant Hydraulics (J.M.T.)			Sustainable use of water in agriculture (E.F.)			Project TurGRO (V.H., C.R.)
11 - 12			Isadora+ App description (R.R.)	Digiorchard/ Lingros (S.G)	Analysis of related literature						
12 - 13	Administrative matters	RIH Research Line & visit to the Plant Crop Biotechnology Service at IRNAS		Analysis of related literature			Measurements related to Dendrochronology (J.S.)	Analysis of related literature			
13 - 14											
14 - 15											
15 - 16		Analysis of related literature					Training on excel files to schedule irrigation (E.F.)		Analysis of data related to the ISADORA project (E.F.)		
16 - 17											
Participants from IRNAS:			Details on the used acronyms related to the research projects:								
E.F. = Enrique Fernández			TurGRO: Role of turgor pressure in plant growth limitation in response to water deficit								
V.H. = Virginia Hernández			Irriwel: A novel plant-based approach to estimate irrigation water needs of orchards for an optimal water management								
R.R. = Rafael Romero			WatchPlant: Smart biohybrid phyto-organisms for environmental in situ monitoring								
J.S. = Jaime Sebastian			Osmoroot: Characterization of Root Ionic Readjustment in Dry soil: a Key Mechanism for Plant Drought Adaptation (OsmoRoot)								
A.D. = Antonio Díaz Espejo			ISADORA: Irrigation Scheduling Approaches in Digital fruit tree Orchards for Sustainable Intensive Agriculture								
J.M.T. = José M. Torres Ruiz											
C.R. = Celia Rodríguez											
J.M.C. = José Manuel Colmenero			Salas reservadas: 24 y 26 junio, delantera; 27 junio, 1 y 2 julio, trasera								
M.M. = María Muñoz											
S.G. = Saray Gordillo											

Summary of the activities:

- ✓ **Greenhouse experiments** focused on monitoring leaf cavitation events, applying micro-dendrometers to leaf petioles, and using psychrometers for precise measurements.
- ✓ **Practical sessions** in the plant hydraulics laboratory included the use of psychrometers to assess osmotic potential and the Scholander chamber to evaluate osmotic pressure, among other methodologies.
- ✓ **Field trips** to *La Hampa* research station and the *Orán* commercial orchard provided training with sensors and techniques for precision irrigation, as well as sensor- and index-based monitoring of soil and vegetation moisture.

Description of the activities:

The activities began with discussion sessions introducing innovative methodologies used in greenhouse and field environments. Through expository lectures, participants explored the practical applications of advanced sensors and technologies.

Dr. Enrique Fernández guided participants through several IRNAS laboratories, explaining the work carried out in each research group. Dr. María Muñoz presented irrigation scheduling using three methods: Alan & Pereira (2009), stomatal conductance, and dendrometers. The methodologies were

discussed, highlighting their respective advantages and limitations. Dr. José Manuel Colmenero presented research from the OSMORROT project, focusing on the role of chloride in seedling development and root growth. Dr. Rafael Romero introduced the ISADORA+ mobile app, which digitally implemented the three irrigation scheduling methods for potential farmers' use. Additional presentations included: Dr. Saray Gordillo: role of Triose Phosphate in lemon and almond crops; Dr. José Manuel Torres: The WatchPlant project, monitoring tree mortality in *Doñana* Park; Dr. Enrique Fernández: sustainable water use in agriculture and related challenges; Dr. Jaime Sebastian: dendrochronology methodologies; and Drs. Virginia Hernández and Celia Rodríguez: results of the TurGRO project.

Participants also discussed the planning of the isUP-AgrO project experiment (Work Package 6), involving two vineyard agrosystems for sensorization of irrigation needs and crop water use traits. Demonstrations included psychrometer installations on stems and leaves to measure osmotic potential, Scholander chamber measurements of leaf water potential, and irrigation scheduling exercises using crop, soil, and weather station data.

At IRNAS greenhouses and laboratories, the TurGRO project was demonstrated. Probes such as Cavicam 2.0 (leaf cavitation monitoring), microdendrometers (petiole diameter fluctuations), and psychrometers were presented, along with a temperature and humidity probe for vapor pressure deficit (VPD) calculation. In the laboratory, participants used the Scholander chamber to measure the osmotic pressure of leaves collected from greenhouse experiments.

Field trips to the *La Hampa* Research Station and the *Orán* commercial orchard provided hands-on exposure to weather station data logger calibration, caudalimeter systems for irrigation, ZIM probe recalibration, micro-lysimeters, trunk dendrometers, and soil moisture measurements. Participants observed real-time data collection and weekly irrigation scheduling calculations based on sensor and weather data.

During the final visit to *La Hampa*, participants observed additional measurements, including canopy dimensions (height and width), weighing of micro-lysimeters placed at different irrigation positions, and assessment of stomatal conductance and photosynthetic rate in olive leaves using a Licor IRGA. Leaves were also collected using the method developed by Dr. Celia Rodríguez (humidity-, CO₂-rich, and cooled storage) and later analyzed for osmotic pressure with the Scholander chamber.

Overall, participants gained in-depth knowledge of sensor technologies developed and tested by the IRNAS group, particularly low-cost sensors, data loggers, and transmission systems for precision irrigation and soil-vegetation moisture monitoring.

Photographic images of the activities are presented below, showing participants (Figure 18), the main laboratory (Figure 19), the greenhouse (Figures 20–21), and field activities (Figures 22–23).

Photographic images of the Task 3.3 Staff Exchange (M12) to IRNAS, Seville

GROUP PHOTOS



Figure 18 Group photos – IRNAS-CSIC and ISOplexis-UMa

MAIN LABORATORY ACTIVITIES



Figure 19 Scholander chamber – Alfonso (IRNAS-CSIC)

MAIN GREENHOUSE ACTIVITIES



Figure 20 Leaf optical dendrometers – Celia Rodríguez (IRNAS-CSIC)



Figure 21 Leaf dendrometer – Virginia Hernandez (IRNAS-CSIC)

MAIN FIELDTRIP ACTIVITIES



Figure 22 Research station of La Hampa, orchards for field trials– María Muñoz, Rafael Romero, Dan (IRNAS-CSIC).



Figure 23 Research station of Orán, a commercial olive orchard – María Muñoz, Dan (IRNAS-CSIC)

Conclusions/expected outcomes:

The staff exchange on smart irrigation strategies and crop monitoring aimed to strengthen the research capacity of the ISOplexis Centre by providing participants with hands-on training in precision irrigation, digitalization, and advanced monitoring techniques for soil and vegetation moisture. The program enhanced participants' technical expertise, deepened their understanding of innovative approaches to water resource management, and reinforced their ability to apply practical solutions to the challenges posed by climate change.

Expected outcomes included the transfer of knowledge and best practices in precision irrigation and monitoring technologies, improved practical skills in sensor-based data collection and interpretation,

and the integration of digital tools for irrigation management. This staff exchange deepened research, improved the team's practical and scientific skills, and gave hands-on experience of advanced monitoring techniques, by strengthening collaboration between the partners.

5. Lessons Learned

A key lesson learned was the value of integrating traditional physiological assessments with digital tools and smart monitoring systems. This combination proved essential for improving technical skills and for designing more efficient, climate-resilient agricultural practices.

Another important insight was that hands-on training—whether in the field or laboratory—greatly accelerates the understanding and adoption of advanced methods, making researchers more confident in applying them to real-world challenges.

Equally important was the recognition that collaboration and knowledge-sharing across institutions significantly strengthen research outcomes. The exchanges highlighted the need for continuous interaction between teams to ensure consistent sensor calibration, data interpretation, and methodological alignment. This experience demonstrated that the success of future project activities will depend not only on individual skills but also on collective coordination and sustained partnerships.

6. Conclusion

The staff exchanges provided ISOPlexis Centre participants with valuable opportunities to strengthen their expertise in crop ecophysiology, abiotic stress research, and smart irrigation strategies. Through a structured program combining laboratory training, field phenotyping, and precision irrigation practices, participants deepened their understanding of how environmental factors—such as water scarcity, nutrients, and climate—affect crop physiology, productivity, and adaptation mechanisms.

Exposure to advanced sensor technologies and digital irrigation tools enhanced their capacity to implement innovative approaches for soil and vegetation monitoring, irrigation scheduling, and crop performance evaluation. Training across different phenological stages further enriched their perspective on plant behavior under stress conditions.

Overall, the exchanges significantly broadened the team's technical capacity, reinforced collaboration with IRNAS-CSIC, and increased the project's impact by promoting innovation and the effective transfer of best practices.

6.1. Next steps

The next steps will be aligned with the upcoming 3rd and 4th staff exchanges. **Task 3.4: Metabolomics and Omics Tools** will take place in February 2026, and **Task 3.5: Valorization of Products and By-Products** will follow in June 2026, both led by the UNIPR partner in Parma, Italy.

ISOPlexis participants will receive advanced training in metabolomics and other omics approaches applied to agriculture and food production (Task 3.4). They will also expand their expertise in waste valorization, gaining skills to integrate agricultural residues into circular bioeconomy models through the training on product and by-product valorization (Task 3.5).

These activities will build on the skills already acquired in crop ecophysiology, stress physiology, and smart irrigation, broadening the team's ability to connect plant performance with molecular insights and sustainable resource management. Together, these complementary trainings will reinforce the project's scientific impact and contribute to the development of innovative, climate-resilient agricultural practices.

