





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

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# Milestone 4.1

Guidelines for harmonised data collection for environmental and socio-economic impact assessment

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Milestone leader: UNIPI

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# 1. Introduction

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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 lowcost climate actions. The DSS will allow obtaining healthier and higher quality productions and higher yields, while will reduce the Use of water and the losses of nutrients and chemicals to the environment. iGUESS-MED will be able to manage efficient fertigation, to forecast diseases and pests, and to improve the climatic efficiency in tomato greenhouses, using only climate data acquisition and basic information on cropping system. The DSS will provide feedbacks and alerts about crop needs and real time recommendations to the farmers through friendly portable real time data visualisation 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 the 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.

# 1.1. Objectives and definition

The DoW indicates two main objectives for the socio-economic analysis, which are pursued through the development of Living Labs (LL).

#### Objective 4

To create a mutual learning space and to facilitate technology exchange between EU and non-EU MED countries, for boosting capacity building locally, empowering a new generation of innovative and younger entrepreneurs, allowing for gender inclusiveness in working environments and promoting a circular and sustainable greenhouse farming in the MED Basin.

Objective 5



To assess the environmental and socio-economic impacts of innovative tomato cropping systems in commercial greenhouses, under a life cycle thinking perspective, thereby highlighting intervention's cost-effectiveness and gender-related issues.

The LL approach is the core of the WP4 and it will be created in each site for actively involving local stakeholders in the creation, validation and testing of the new technology and the associated new greenhouse management system, in real production facilities and contexts.

The LL will discuss the knowledge gaps, end-user needs, working conditions, gender issues as well as the usefulness and social acceptability of the innovation.

The LL will be applied to triangulate both qualitative and quantitative information will be collected which will be feed into the socio-economic impact assessment.

The Preliminary assessment results will be discussed during the labs to create reinforcing feedback loops and allow technology and management system adaptation to site-specific needs and issues.

The LL represent a community of actors each organised towards the following focal question

"How to improve the competitiveness, environmental performance and efficiency of the MED protected horticulture sector, by ensuring its social sustainability, especially by improving health-related issues, as well as gender inclusiveness and equality?"

LL will be open to a broad range of stakeholders, including SMEs, technology developers and suppliers, practitioners, NGOs, education and extension organisations, civil society, policy makers and local administrations, and local communities, among others

#### 1.2. WP4 structure

The overarching objective of WP4 is to create an enabling environment for the transition towards sustainable, resilient and inclusive greenhouse cropping systems.

Sub-objectives are as follows:

- To boost stakeholders' involvement, to empower a new generation of farmer and to overcome gender barriers
- To provide sound evidence-based information about the socio-economic and environmental performance of the innovative solutions proposed in previous WPs, with emphasis on country specific issues.
- To support farmer investment decisions, while promoting social dialogue, gender equality and inclusion, by removing knowledge barriers

Task 4.1

#### T4.1 (M0-M18): CAJAMAR, UNIPI, Akdeniz University, and CRRHAB.



**Aims**: The task aims to develop the conceptual and analytical framework for the socio-economic impact assessment, based on a systematic literature review.

### Approach:

- The outputs of the conceptual and analytical framework will involve the concepts and methods to be applied in tasks 4.2 and 4.3, as well as data needs. The task will identify the critical country specific sustainability and gender issues, focusing on case-specific issues, including policy, governance, state-of the-art technology and gender issues, which will be used to formulate living labs' focal questions.
- The task will interact with WP2 by highlighting relevant sustainability issues to be investigated.
  - Task 4.2

#### T4.2 (M12-36): UNIPI, CAJAMAR, CREA, Akdeniz University, and CRRHAB.

**Aims:** The living labs aim at assessing feasibility and sustainability of technology adoption includes will combine Life Cycle Sustainability Assessment, cost-effectiveness analysis and participatory activities. This task will inform about the potential environmental, economic and social impacts and the trade-offs among them.

**Approach:** The theoretical and analytical framework (T4.1) will be shared with stakeholders during living labs to allow knowledge co-creation and continuous technology improvement. This will allow to meet investigate site and country-specific needs. During the living labs, hands-on sessions will help improve and target the DSS to specific needs.

#### This task includes two subtasks

T4.2.1 Life cycle sustainability assessment (LCSA) (M12-M24).

It will adopt a life cycle thinking perspective to develop an environmental Life Cycle Assessment, a Life Cycle Costing and a Social Life Cycle Assessment, based on data gathered from living labs and the guidelines provided by task 4.1. Multiple assessments will be carried out to compare the stages of DSS adoption; intermediate LCSA outputs will be discussed during the living labs to allow for applying value judgement to LCSA result, thereby ending with a single score assessment, which will facilitate result use for evidence-based decision making in policy and business.

T4.2.2 Assessment of stakeholders needs, expectations and impact (M12-M36).

It will combine a participator appraisal of the Needs, Expectation and Impacts (NEI) with a simulation of impacts of the proposed solutions. For starters, a data collection will be performed. Then, a participatory workshop (10 relevant stakeholders) will be carried out in each country at the Living lab level, based on the guidelines provided by task 4.1 and after 5 preliminary interviews with key informants. Those activities will aim at assessing the past and current needs, as well as the expectations and impacts of the proposed solution in each living lab. The candidate analytical



method for to assessing potential impacts of the introduction of the new technology is the Bayesian Belief Network.

The task 4.2 will be implemented in Turkey, Tunisia, Spain and Italy.

Task 4.3

#### T4.3 (M24-M42): CRRHAB, Akdeniz University, UNIPI, UAL; BIOPLANET, and La Caña.

Aims: The main goal of this task is to establish a COP by stimulating a continuous interaction among stakeholders and coordinating education and training of growers as well of young and prospected farmers, through specific capacity building activities.

Approach: A list of 20 potential stakeholders will be drafted, which can benefit from and establishing a continuous information exchange by means of one Workshop and one training events. The former will validate and disseminate project results. The latter will address growers and new entrants in agriculture as well as PhD students, Post Doc and young researchers, to co-create transition pathways towards circular and gender inclusive greenhouse farming. In addition, an open section will be created in the iGUESS-MED website to promote stakeholders' interaction and facilitate social acceptability of the proposed solution. The table 1 presents the main WP4 outcomes.

**Table 1** Description and dead-line of the deliverables and milestones expected from WP4 of iGUESS-MED project.

List of WP4 outcome	Description	Due to
D4.1: Conceptual and analytical	It will contain both conceptual and analytical	Month 12
framework	framework to conduct the impact assessment	
D4.2: Protocol for living labs creation	It would contain the protocol for data collection and	Month 14
	LCA	
D4.3: Feasibility and sustainability	It will be developed by integrating the intermediate	Month 36
assessment document	LCSA outputs and by combining country-specific and	
	socio-economic impact assessment results	
D4.4: Mutual learning and knowledge	It will include results of outreach activities	Month 42
co-creation		
MS4.1 Guidelines for harmonised	Approval of Guidelines and workplan by all partners	Month 6
data collection for environmental and	in charge of LL.	
socio-economic impact assessment		
MS4.2 Environmental and socio-	Accomplishment of the socio-economic impact	Month 42
economic impact assessment	assessment	



# 2. Socio-technical system of greenhouses production in each country

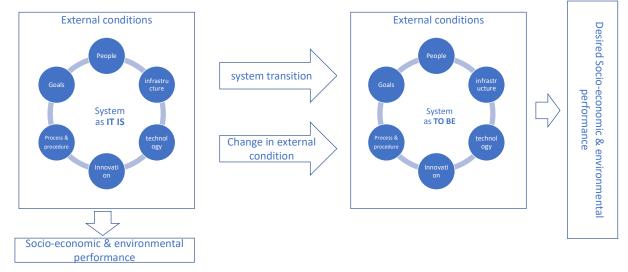
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A growing literature describes the interplays between innovations, human and ecosystem in the socio-technical system (STS). The STS concept describes the system's evolution due to interacting internal sub-systems (i.e. people, infrastructure, technology, culture, procedures, goals) with external conditions (formal and informal institutions; policy and political, environmental, demographic, social conditions).

This approach can ensure large engagement and understanding of both how the current system is working ("system as it") and how the project can be improved ("system to be").

This concept implies describing the inherent trajectory of change of any STS and external condition, which may affect the reaching of a desirable transition toward sustainable as defined by the LL focal question. Figure 1 summarises the concepts

Figure 1. Baseline conceptual framework



The approach requires actors' engagement to co-create a desirable transition by focusing on current socio-economic and environmental performance. In accord with the baseline conceptual framework, the WP4 analysis will focus on:

- 1) Description of the system as it is (tasks 4.1 & partial 4.2)
- 2) Impact appraisal (task 4.2)
  - a. LCA
  - b. NEI
- 3) Co-creation process towards the system as to be (task 4.3)



Point 2 and 3 are not included in the current guidelines as LCA and NEI guidelines are supposed to be delivered at month 14 and month 24, respectively.



# 3. Workplan

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Table 2 summarises the working plan for WP4.

**Table 2** Working plan for WP4.

Task	Reference to conceptual framework	References to activities	Contents	Timing	Outcome	Proposed activity in each LL
4.1	Description of system as it is	Preparatory activities	Decription of the main characteristics of Greenhoiuses production in the country	Month 10-12	Description of diffusion, typologies, products, markets of greenhouse productions in each country	Secondary documents and literature review
			Definition of Focal question & understating of the main set of stakeholders involved	Month 10-12	<ul><li>a) identification of focal question</li><li>b) Preliminary Description of context and</li><li>STS</li></ul>	Secondary documents and literature review
			Formulation critical country specific sustainability and gender issues	Month 10-12	Finalise focal question and selection of the most relevant socio-economic and environmental indicators	Interview to key informant
4.2		LL	Description of the context	Month 14-18	Description of external factors which affects the STS	Secondary data + 5 interviews to key informants
		LL	Description of greenhouses STS	Month 14-18	Description of STS system of LL and innovation	Secondary data + 5 interviews to key informants
	Impact appraisal	NEI (methodology will be developed in D4.2)	Stakeholders' and society's NEEDS and EXPECTATION	Month 30-36	Narrative & SWOT analysis	Interview to key informant
		LCA (methodology will be developed in D4.2)	Socio-economic and environmental Impacts	Month 18-30	Measure of impact on relevant socio- economic and environmental parameter	Collecting data as expected in protocol for LL (D4.2)

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		Analyse Impacts in each LL	Stakeholders' and society's  IMPACT	Month 30-36	Estimation of trade-off among different impact domains and drivers of impact (i.e. STS structure, internal and external conditions)	Workshop (* option to BBN)
4.3	Co-creation process - System as to be	Community of practices	Social acceptability of the proposed solution	Month M24 -42	Questionnaire about acceptability (- Political, Economic, Sociological, Technological, Legal and Environmental - PESTLE methodology)	Questionnaire to 20 stakeholders & one final Workshop

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# 4. Guideline for Description of system as "it is"

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In each LL will be developing the following activities:

- Preparatory activities
- Description of the context
  - o Representation of the current Socio-technical system
  - Assessment of needs and expectations

# 4.1. Preparatory activities

The preparatory activities will allow the LL members to check the proposed LL's feasibility and collect information needed for the next tasks. The preparatory activities would be based on filling a common template collecting information to explore the feasibility of LL and understand the qualifying case-specific elements of context and system.

Moreover, these activities will help build an initial relationship with the main actors that will constitute the living lab. Considering COVID-19 restrictions, we propose to collect secondary material (deliverables from previous projects, published paper) and up to 5 interviews with the key information.

These activities concern:

- 1) Description of the diffusion of Greenhouses in each country;
- 2) Refinement of focal questions around which the LL will be established;
- 3) Description of the current STS for greenhouses production;
- 4) Setting up the LL;
- 5) Identification of country-specific sustainable issues.

# 4.1.1. Description of diffusion of greenhouses in each country

The section aims at describing the profile of greenhouse production in each country. This section investigates the dominant technological solution in greenhouses and a Description of the main production system (diffusion, typologies crops). The section also contains an overview of the current Mediterranean greenhouse farming system's economic, environmental and social performance. The information will be collected using secondary data (i.e. already published paper), official statistics, and interviews with experts and key informants. The area of interest will be: a) Diffusion; b) Performance; c) Technology; d) Job and Worker conditions; Economics; governance and supply chian



### Table 3 Description of greenhouse farming system

Domain	Indicator	Answer
Diffusion		
Performance		
Technology		
Job and Worker condition		
Costs and revenue		
Governance and supply chain		

# 4.1.2. Definition of focal questions and preliminary Needs and Expectations

During the first discussion with the contact person, each LL should provide and reside the focal question. The DoW define the initial focal question as: "How to improve the competitiveness, environmental performance and efficiency of the MED protected horticulture sector, by ensuring its social sustainability, especially by improving health-related issues, as well as gender inclusiveness and equality?"

A country-specific focal question should be identified in each LL, possible splitting in sub-questions if relevant. Table 4 contains a suggestion to summarise both past needs and future expectation of the greenhouses production in each case study area.

Table 4 Needs and expectations

Focal question and sub-focal question	Past Needs (5- 10 years)	Expectation for the next 10 years

# 4.1.3. Preliminary Identification of STS

Any LL has to describe the greenhouses as a Socio-technical system following the definition provided in the previous section. The objective of this part of the preparatory activity is to provide a baseline description of the STS against four main points:

- 1) What are the main actors that interact with the greenhouses production in each case study?
- 2) What are the main resources/entities mobilised in greenhouses production in each case study?



- 3) What are the main drivers involved in greenhouses production in each case study and how they interact in driving changes to greenhouses production in each case study?
- 4) What are the main impact domains of greenhouses production in each case study?

The LL will progressively build socio-technical system representations through an interactive process using both the preliminary activities and interview to key informants and validating it during the participatory Workshop.

#### 4.1.3.1. Actors

During the first interview with the key informants, it is possible to define a set of actors contributing or affected by the production of the greenhouse in the LL. It is also important to outline a scheme of inquiring about considering a more comprehensive stakeholder categorisation relevant for the greenhouses production. It is possible to determine six actors groups:

- Agriculture, agro-industries;
- Policy & administration;
- Technology & ICT;
- Civil society;
- Research & innovation;
- Services & consumption.

During the first interaction with the LL contact person, the interviewers should consider the most relevant actors groups (Table 5). Actors to be included should cover both direct and indirect. The formers are those who use or whose practices have a direct impact on key resources of the territory, while the latter are people whose actions will encourage the direct stakeholders to change their practices.

Table 5 Actor Groups

Group	List	Direct	Indirect
Agriculture, agro-industries	i.e., farmers, processing industries, manufacturing firms, Unions, etc.		
Policy & administration	i.e., regional and local Policymakers, mayors for municipalities, etc.		
Technology & ICT	i.e., start-ups, software/hardware companies, etc.		
Civil society	environmental/cultural associations, citizens' representatives, schools, etc.		
Research & innovation	i.e., universities, research institutions, etc.		
Services & consumption	i.e., service companies, credit institutions, wholesalers, costumer		



associations, etc.	
associations, etc.	

# 4.1.3.2. Resources/entities

Resources refer to any goods, products or other means used by any of the stakeholders previously identified. They can be grouped into three main categories:

- 1) Socio and economics: good and products used also considering markets, institutional job elements and formal rules and regulations and informal cultural non-written rules, norms and values
- 2) Environmental: living organisms (plants, animals, etc.), physical things to support living and working in the (natural) environment (e.g. analogue technology, infrastructure, finances);
- 3) Technical: the innovation and technology mobilised and applied in the greenhouse concerning production system (soiless) or technology adopted (big data; sensors; front-facing technologies and applications).

Table 6 provides a synthesis of the main information to be collected.

**Table 6** Description of resources

Domain	Entities	Description
Socio-economic		
environmental		
Technical		

#### 4.1.3.3. Drivers

The drivers are both main internal and external factors that are supposed to affect the structure and function of STS. Table 7 provides an initial list.

Table 7 Examples of drivers considered when describing the context since the last ten years

Factors	Description
Group age distribution (i.e. are elderly people relevant?)	
Depopulation (emigration rate, birth rate, etc.)	
Economic conditions (income level, householder expenditure, etc.)	
Social asymmetries (female employment rate, relative poverty rate, etc.)	
Education (tertiary education rate, presence of high schools, etc.)	
Environment (Use of renewables, organic prodcution, etc.)	
Digitalisation (people using the net for interact with public authorities, etc.)	



Social concerns in the area ( food security, social justice etc.)	
Level of tecnhology	
Please, insert other parameters if it is necessary	
How has the system changed in the last 10 years	

# 4.1.3.4. Impact domains

The aim is to describe the main dimension affected by greenhouses production in each case study by considering both past and current impact on sustainability.

Table 8 considers the main dimensions affected by the greenhouses production

**Table 8** Main aspects related to the impact of GH productions.

Impact area	Description	Past	Current
	(i.e. income of GH produ	cers)	
Economic			
	(: - 002 : : : - : )		
	(i.e. CO2 emissions)		
Environmental			
	(i.e Worker conditions; g	ender )	
Social			

# **4.1.4.** Summary

After describing the STS as it is, Table 9 aims to collect information on the main critical points on the greenhouse's STS. The critical point represents the main area of concerns that will be investigated in task 4.2



# Table 9 Socio-Technical System critical points.

<b>Critical points</b>	Evolution	Past identified solutions (if any)



# 5. Stakeholders involvement in WP4

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Following the Ethics Guide, all stakeholders and actors involved in the project have to fill the consents form.

Therefore, the following procedure should be ensured.

- Translate it in your own language, both information sheet and privacy statement and informed consent forms (if your stakeholders do no speak English). Both documents are available in annexes 1 and 2.
- Fill in the missing information highlighted in yellow
- Ask the signature
- Convert the document into a PDF
- Save the pdf in your repository

# 6. Proposed Timeline

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- From February to March 2021 (M8-M10)
  - preliminary activities using secondary documents and one/two interviews with experts:
    - Description of GH production (table 3)
    - Focal questions (table 4)
    - Preliminary list of Actors (Table )
    - Preliminary list of elements and Interactions (Table 6 and Table 7)
  - Interview to stakeholders
    - Impact domain (Table 8)
    - Critical point (Table 9)
- Next step
  - Define guideline for Living Labs and LCA (task 4.2)



# **Annex 1 Information Sheet**

I guessed is a PRIMA (Partnership for Research and Innovation in the Mediterranean Area) project, relates to the Call: Section 1 – Farming Systems 2019 and belongs to the IA – Topic 1.2.2: "Sustainability and competitiveness of Mediterranean greenhouse and intensive horticulture"

I guessed supports the transition toward innovative, sustainable and competitive Mediterranean horticultural greenhouses by developing, validating and transferring a pioneering Decision Support System (DSS) for the MED greenhouses, which is able to:

- REDUCE NUTRIENT LEAKAGE into sub-surface and groundwaters by optimising the fertigation management (both irrigation and fertilisation) under low quality water conditions;
- REDUCE THE USAGE OF CHEMICALS thanks to a sustainable and integrated pests and diseases control;
- INCREASE THE PRODUCTIVITY thanks to an improved and cost-effective efficiency of climatic control procedures, introducing specific low-cost solutions to apply to pre-existent greenhouse structures

The project will be carried out on tomato as reference crop, in soil and soilless culture in low-tech greenhouses typical of the Mediterranean region, by applying participatory and integrated interdisciplinary toolkit of novel and emerging technologies such as sensor technology, IoT, advanced agronomic management, simulation models and self-calibrating mathematical algorithms.

The project started in APRIL 2020 and has an extension of 4 years.

The iGUESS-MED consortium is comprised by 4 of the most important countries in Med-area as regards the greenhouse tomato cultivation, 2 European (Italy and Spain) and 2 non-EU (Turkey and Tunisia). There are 7 entities from the 2 European countries and 2 entities from 2 non-EU countries, from which 1 very small company, 1 SME, 1 big company, 1 non-profit foundation, and 5 RTDs.



# Annex 2 – Privacy notice and Informed Consent Forms

### **Privacy notice**

The [Name of the Organisation] will use your personal data for the purposes of the research undertaken in the iGuessmed project. Our legal basis for processing your data is that it is necessary for the performance of a task carried out in the public interest in relation to research funded by the PRIMA, supported under Horizon 2020.

We are the Data Controller over your personal data. We will not share your personal data beyond the project team, unless required by law and shall only retain it according to good scientific practice for as long as is necessary to fulfil the research undertaken on the project, to deliver project outcomes, and to fulfil the requirements of the funder. For further information, please contact our Data Protection Officer on [add email address of data protection officer]<sup>1</sup>.

[Insert data collector name] Contact details: [Name of organisation] [Address] Email: Telephone:

#### **Informed Consent**

Name and organisation of data collector:_	
Name of the research participant:	

#### 1) Consent statement

the research participant has been informed that:

- Data is being collected as part of the PRIMA Project iGUESS-MED.
- Data collected, audio recording, video-shooting and photos may be taken and used for research, dissemination, and communication purposes.
- Data will be analysed by members of the iGUESS-MED project, and in some cases may be analysed by project members other than the interviewer.
- Participation is voluntary.
- Consent can be withdrawn at any time without reason.
- Participants can access personal data at any time without reason.
- Data will be anonymised if possible. In cases in which the data cannot be anonymised, any publications will be shown to identifiable participants for further consent for publication.
- Data will be safely stored in certified repositories for long term preservation and curation.

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<sup>&</sup>lt;sup>1</sup> If there is no privacy notice on the partner's website, and if a partner does not have a Data Protection Officer, substitute the sentence with the following: "For further information please contact [add email address of person responsible for data protection]."



Signed Date	(participant)
Date	<del></del>
2) Recording of consent Project partners will keep evidence of	consent by recording.
Name of the person who gained conse	ent:
Data and time that consent was given:	