LIFE Project Number

< LIFE17 ENV/GR/000220>

Final Technical Report
Covering the project activities from 01/07/2018 to 30/06/2022

Reporting Date

30/09/2022

LIFE PROJECT NAME or Acronym

LIFE GAIA Sense

Data Project

Project location:	Greece, Spain, Portugal
Project start date:	<01/07/2018>
Project end date:	<30/06/2022>
Total budget:	2979297 €
EU contribution:	1751574 €
(%) of eligible costs:	60%

Data Beneficiary

Name Beneficiary:	NEUROPUBLIC AE
Contact person:	Mr Vasileios Pyrgiotis
Postal address:	Methonis 6, 18545, Piraeus, Greece
Telephone:	+30 210 4101010 + direct n°7441
E-mail:	pm_funded@neuropublic.com
Project Website:	www.lifegaiasense.eu

As this report is confidential, the uploaded document does not contain all the information/ content and all the chapters that were included at the "original" report.

This deliverable was produced under the co-finance of the European financial instrument for the Environment (LIFE) programme during the implementation of the project "LIFE GAIA Sense" (LIFE17 ENV/GR/000220).

1. Table of contents

2. List of key-words and abbreviations

Acronym/Term	Explanation
AIGINA	OMADA PAGAGOGON KELYFOTOU FISTIKIOU AIGINAS (PRODUCER ORGANISATION OF PISTACHIO AIGINAS)
ALEXANDROUPOLI	TRELLIS & SIA E.E
ARTA	APOSTOLIDIS AE
BMPs	BEST MANAGEMENT PRACTICES
AUTH	ARISTOTELIO PANEPISTIMIO THESSALONIKIS (ARISTOTLE UNIVERSITY OF THESSALONIKI – SPECIAL ACCOUNT OF RESEARCH FUNDS)
BMPs	GUIDELINES ON GENERAL BEST MANAGEMENT PRACTICES
CE	CIRCULAR ECONOMY
CONFAGRI	CONFEDERAÇÃO NACIONAL DAS COOPERATIVAS AGRÍCOLAS E DO CRÉDITO AGRÍCOLA DE PORTUGAL CCRL
COSTEIRA	VIÑA COSTEIRA SCG
DRAMA	ENOSI AGROTIKON SYNETAIRISMON DRAMAS (UNION OF AGRICULTURAL COOPERATIVES OF DRAMA)
ELASSONA	AGROTIKOS SYNETAIRISMOS FYTIKIS KAI ZOIKIS PARAGOGIS – ENOSI ELASSONAS (AGRICULTURAL COOPERATIVE OF PLANT AND ANIMAL PRODUCTION – UNION OF ELASSONA)
EU	EUROPEAN UNION
EUBOEA	ATYPI OMADA PARAGOGON TOMATAS DYSTOU (DYSTOS INFORMAL GROUP OF TOMATO PRODUCERS)
FARSALA	AGROTIKOS SYNETAIRISMOS “FARSALON GIS” (AGRICULTURAL COOPERATIVE “FARSALON GIS”)
GAIA	GAIA EPICHEIREIN ANONYMI ETAIREIA PSIFIAKON YPIRESION (GAIA EPIECHEIREIN SA – PROVIDER OF DIGITAL SERVICES)
gaiatron	NP’S SMART FARMING TELEMETRIC STATION
IACS	INTEGRATED MANAGEMENT AND CONTROL SYSTEM
ICM	INTELLIGENT CROP MANAGEMENT
IoT	INTERNET OF THINGS
KASTORIA	RADOPOULOS D. LTD
KIATO	GEOPONIKI KIATOU
KOMOTINI	THRAKIKA EKOKKISTIRIA
LASITHI	ENOSI AGROTIKON SYNETAIRISMON OROPEDIOU LASITHIOU (UNION OF AGRICULTURAL COOPERATIVE OF OROPEDIO LASITHIOU)
MESSINIA	AGROTIKOS SINETERISMOS MESSINIAS “ENOSI MESSINIAS” (AGRICULTURAL COOPERATIVE OF MESSINA “UNION OF MESSINIA”)
MIRABELLO	AGROTIKI ETAIRIKI SYMPRAKSI MIRABELLOU “UNION OF MIRABELLO” (AGRICULTURAL COOPERATIVE PARTNERSHIP MIRABELLO UNION S.A.)

NP	NEUROPUBLIC AE PLIROFORIKIS & EPIKOINONION (NEUROPUBLIC SA INFORMATION SYSTEMS AND TECHNOLOGIES
ORESTIADA	ENOSI AGROTIKON SYNETAIRISMON ORESTIADAS (UNION OF AGRICULTURAL COOPERATIVES OF ORESTIADA)
PC	PROJECT COORDINATOR
PELLA	NOVAPLAN IKE
QA	QUALITY ASSURANCE
SF	SMART FARMING
SPEKO-PESKO	KOINOPRAKSIA AGROTIKON SYNETAIRISMON – SPEKO-PESKO (CONSORTIUM OF AGRICULTURAL COOPERATIVES – SPEKO-PESKO)
STYLIDA	STYLIS OLIVE PRODUCERS COOPERATIVE
THESGI	SYNETAIRISMOS AGROTON THESALIAS (FARMERS' COOPERATIVE OF THESSALY)
THESTO	AGROTIKOS SYNETAIRISMOW THESTO (AGRICULTURAL COOPERATIVE OF THESSALIAN TOMATO PRODUCERS)
VELVENTOS	AGROTIKOS SYNETAIRISMOS EPEXERGASIAS KAI POLISEOS OPOROKIPEFTIKON PROIONTON (ASEPOP) VELVENTOU SYN.P.E (AGRICULTURAL COOPERATIVE FOR THE PROCESSING AND SALE OF HORTICULTURAL PRODUCTS)

3. Executive Summary

The present report summarizes the progress of the project LIFE GAIA Sense (LIFE 17 ENV/GR/000220) from 01/07/2018 to 30/06/2022. The main aim of the LIFE GAIA Sense project is to demonstrate the applicability of gaiasense, an innovative “Smart Farming” (SF) solution that aims at reducing the consumption of natural resources, as a viable means for the protection of the environment and the support of Circular Economy (CE) models.

More specifically, during the project a total of 18 demonstrators across Greece, Spain and Portugal, covering 9 crops (olives, peaches, cotton, pistachio, potatoes, table and industrial tomatoes, walnut, vine and kiwi) under different terrain and microclimatic conditions were launched. During the demonstrator pilots the efficiency of the gaiasense innovative method based on high-end technology, suitable for replication, accessible to and affordable by farmers either as individuals or collectively through Agricultural Cooperatives, will be assessed.

Moreover, LIFE GAIA Sense sought to promote resource efficiency practices in SMEs of the agricultural sector and eventually, contribute to the implementation of the Roadmap to a Resource Efficient Europe. This project demonstrated a method on the optimisation of the farmers decision making on the use or avoidance of certain inputs (irrigation, fertilizers, pesticides etc.), without risking the annual production. The potential of the resource consumption reduction side of CE was estimated based both on qualitative and quantitative assessments taking also into account the resources’ efficiency in the agricultural sector.

The project was multi-objective and intended to:

1. Setup and establish a large scale SF infrastructure for data collection and analysis and 18 Use Cases of gaiasense SF solution.
2. Establish a network of scientists and professionals and engage them in adapting the SF services and models to the specific needs of each demonstrator and each crop.
3. Apply the results to the field and measure the rate of decline of inputs on selected crops and correlate between the gaiasense results’ and the targets set as policy by EU over the CE.
4. Measure the impact of gaiasense on soil, water and air quality.
5. Disseminate the project’s results at national and EU level and build a robust business model to ensure their replicability and sustainability.
6. Form policy making proposals in order to implement efficient methods of managing resources in the agriculture sector.
7. Starting from investing on the success of small scale demonstrators, the project intends to attract the interest of larger stakeholder groups, to achieve the scale needed for adaptation efforts that make real sense e.g. from local cooperatives to organizations like Copa Cogeca.

During the reporting period the preparatory actions have been completed (A1, A2). Within the scope of Action A1, 13 Informative meetings (Full and light meeting) were conducted for the Use Cases of the 1st wave reaching approximately 500 stakeholders. During the Informative Meetings that took place, face-to-face interviews with the different actors have been held in order to establish cooperation between NP and the Use Cases but also to obtain a better understanding of the current cultivation practices, as well as the current fertilization, irrigation, and pest management processes and challenges. As far as the 2nd wave Uses Cases, and given the limitations imposed due to the Covid-19 pandemic, this valuable information was obtained through continuous phone and skype meetings with both the farmers, field agronomists and advisors but also with the exchange of explanatory emails.

Within the framework of Action A1 a scientific method for deploying the gaiatrons was developed. A web based and mobile based application design was completed in Action A2.

Implementation Actions B1-B9 started and concluded on time. In B1 training material has been prepared and in total 14 training events have been conducted in Greece, Spain and Portugal. Moreover especially in the case of the 2nd wave Uses Cases but also for those of the 1st wave, several training courses were held online in order to verify that all actors were continuously well informed of their duties and aligned towards the common targets set. In B2 a fully operational network of 59 gaiatrons and sensors has been deployed according to the methodology developed in A1 and 201 traps according to the trap placement study. In B3 cooperation with the scientific experts had been established and a total number of 18 irrigation models for 73 soil-climatic zones, 73 crop management models, and 18 fertilization models have been adapted. Moreover, 2 SF applications have been developed, the “gaiasense web-based application” and the “gaiasense mobile application”. Access has been provided for 34 unique users for the Gaiasense web based dashboard and 26 for the Gaiasense mobile application. In B4, B5 and B6 information about field activities in all Use Cases has been captured with the use of an IPM system parameterized for the needs of the project, called ICM. During growing seasons 2020 and 2021, SF advices were notified to the farmers and significant decreases in the use of inputs were noticed despite the difficulties arisen due to Covid-19 pandemic. More precisely,

Country		Baseline	2020		Baseline	2021	
		KPi	**Achieved variation**	**Optimum variation**	**KPi**	**Achieved variation**	**Optimum variation**
Greece	**Water consumption**	-19%	-5,62%	-16,84%	-19%	-11,13%	-19,55%
	Fertilizers	-18%	-16,46%		-19%	-22,84%	
	Pesticides	-21%	-24,69%	-43,08%	-21%	-35,29%	-34,58%
Spain	**Water consumption**	-10%	-22,23%	-8,16%	-10%	-23,44%	-23,44%
	Fertilizers	-8%	-2,57%			-9,45%	
	Pesticides	-10%	-2,57%	-14,16%	-10%	-14,16%	-73,20%
Portugal	**Water consumption**	-25%	-25,13%	-21,13%	-25%	-27,98%	-27,98%
	Fertilizers	-16%	-23,94%		-16%	-20,04%	
	Pesticides	-10%	-23,94%	-54,05%	-10%	-29,74%	-77,42%

In B7 the experimental setup for the environmental impact assessment of the smart farming applications has been completed In total, samples were collected from 11 different locations in Greece. In these locations it was possible to collect the necessary data, thus allowing for environmental impact assessment of SF through mathematical modelling. CropSyst was used to model crop rotations and crop productivity in reaction to soil, management practices (including N application) and weather. The contribution of emitted pollutants was alo calculated, as well as deposition fields for PM10 and NH3. A comprehensive evaluation of the environmental impact of demonstrator areas was undertaken and 9 BMPs were developed as policy recommendations. In B8 the initial replicability and transferability plan was set and the 5 new Use Cases for replicating the approach of the project starting from 2020 were identified. Within the framework of the Action, farmers, agricultural cooperatives, agricultural advisors, researches and developers were recognised as key stakeholders, Spain, Portugal, Greece, Romania and Cyprus are the countries to replicate the SF solution and the located potential sectors for applying the gaiasense solution are the greenhouses and the indoor farming. In B9 the initial and final business model were developed using the Business Model Canvas methodology including informarion gathered within the framework of the market analysis. For each targeted country, key partners, activities, resources, channels, costumer relations and segments were recognized as well as the expected revenues and profit.

Action C1 focused on all necessary activities to prepare and collect questionnaires for capturing base information to which end results were compared to monitor the impact of the project. A total number of 33 questionnaires were analysed. Performance indicators for environmental and socio-economic impact were calculated. The analysis of the indicators showed that the targeted reductions were accomplished (and surpassed) for most of them (PM10, NOx, NMVOC, CO2 and CH4), while NH3 and N2O emission targets were not managed to be reached, but their emissions showed high/significant reductions, close to targeted ones. As for phosphorus inputs to field through fertilization, a decrease of 18.6% was calculated, while regarding phosphorus losses in water from fertilization, they have shown a decrease of 3.5%. As far as the dissemination is concerned, (Action D1) the project is actively presented in social media (Facebook, twitter, YouTube, LinkedIn). Dissemination material was developed including dissemination templates, 2 brochures, 4 posters, 4 roll up –banners have been created and 18 notice boards have been printed and distributed to all partners. Six newsletters were produced and circulated to more than 40000 people each and more than 40 coverages were published both in online and printed press in all three countries. The project was presented in 15 conferences/fora and symposia, 6 fairs/exhibitions and 8 workshops. Moreover 18 webinars have been prepared for all Use cases and 2 informative videos have been created. As far as the LIFE GAIA Sense policy uptake (Action D2) strategic planning identified 7 suitable key messages:

KM 1 - Smart farming can bring concrete sustainability benefits to all EU farmers, whichever the size & production orientation of their farm;
KM 2 - Smart Farming needs to be understood as a holistic process that involves Precision Farming as part of the process. Smart Farming regards the use of digital technology to improve the overall decisions taken in a farm while Precision Farming focuses on application methods;
KM 3 - Smart Farming is closely linked with the provision of smart advice to farmers: it is a human-centered approach where the agricultural advisor plays a key role in the systematic diffusion of knowledge to the farmer, accompanying his sustainability efforts all along the way, based on accurate data and scientific knowledge. The agricultural advisor also acts as innovation broker bringing together knowledge & data from all involved stakeholders & machinery (scientists, agronomists, farmers);
KM 4 - Smart Farming is not competitive but compatible to other sustainable agricultural practices (ie organic farming);
KM 5 - Collective farmers' schemes (agri-cooperatives, producer organizations) are advantageous platforms for the diffusion of knowledge & innovation to farmers in an environment of trust, thus contributing to speeding up the digital transition of the EU farming sector;
KM 6 - Smart Farming needs to be explicitly recognized as a sustainable practice & be supported with suitable policy tools and financing as such;

KM 7 - Smart Farming should be enabled and supported not only within the CAP policy toolbox, but also in the context of other EU policies.
These messages were selected in order to reach out to policy makers and maximize the project's impact, taking advantage of GAIA EPICHEIREIN's strong presence and reputation in the Brussels agri-food lobbying sphere.
The policy uptake actions undertaken were instrumental in both maximizing the impact of the LIFE GAIA Sense project and achieving concrete policy outputs something that was achieved also during the Final Policy uptake event in which 4 MEPs participate as well as high level stakeholders from the European Commission and organisations.

The project was managed in a very efficient way (Action E1), solving any upcoming problems in the best possible way.

All due deliverables were submitted on time with the only exception of Deliverables

- Report of environmental simulation and impact assessment models (Action B.7.)
- Report on soil and water samples collection and analysis(Action B.7.)

which were delayed due to delays of analyses performed in laboratories as a result of the Covid-19 pandemic.

Website as well as all dissemination material produced within the framework of Action D.1 were duly prepared and used in the relevant dissemination opportunities.

4. Introduction

Environmental problem/issue addressed

By 2050, global population is expected to reach 9 billion (Seelan et al., 2003)[1], which means a 70% increase in food production (FAO, 2009)[2]. The nutritional needs of future generations will put further enormous pressure on resources. Historically, the increased demand for food production was based on high use of fertilizers, pesticides and water as well as fossil fuels for the agricultural sector. The irrational use of these resources explains the negative effect of agriculture in major environmental issues like poor soil and water management, low resource efficiency, poor air quality and greenhouse effect.

The targeted environmental problem is identified at the development of a model on how to improve crop production using all the necessary resources in the most efficiently way. The problem consists of direct environmental factors (e.g. depletion of resources) and indirect factors (e.g. farmers' reluctance to apply innovative techniques) and applies to irrigation, fertilization and pest management.

Gaiasense has been developed as a resource efficiency tool for agricultural enterprises. Its main purpose is to monitor crops, collect data and offer advices about irrigation, fertilization and pesticides based on soil, weather and plant nutrition data. This philosophy leads to an increase of resource efficiency promoting green (sustainable) and circular economy, at the agriculture sector. This project is implementing the circular economy concept through actions spanning the value chain, by minimizing the inputs (chemicals and harmful compounds) which means less outputs and waste to process.

Hypothesis to be demonstrated/verified by the project

The way that LIFE GAIA Sense is designed, offers to agribusiness the ability to implement a new model for resource efficiency cultivation, by establishing innovative practices particularly for farmers and cooperatives who have lower ability to invest in new equipment. The main hypothesis to be tested and validated within the project is the correlation of the SF solution with the improved cultivation practices and the EU policy over CE.

Description of the technical/methodological solution

gaiasense computing services called gaia cloud and SF advisory services called gaiasense services. Gaiatrons are telemetric autonomous stations that collect data from sensors installed in the field and record atmospheric and soil parameters. Gaiatrons are specially designed for providing exact fit to the operational requirements of gaiasense. Dense installation network under the canopy, large scale deployment, low operation cost and mobility are some of these operational requirements in order for gaiasense to be viable and commercially successful.

At the heart of gaiasense is the gaia cloud platform, a set of computing services allowing not only the management of the IoT infrastructure but also the fusion and transformation of data into knowledge and finally to well-documented advices. The interaction with the platform is taking place through an API which allows the development of web applications that are able to run either using the gaia cloud deployment units or other units that are hosted by other/3rd party platforms, thus, extending gaiasense's business model.

[1] https://www.sciencedirect.com/science/article/pii/S0034425703002360
[2] http://www.fao.org/3/a-i0680e.pdf

Gaiasense SF services provide fertilization advice, irrigation advice and hazard warning. Fertilization advice refers to the proper fertilization prescriptions leading to input cost reduction, increased yields and improved plants' health. The irrigation advice refers to the potential to drastically reduce water consumption, fertilizer consumption, soil fungus hazards and control fruit quality characteristics, etc. Hazard warnings refer to the production of warnings along with advice for managing certain risks associated with extreme weather conditions, pests, insects, weeds.

Data is the raw material for the gaiasense approach and there are 5 different means of collecting data, which gaiasense is able to collect from, depending on the needs: Data directly from the field with gaiatrons; from proximity with the plants and the soil with mobile sensors; remotely with image sensors on aerial or in-orbit platforms; forecasting the weather and by monitoring the application of inputs and outputs in the farm.

Gaiasense is combining advanced data handling techniques (i.e. assimilation, fusion and spatiotemporal interpolation) to transform the collected data into actionable advices. In order for this advice to best reflect the actual situation at a given field, scientific models are developed incorporating the human experience of the farmer or advisors.

To ensure the sustainable incorporation of this process into the farmers' practices, training is provided to the farmers and advisors in applying the advice correctly. Producing an advice which is being fed by a broad range of data, powered by both scientific knowledge and human experience and supporting its application, is the single most important innovation of this proposal.

Expected results and environmental benefits

The project aims at demonstrating a novel approach for offering reliable advice to farmers in order to use resources in a more efficient and sustainable way. Gaiasense as a close to market solution aims to reduce: Fertilizers (NH_3 and P up to 34% and 11% respectively), Water consumption up to 25%, Energy consumption up to 25%, Greenhouse gas emissions (GHG) / Nitrous Oxide up to 32%, Air pollution and emissions (PM10 emissions up to 10%, Nox and VOCs emissions up to 15%, NH_3 emissions up to 30%), Reduction / substitution of dangerous substances (Irritant / Corrosive / Toxic up to 11%, Persistent / Bioaccumulative up to 34%).

Expected longer term results (as anticipated at the start of the project)

In the long term, the project aims at implementing new business models for resource efficiency, including establishing resource efficiency practices in Small and Medium Sized Enterprises (SMEs), focussing on the environmental impact, durability, reuse, repair and recycling of their products. This is planned to be in line with the priorities set in the Roadmap for a Resource Efficient Europe and the national and European policy and legislation.

5. Administrative part

The project management process

NEUROPUBLIC AE PLIROFORIKIS & EPIKOINONION is the coordinating beneficiary responsible for the coordination of the project and leading its QA activities. The management structure included the following roles. The PC was in close cooperation with the Technical Manager (TM), Pilots and Outreach Manager (POM), the Business & Replicability Manager (BRM) and the Financial Manager. The Technical Manager (TM) was responsible for monitoring the technical development and deployment of the proposed solution. The Pilots and Outreach Manager (POM) was responsible for the efficient and successful outreach of project in all the relevant communities. The Business & Replicability Manager (BRM) was responsible for designing the business model and the replicability strategy to ensure the sustainability of the project outcomes and the maximization of their impact after the end of the project. The Financial Manager (FM) was responsible for all the financial and administrative issues of the project

Three boards were formed namely: The Project Board (PB) responsible for the supervision of the project, as its formal decision-making body and its highest level of management. The Advisory board (AB) featuring experts representing both the industry and the respective research community. The AB consisted of Dr. Sander Janssen from Alterra WUR, Dr. Spyros Fountas, the Editor-in-Chief in the ELSEVIER journal "Computers and Electronics in Agriculture" and Mr. Juan Sagarna on behalf of Copa and Cogeca. Mr Peter Paree from ZLTO, was announced as the 4th member volunteering to participate through skype when needed. The Executive Board (EB) consisted of all Action Leaders (ALs) who manage the operational activities within their actions. The EB was responsible for monitoring the progress across partners in the actions and ensuring that objectives, timescales and milestones are met.

During the Kick-off meeting in Athens, 25-26.07.2019, the management structure as well as management processes (i.e. preparation of deliverables, financial reporting etc.) were presented, discussed and agreed with all the members of the consortium. Regarding technological means and solutions to be used within the project, Google online services such as google drive and google docs were chosen for exchange of technical and financial documents and data, doodle services for scheduling meeting and skype for virtual meetings. Regarding the financial part, timesheets and other supporting documents are sent to the PC every 3 months.

All partners were in close communication to each other and to the PC since the beginning of the project. Emails and skype calls were organized among all or between individual partners depending on the issues to be discussed whenever needed. Physical meetings with all partners were initially organized to take place every 6 months. However due to travel restrictions as a result of the Covid-19 pandemic, led to the realisation of 4 physical and 4 online meetings.

Communication with the Agency and Monitoring team.
NP was in close communication with the Monitoring team through visits, emails and telcos. A detailed report about the progress project was provided every 3 months to the project monitor by phone. No amendment has taken place.

6. Technical progress, per Action

Action A1: Informative meetings with stakeholders, requirements elicitation and performance indicators definition

Foreseen start date: 01/07/2018 Actual start date: 01/07/2018
Foreseen end date: 31/12/2018 Actual end date: 30/06/2022

The Action A1 started on time and its main objectives were to raise awareness, set up the first wave of 13 Use Cases starting from the 1st year of the project and develop and implement the gaiatrons' placement study. The 13 Use Cases chosen were: 11 in Greece: AEGINA, STYLIDA, KIATO, THESTO, THESGI, ELASSONA, ORESTIADA, SPEKO-PESKO, VELVENTOS, MIRABELLO, and LASITHI, 1 in Spain: COIO BRANCO & SAN CIBRAO, and 1 in Portugal: BEJA & SERPA.

Informative meetings (A1.1) have been conducted by GAIA in all 13 areas of the Use Cases in October and November 2018 as planned in the proposal. Approximately 500 interested stakeholders (farmers, agronomists, agribusinesses) were reached. The project objectives and means were presented. In interactive sessions, information about the current agricultural practices and challenges were retrieved from the participants and the list of interested farmers and potential parcels was set up (A1.2). Indicative information regarding the agricultural practices about irrigation, pest management and fertilization, the challenges and constraints, the profile of the organization, etc were collected To ease the process and organize the information, a template was designed and used for each Use Case.
In 3 cases namely THESTO, THESGI and ELASSONA, during our preparatory communications with the organizations, it was commonly agreed that a first Light Meeting would be necessary, engaging only key persons from each cooperative, in order to fully convince them to participate to the project. For the cases where a Light Meeting took place, the full Informative Meeting that was originally planned, would take place later, and particularly until September 2020 (in order to show results from the first year of applying the advice as requested by the local Use Case partners). This adjustment was communicated to the project monitor during the project visit on January 14th 2019. Given the restrictions due to the Covid-19, it was not possible to realize these full meetings and communication of the initial results was done through bilateral meetings with farmers and phone calls. In Spain and Portugal, the Informative meetings were combined also with trainings. Additionally, within the scope of Action A1, a scientific method was developed by NP for defining the location of the gaiatrons based on certain climate and soil conditions (A1.3).
In the framework of the "Replicability and transferability strategy development" (Action B.8) 5 new demonstrators in Greece were selected: MESSINIA, ARTA, FARSALA, EUBOEA, PELLA. Given the restrictions due to the Covid-19, it was not possible to realize physical informative meetings also in these Use Cases. In order to collect the necessary information about the current agricultural practices and challenges, continuous phone and online meetings, and exchange of explanatory emails took place both with farmers but also with field agronomists and advisors.

For further details please see deliverables in Project's website:
- Informative meetings report, including list of demonstration parcels and telemetric stations network deployment plan
- Documentation of use case existing agricultural practices and restrains, requirements, needed interventions and KPIs

Action A2: Smart farming application design

Foreseen start date: 01/10/2018 Actual start date: 01/10/2018
Foreseen end date: 31/03/2019 Actual end date: 31/03/2019

The scope of the action A2 was to define the design of the Smart Farming (SF) application that were to be implemented and used within the scope of the project. The targeting users of the smart farming applications are farmers, advisors and agronomists.

Two distinct versions of the service have been designed:
a) The gaiasense web-based application to be utilized by the agronomists and the advisors through resource rich devices (e.g. desktop and laptop personal computers).
b) The gaiasense mobile-application to be utilized by the farmers through mobile devices (e.g. smart-phones, tablets).

Both applications are based on the gaiasense cloud services which serve as a common back-end information management set of services that provide access to the necessary data both to gaiasense web-based and the mobile apps in support of their overall functionality.

A first version of the mock-ups was presented to agronomists in face2face meetings at the premises of NP in December 2018 and to the partners during the 2nd Project Meeting in January 2019. The agronomists and partners evaluated the design and made suggestions regarding the different types of information that are of interest for the different user groups. The suggestions were incorporated in the final design of the mock-ups which was completed in March 2019.

For further details please see deliverable in Project’s website:
- Final application design and mockups

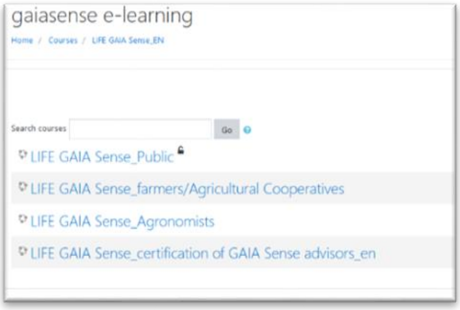
Action B1: Community Engagement and Support

Foreseen start date: 01/07/2018 Actual start date: 01/07/2018
Foreseen end date: 30/06/2022 Anticipated end date: 30/06/2022

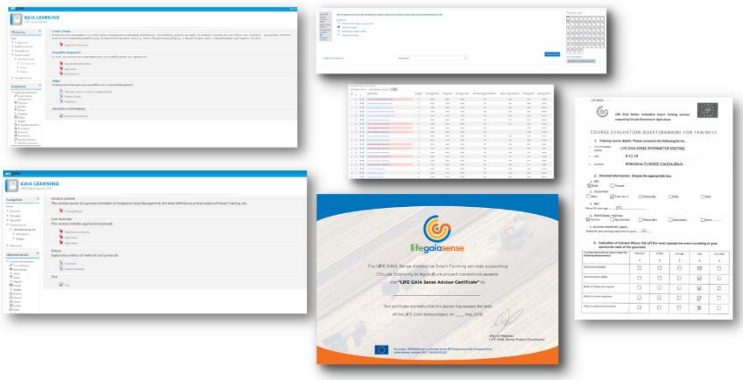
GAIA in collaboration with the consortium built up a database of active members (329), who were systematically contacted and involved in the LIFE GAIA Sense project and its activities (see Appendix VI of the revised Deliverable: Annex_3_LIFE_GAIA_Sense_Training Plan and Material_v1.1_B.1).
Thirty (30) meetings and visits to agricultural cooperatives have been done in the context of this action & the implementation activities of Action B.4. Furthermore, the Advisory Board was formed and consists of: Dr. Janssen, Dr. Spyros Fountas and Mr. Juan Sagarna. Mr Peter Paree, was announced as the 4th member volunteering to participate through skype when needed (B1.1). The formed advisory body was informed at the first semester of 2020 about the first results of the project and right after the first trimester of 2021 about the results of the 2nd cultivating year that the SF were applied. In addition to this, advice on how to implement and disseminate the project, through bilaterally meetings with representatives of GAIA and NP was given, as for example Mr. Foundas explored the possibility to disseminate LIFE GAIA Sense in the Smart-AKIS community, led by AUA, as well as in the communities of other prestigious projects where AUA is partner, was also discussed in length. AUA helped in the dissemination of LIFE GAIA Sense in the social media channels of the projects they were involved in. A special focus was on connecting to the pan-European network of DIHs of SmartAgriHubs project, as well as the network of the forthcoming EDIHs that will be funded by the "Digital Europe" funding programme. Also, Dr Janssen provided input based on the current lessons learnt from applying agrienvironmental monitoring practices in the context of NIVA project. A discussion took place on a potential future collaboration to examine the possibility of combining the currently exploited data with additional data coming from a European soil repository, to support the creation and provision of new added-value services for farmers and policy makers. From his side, Peter Paree highlighted the need for local presence and he highlighted the need to continue collecting results over the next years, to ensure that we have data on the performance of gaiasense, covering a range of years with different conditions, something that will allow us to extract safer conclusions. The current status but also the future plans to disseminate LIFE GAIA Sense in the Copa Cogeca community was discussed in length, focusing especially on potential presentations of the project results at a European level.

To enable the end users and collaborators to understand the value of gaiasense solution and how to use its services most efficiently, it was important to provide appropriate training and material (B1.2). The curriculum for the 1st and 2nd phase of training events and the specific material was completed on time. In the context of these two phases, 11 training events were held in Greece and 2 in Ourense (Spain) and Lisbon (Portugal). GAIA created questionnaires regarding the evaluation of trainers and trainees and the effectiveness of the training procedure. The questionnaires were translated into English, Portuguese and Spanish with the valuable help of VIÑA COSTEIRA and CONFAGRI and circulated to project partners. The results of these questionnaires for the 1st and 2nd phase of the training events indicated that the trainers, the training course and materials met the expectations of the trainees. Moreover 30 training courses of a total duration of 77 hours were conducted via Skype and a training event for agronomists was organized in Athens 15-17.04.2019 with 35 participants. In this event the tool for documenting the applications in the field was presented and training on the several aspects of data collection and application of the smart farming advice on the field was provided.

In the framework of the 3rd phase of the training events, GAIA included webinars at the project's e-learning platform, Moodle (https://elearn.neuropublic.gr) focused on a wider audience. In these webinars 3 main topics were developed (Smart Farming, Integrated Crop management and gaiasense system), are available both in Greek & English version and are "open" - accessible to anyone, since no login is required. Up until the end of the reporting period 187 guests had visited the Greek version of the LIFE GAIA Sense Public webinar and 230 the English one. In order to maximize the impact of the project, 18 differiented videos have also been created and uploaded both in the Moodle but also to the online sites of project partners. Each video has, as mentioned above, differentiated content depending on the selected crop and the results of the project in the specific area.



Moreover, GAIA has created a Moodle in a e-learning platform (in Greek & English version) in order to provide appropriate training to : collaborators, end users and policy makers/general public. More specifically, GAIA has created webinars focused on abovementioned target groups at gaiasense platform accompanied with relevant training material concerning the project translated from/to Greek and English . Taking into account the trainees' needs and requirements specific sessions have been created addressing to each defined trainee category. In each category multimedia training material such as presentations, manuals, videos and useful links are available in order to enhance trainees' knowledge and expertise and it is aligned to the proposed curriculum. The number of engaged users at the updated version of the e-learning platform is constantly enriched. So far, 316 unique users are registered at LIFE GAIA Senses Moodle. Specifically : 167 users at "LIFE GAIA Sense_αγρότες/ αγροτικοί συνεταιρισμοί" module, 106 users at "LIFE GAIA Sense_Γεωπόνοι" module, 21 users at "LIFE GAIA Sense_Farmers/ Agricultural Cooperatives" module and 22 users at "LIFE GAIA Sense_Agronomists module".



Moreover, specific tests have been created with the valuable help of our partners who are agronomist experts with extensive experience in farming advisory in order to train and certificate GAIA Sense advisors (B1.3). These tests are actually in the form of procedures and guidelines creating a mechanism for providing support to the farmers when applying to the field the SF advices issued by the gaiasense system. To compliment that end, a LIFE GAIA Sense certification procedure regarding advisors has been designed and put into place.

The Community Support Mechanism includes a) Advisors from GAIA supporting end users in applying the smart farming advice on the field, b) the team of NP supporting end users in using the gaiasense services and applications, and c) Advisors from the cooperatives. So far, 44 people have been certified as LIFE GAIA Sense advisors with an average score of

84.5%. A total of 69 users have registered on the Greek version of the platform, 46 of whom have completed the certification test. Of the 46, 44 have achieved a score of more than 70% and have received the relevant certification. 19 users have registered on the English version of the platform, but none of them has completed the test.

For further details please see deliverables in Project’s website:
- Training plan and material
- Final training report

Action B2: Deployment and operation of infrastructure for data collection and analysis

Foreseen start date: 01/12/2018 Actual start date: 01/12/2018
Foreseen end date: 31/12/2021 Actual end date: 31/12/2021

Within Action B2 telemetric stations and traps were deployed in each Use Case by NP. Based on the results of the placement study (Action A1) a plan was set up on organizing the trips for the deployment. A total number of 59 gaiatrons and sensors have been deployed on the 18 Use Cases (B2.1).

Based on the traps placement study a total number of 201 traps were deployed in the Use Cases (B2.2). In Spain and Portugal, the traps were already in the field from previous years, so no more action was needed. In the Greek Use Cases and depending on the crop the traps were placed until the end of June 2019 as foreseen in the proposal and were replicated accordingly in the two following years as soon as travel restrictions were suspended due to Covid -19.

A minor change had to take place in KIATO. Although the initial plan was to include "Helicoverpa armigera" in the list of enemies and deploy traps, no occurrence of this enemy during the cultivation period was observed. Therefore, there was no need for traps in this case as the enemy will not be further studied in the project. Similarly a minor change had to take place in ARTA since no occurrence of enemies during the cultivation period was observed, therefore, there was no need for traps. Should be also noticed that in KASTORIA that replaced EUBOEA the identified enemy was in both cases "Helicoverpa armigera" so all necessary actions were completed on time without any problem.

As far as the activities required to collect and analyze data in the cloud computing infrastructure of NP (B2.3), it should be mentioned that the core sources of data were: The installed network of telemetric stations (fixed IoT sensors), remote sensing platforms providing satellite data (Sentinel 1&2, Landsat), manually imported data from farmers and advisors referring to applied cultivation practices, number/type of insects captured in traps, and farm properties. All data collections were periodically transmitted to a cloud computing data repository where data were homogenized, stored and processed. The outcomes of the processing were analysed by experts (e.g. agronomists and data experts) in order to generate SF advices towards the optimization of irrigation, pest management, and fertilization, tailored to the context of the specific parcel. For each of these categories an analysis was conducted elaborating on the nature of data items, the information properties that the data types correspond, and an estimation of the update frequency. Overall the implemented data collection process proved to be sound and robust mitigating successfully the various disruptions that can occur given also the harsh conditions at rural areas.

For further details please see deliverables in Project's website
- Traps placement study
- Report on the deployed networks of Telemetric stations and Traps
- Data report

Action B3: Development of Smart Farming models for selected crops and services and Smart Farming application

Foreseen start date: 01/01/2018 Actual start date: 01/01/2018
Foreseen end date: 31/12/2021 Anticipated end date: 31/12/2021

Action B3 is focusing on the development of the scientific models used for the production of smart farming advice on irrigation, fertilisation and pest management for all demonstrators as well as the development of the web and mobile services of the project.

For each Use Case a number of irrigation and pest management (enemies and diseases) models of interest were defined in collaboration with the agronomists of NP, the agronomists and farmers of the Use Cases and the Professors (subcontractors). For the first wave of 13 Use Cases, 13 irrigation models for 44 soil-climatic zones (B3.2) and 35 diseases and 23 pest management models (B3.1) and 13 fertilization models (B3.3) were defined.

For the development of the scientific models in Greece, NP had already established collaborations with well recognized scientific experts and universities from Greece which are subcontractors in the project. The experts started to work close with personnel of NP for developing and optimising the models. Contracts were prepared and signed between NP and the scientific experts and universities for the development of irrigation and pest management models (B3.1 and B3.2). As far as fertilization is concerned, existing models are used and adapted to certain conditions of the Use Cases (B3.3).

For Spain and Portugal, NP, by the end of December 2019 an initial form of the models was delivered by the scientific experts to NP. After the completion of the first cultivating year (end of 2020) an updated form of the models was delivered by experts based on observations and trap catches, followed by a final one after the completion of the second cultivating year (end of 2022)

For the second wave of 5 Use Cases, 5 irrigation models for 29 climatic zones (B3.2) and 9 disease 6 pests management models (B3.1) and 13 fertilization models (B3.3) were defined. Given the existing cooperation with the scientific experts, new contracts were prepared for the development of the scientific models. An initial version of the models was delivered by the scientific experts to NP and an updated one based on observations and trap catches, by the end of cultivating year (end of 2022).

Regarding the application development (B3.4), both the gaiasense web-based application and the gaiasense mobile application were developed. Particularly for the gaiasense mobile application although it was fully functional, it was considered necessary to proceed to further improvements especially regarding off-line functionality. Overall there were created accounts for 34 unique users for the Gaiasense web based dashboard and 26 accounts for the Gaiasense mobile application. In addition regarding both applications, and as the applications were used, minor additional improvements on lay-out design and use experience were conducted.

For further details please see deliverables in Project's website:
- Initial Smart Farming Application
- Final Smart Farming Application
- Final technical testing and user validation report
- Final specialised scientific models

Action B4: Application of good agricultural practices/Smart Farming advice in Greece

Foreseen start date: 01/01/2019 Actual start date: 01/01/2019
Foreseen end date: 28/02/2022 Actual end date: 28/02/2022

During the first cultivation period of the project (from Spring to Autumn 2019) farmers and agronomists/farming advisors of the Use Cases were contributing a lot to Action B4 with sharing information about their cultivation practices such as when and how much they irrigated the fields, which product they applied for pest management accompanied with the concentration and the targeted enemy, when, how much and what type of fertilizers they used etc. and the costs of all above. Similar information was gathered for Use Cases that participated in the second wave of the project (cultivating period 2020). This information was shared with NP and the scientific experts for developing and adapting the models but also for creating the baseline – reference costs for each Use Case.

All these applications on the field, were documented with the aid of specific forms. The platform which was used by farmers and agronomists was the ICM which has been developed by NP and is one of the existing services that were configured and used within the LIFE GAIA Sense project (B4.2). The ICM was used to record all information that is related to the daily cultivation work of the producer. This is the full and detailed picture of the exploitation, which contributes significantly to the decision-making process. The aforementioned data were also combined with valuable information which were collected uninterruptedly by the gaiatrons that refer to the atmospheric, soil and biological parameters, such as air and soil temperature, air and soil humidity, soil salinity, leaf wetness, rainfall, solar radiation and so on. All the above were combined with the information gathered from other gaiasense system dimensions (gaiasense remote and gaiasense eye).

The data that were collected through the four dimensional system are of different importance and therefore they are analyzed and processed with the valuable experience and help of gaiasense advisors (scientists and agronomists) who are able to better understand the special needs and conditions of each plot.

So, during a cultivating year, all four (4) dimensions had to continuously work properly for the continuous data feed into the gaiasense system and into the ICM platform so as to have automated irrigation, fertilization and pest management SF advices issued by the system which needed to be interpreted and handled/characterized by the advisor. However given the fact that both farmer and advisor are key actors of the gaiasense system, the establishment of a high level of timely and direct communication and collaboration among each other was crucial for the best implementation of the SF system.

This process took place for two years for the 1st wave of the 11 Greek demonstrators (January 2020 - December 2021) and one year for the 2nd wave of the additional 5 Greek demonstrators (January - December 2021).

In the following table are presented the average reductions achieved as far as costs are concerned

	Baseline	2020		Baseline	2021	
	KPi	**Achieved variation**	**Optimum variation**	Reduction targeted goal	**Achieved variation**	**Optimum variation**
Water consumption	-19%	-5,62%	-16,84%	-19%	-11,12%	-19,55%
Energy consumption	-20%	-19%		-20%	-20,18%	
Fertilizers	-18%	-16,46%		-19%	-22,84%	
Pesticides	-21%	-24,69%	-43,08%	-21%	-35,29%	-34,58%

Also in the following table are presented the average reductions achieved as far as actual values of quantities are concerned

	Baseline	2020		Baseline	2021	
	KPi	**Achieved variation**	**Optimum variation**	Reduction targeted goal	**Achieved variation**	**Optimum variation**
Water consumption	-19%	-5,62%	-16,84%	-19%	-11,13%	-19,55%
Fertilizers	-18%	-4,92%		-19%	-4,02%	
Pesticides	-21%	-25,91%	-50,78%	-21%	-32,23%	-61,62%

Should be noted in 2021 a total of 911 irrigation actions that took place in the field 773 were the result of a SF advice. Similarly in a total of 202 pest management actions that took place in the field 106 were the result of a SF advice.

For further details please see deliverables in [Project's website]:

- First report from the application of the Smart Farming advice in Greece
- Final report from the application of the Smart Farming advice in Greece

Action B5: Application of good agricultural practices/Smart Farming advice in Spain

Foreseen start date: 01/01/2019 Actual start date: 01/01/2019
Foreseen end date: 28/02/2022 Anticipated end date: 28/02/2022

In COSTEIRA, two parcels were defined to participate in the project. Both of them belong and are managed by the organization and are located in Coio Branco and San Cibrao.

COSTEIRA used the ICM for documenting the activities on the field regarding irrigation, pest management and fertilization (B5.2) and was in close cooperation with NP and GAIA particularly at the beginning of the cultivation period in order to get familiar with the platform. All users are familiar with the platform and constantly enriching it with new information. The action had similar activities, progress and difficulties as B4 with the only difference being the implementation of it in Spain. In order to omit duplicates, all related information can be found in the description of Action B4.

This process took place for two years (January 2020 - December 2021)

In the following table are presented the average reductions achieved as far as costs are concerned

	Baseline	**2020**		**2021**	
	KPi	**Achieved variation**	**Optimum variation**	**Achieved variation**	**Optimum variation**
Water consumption	-10%	-22,23%	-8,16%	-23,44%	-23,44%
Fertilizers	-8%	-2,57%		-9,94%	
Pesticides	-10%	-2,57%	-14,16%	-14,16%	-73,20%

Also in the following table are presented the average reductions achieved as far as actual values of quantities are concerned

	Baseline	**2020**		**2021**	
	KPi	**Achieved variation**	**Optimum variation**	**Achieved variation**	**Optimum variation**
Water consumption	-10%	-22,23%	-8,17%	-23,44%	-23,44%
Fertilizers	-8%	-2,58%		9,44%	
Pesticides	-10%	20,10%	-2,56%	-6,37%	-47,06%

Should be noted in 2021 a total of 13 irrigation actions that took place in the field 13 were the result of a SF advice. Similarly in a total of 42 pest management actions that took place in the field 17 were the result of a SF advice.

For further details please see deliverables in Project's website:

- First report from the application of the Smart Farming advice in Spain
- Final report from the application of the Smart Farming advice in Spain

Action B6: Application of good agricultural practices/Smart Farming advice in Portugal

Foreseen start date: 01/01/2019 Actual start date: 01/01/2019
Foreseen end date: 28/02/2022 Anticipated end date: 28/02/2022

Regarding CONFAGRI, two organizations were identified for running the project in the field. The one is the Professional School of Rural Development in Serpa and the Cooperativa Agrícola de Beja e Brinches. One parcel in each region (Beja and Serpa) is participating in the project.

CONFAGRI used the ICM for documenting the activities on the field regarding irrigation, pest management and fertilization (B6.2) and was in close cooperation with NP and GAIA particularly at the beginning of the cultivation period in order to get familiar with the platform. All users are familiar with the platform and constantly enriching it with new information. The action had similar activities, progress and difficulties as B4 with the only difference being the implementation of it in Portugal. In order to omit duplicates, all related information can be found in the description of Action B4.

This process took place for two years (January 2020 - December 2021)

In the following table are presented the average reductions achieved as far as costs are concerned

	Baseline	**2020**		**2021**	
	KPi	**Achieved variation**	**Optimum variation**	**Achieved variation**	**Optimum variation**
Water consumption	-25%	-25,13%	-21,13%	-27,98%	-27,98%
Fertilizers	-16%	-23,94%		-20,04%	
Pesticides	-10%	-23,94%	-54,05%	-29,74%	-77,42%

Also in the following table are presented the average reductions achieved as far as actual values of quantities are concerned

	Baseline	**2020**		**2021**	
	KPi	**Achieved variation**	**Optimum variation**	**Achieved variation**	**Optimum variation**
Water consumption	-25%	-25,13%	-21,13%	-27,98%	-27,98%
Fertilizers	-16%	-23,31%		-20,55%	
Pesticides	-10%	113,63%	-1,40%	29,57%	-60,76%

Should be noted in a total of x188 irrigation actions that took place in the field 188 were the result of a SF advice. Similarly in a total of 8 pest management actions that took place in the field 2 were the result of a SF advice

For further details please see deliverables in Project’s website:

- First report from the application of the Smart Farming advice in Portugal
- Final report from the application of the Smart Farming advice in Portugal

Action B7: Environmental impact assessment of Smart Farming application

Foreseen start date: 01/07/2018 Actual start date: 01/07/2018
Foreseen end date: 30/06/2022 Anticipated end date: 30/06/2022

Action B7 is led by AUTH and particularly the Laboratory of General & Agricultural Hydraulics & Land Reclamation and the Laboratory of Heat Transfer and Environmental Engineering. The two laboratories coordinate their activities aiming at a holistic and realistic assessment of the environmental impact of the SF solution of the project.

Soil samples were collected in a given (by NP) experimental network of sampling locations during the time period of 2019-2021 (B.7.1). In each one of the sampling locations, two demonstrator areas were assigned: a "reference" and a "treatment" area. The treatment areas were situated in a field where SF approach was used. For each treatment area, a reference area was assigned, which was similar in important respects, except that it was situated in a field where the usual crop management, irrigation, fertilization and pest management practices were applied.

In total, samples were collected from 11 different locations (pilot cases) in Greece, namely: THESGI, ORESTIADA, THESTO, KIATO, LASITHI, SPEKO-PESKO, ELASSONA, VELVENTOS, STYLIDA, MIRABELLO and AEGINA. In these locations it was possible to collect the necessary data, thus allowing for environmental impact assessment of SF through mathematical modelling (B7.2). In these locations, 9 different crops (both annuals and perennials) were cultivated: cotton, industrial tomato, table tomato, potato, kiwi, walnut, peach, olive and pistachio. In each location, soil samples were collected from both areas (reference and treatment), at least three times through the growing season (before, during and after growing season), and at three different depths (0-30 cm, 30-60 cm and 60+ cm).

In 2019, soil sampling was carried out only at the location of THESGI, four times during the crop growing season. The particular location was selected because of its close proximity to A.U.Th., so as to be the case for the design of the experimental network and for the setup and initial evaluation of the model approach (B7.2). Moreover, this location was selected due to the crop type (cotton) which is a dynamical and annual crop cultivated in large areas and of great interest in Greece.

Due to Covid-19 pandemic restrictions, it wasn't possible to visit all pilot cases in 2020 such as KIATO, AEGINA, MIRABELLO and LASITHI where a hotel accommodation was required but wasn't feasible due to health measures. However, the required field data for the model elaboration were collected by the AUTH team, despite the difficult and health risk circumstances, in the 2020-2021 study period.

After, the soil samples were transferred to the laboratory of AUTH. and further analyses were conducted on: soil texture, pH, organic matter, $CaCO_3$, available P, available Nitrogen Nitrate (NO_3^--N) and Nitrogen Ammonium (NH_4^+-N), Cation Exchange Capacity (CEC), Exchangeable Cations (K, Na, Ca, Mg), electrical conductivity (EC), Total Dissolved Salts (TDS) and Exchangeable Sodium Percentage (ESP). Access to the meteorological data, soil moisture and salinity sensors of the gaiatron station in Girtoni was provided by NP to A.U.Th.

The measured data have been used also as inputs for the environmental modelling procedure within sub-action B7.2 in order to assess the environmental impact of the proposed SF application. More precisely LHTEE used the CropSyst, a multi-year, multi-crop, daily time step cropping systems simulation model. CropSyst model was selected for its robustness and relative ease of application, using commonly available data, involving different cropping systems, management options, and soil and climatic conditions.

CropSyst was used to model crop rotations and crop productivity in reaction to soil, management practices (including N application) and weather. CropSyst used five input files for simulation: (i) Simulation Control file (ii) Location file (iii) Soil file (iv) Management file and (v) Crop file. The parameters used for the CropSyst model were measured or estimated using the data of an experimental network of eleven different locations in each one of which two demonstrator areas were assigned (reference and treatment area), concerning nine crops during their cultivation periods. Some of this information was based on field experience and bibliography and other parameters used the default values given in the model, regardless of the year. The input data were processed to be adapted to the specific application case for the model set-up. The output data had to do with Nitrogen budget and the nitrous oxide gaseous losses in daily basis. These results were used in order to assess the environmental impact of the proposed Smart Farming Application in sub-action B7.3.

The contribution of emitted pollutants NOx, PM_{10}, NH_3, VOCs and N_2O were calculated, as well as deposition fields for PM_{10} and NH_3. on ambient concentrations and deposition rates around the pilot fields was also assessed by performing dispersion calculations for a period of one year or two years using the Lagrangian dispersion model AUSTAL2000. For this assessment, six pilot fields were chosen on the basis of the completeness of activity and emission information and the availability of local meteorological measurements from 16 permanent monitoring air quality stations. These pilots were located in Northern parts of Greece, in central Greece, in Southern Greece and in this way a representation of different climatic and meteorological regimes of a Mediterranean region was achieved.

Emissions from all activities were represented as polygonal area sources coinciding with the limits of each pilot field. Activities realistically occurring outside the field, i.e., transport of on-road machinery or material spillage were also incorporated in the polygonal area. The nominal emission height for both exhaust and suspension sources was set to 2 m above ground. As usual in the application of AUSTAL2000 over long periods, emission rates were considered constant throughout the simulation period, with the exception of NH3 emissions in the Elassona case, which were introduced as a time-variable series depending on the dates of fertilizer application. The fact that agricultural activities occur under a variety of meteorological and atmospheric stability conditions throughout the cultivation period minimizes any bias that is introduced by this assumption.

For most of the studied parcels, a single year (2020 or 2021) is presented as representative case, using as a selection criterion the availability of emissions data and measurements for boundary conditions. However, it should be noted that the atmospheric pollution burden between different parcels and farming regimes is not always comparable and furthermore notable differences between years may exist for the same parcel. In the case of perennial crops, it is suggested that more than one reference years is used for the assessment. For the same reason, no attempt to extract a “total average” of concentration additional loads across all parcels was made, as this would incorporate a substantial amount of case-dependent noise that would tend to mask any significant correlations with the farming regimes. In order to remove any effect of meteorological variation in comparison between 2020 and 2021 applications, a common meteorological input was used, corresponding to the 2020 conditions.

In order to represent the background air quality situation as well as air quality effects of the farming process in mid-ranges around the target study areas, measurement data from 16 permanent monitoring air quality stations were collected for the reference years 2020 and 2021. For each of the target parcels, one or more adjacent stations were selected to obtain boundary conditions for the model simulations. In the case of multiple stations for one parcel, the average value over all stations per pollutant was used. In principle, each monitoring station is measuring a different set of atmospheric pollutants. In the case of missing pollutants, the corresponding medium-scale concentration was set to the value of the national (large-scale) background concentration, as obtained from all the available stations.

Measurement data were introduced as baseline concentrations in the AUSTAL2000 simulations in order to represent the background chemical composition of the atmospheric environment in the areas near but not directly over each parcel, upon which concentrations the additional loads due to the farming activities of the parcel, are obtained. However, in most cases the calculated additional load is much smaller in magnitude than the background value.

In the framework of sub-action B7.3 a comprehensive evaluation of the environmental impact of demonstrator areas was undertaken, on the basis of the results of B7.2. The findings of the evaluation were used in order to assess the environmental impact of the proposed SF Application and propose the 9 BMPs for reducing the use of natural resources to protect the environment without risking production.

Guidelines on General Best Management Practices (BMPs)		
Management Practices	**Description**	**Benefits**
Realistic Yield Goals	Use actual yield records for crops on the specific field. If desired, adjust for expectation of a 5-10% yield increase. Do not fertilize for an unattainable yield goal	Limits potential for excess soil levels of nitrogen
Soil and Leaf Analysis	Base nitrogen fertilization on results from current soil analysis showing the amount of available N in the soil	Provides information for the precise amount of supplemental N to be applied to meet expected crop yield
	Leaf sampling during the growing season	Monitor N status throughout the growing season
Nitrogen Fertilizer Timing	Apply fertilizer close to the period of maximum crop growth	Ensures adequate N availability to the crop during critical growth stages and minimizes N losses from the field

Nitrogen Fertilizer Placement	Incorporate surface applied fertilizers Use micro-irrigation systems for N fertilizer application	Enhances N uptake by the plant. Limits N surface losses
Nitrogen Fertilizer Amounts	Estimate the soil available N and apply fertilizer to meet the crop's total N requirements	Optimizes crop yield and increases profitability for the farmer. Minimizes N loss to the environment
Nitrogen Fertilizer Forms	Use N fertilizer source (nitrate, ammonium, organic) according to timing and application method	Increases the available N in the soil and decreases the risk of leaching losses
Promoting Efficient Uptake	Minimize traffic on wet soils Choose good crop varieties Manage soil P, K and pH Prevent weeds from getting too large	The crops are capable of efficient N fertilizer uptake
Irrigation Management	Develop a proper irrigation schedule. Use efficient irrigation systems	Increases water use efficiency. Reduces the amount of water drained through the soil and leaching losses

For further details please see deliverables in Project's website:

- Report on soil and water samples collection and analysis
- Report of environmental simulation and impact assessment models
- Report of guidelines for best management practices

Action B8: Replicability and transferability strategy development

Foreseen start date: 01/07/2019 Actual start date: 01/07/2019
Foreseen end date: 30/06/2022 Anticipated end date: 30/06/2022

A set of concrete actions has been taken up in order to develop a realistic strategy and action plan for sustainability and replication, including funding and provisions by GAIA. This strategy among others included preliminary actions that have to be taken up according to Initial replicability and sustainability plan to facilitate replication to other sectors, entities, regions and countries during and/or after the duration of LIFE GAIA Sense project.

GAIA took advantage of its extensive network and identified the 5 new demonstrators (DRAMA – potato, ARTA – kiwi, EUBOEA - table tomato (later on replaced by the Kastoria see details in 6.2) PELLA – peaches, FARSALA - cotton) in the framework of sub action B8.1). The Use Case In particular, GAIA's network consists of shareholders which amongst others are 71 Agricultural (Cooperative) organizations, representing more than 150.000 farmers. a national infrastructure of a nationwide network of 118 Farmers Service Centres (FSCs) all over the territory, located at the premises of the Agricultural Cooperative Organizations that collaborate with GAIA. The 5 new demonstrators were deployed in Spring 2020 depending of the crop type and before the start of the cultivation period.

In the framework of sub actions B8.2-5 a market/competitor analysis was realized and a series of marketing, commercial and business development activities took place in order to explore the attractiveness and the possibility of replicate gaiasense to other sectors such as greenhouses and livestock sector. In particular, the feasibility and ease of customization of gaiasense for other sectors was explored, while an initial inventory of competitors operating in these sectors at national, European and international level was explored.

It was evident since the start of the project that the process of conceiving a replicability strategy would require interactions with stakeholders, as their inputs and involvement was considered crucial both for the development of a replicability plan and for the actual implementation of the replicating effort in the future. Actions performed in the context of LIFE GAIA Sense, helped to sound the ground for the feasibility of a replication effort in the areas of transferability of the project identified in the work plan, to conceive a methodology for its implementation. Also, the training, the Policy Uptake event, the lobbying activities with policy makers at EU level and the final conference were key part of this process, especially for the stakeholders' involvement. Growth is crucial to the long-term survival of any business, and so its expansion is a significant undertaking that comprises of many rewards and certain risks. Therefore, careful measures with a fool proof strategy have been designed in order to minimize the risks.

Gaiasense target market consist of people or sectors who are connected in agriculture and rural activity.
The stakeholders that LIFE GAIA Sense has worked with during the lifetime of the project included farmers, agricultural cooperatives, advisors, researchers and developers of smart farming solutions.

- Farmers are the main targeted group of gaiasense solution as they form the end users who will apply the outcomes of the project and will use the provided services.
- Agricultural Cooperatives are another main target group of the gaiasense solution as they, in contrast to individual farmer of rather small farms, will use the services in an extended area.

- Agricultural advisors, through smart farming, take on a more scientific role based on the collection and interpretation of data as well as on the guidance of farmers.
- Researchers can test their research results in real-world conditions in fields of collaborated producers with the use of gaiasense
- Developers can have access to the hardware, software and data of gaiasense so that they can develop new functionalities that provide added value to the services

Starting from the succeeded investment on the small scale, the project intends to be expanded in potential markets inside EU. With the purpose of reaching a transferability and replicability more efficient of the project in other EU territories, the following criteria have been used : Similarities with Greece, Distance from Greece, Size of agricultural holdings, Existence of preliminary work in the context of others EU projects , Competition. Based on the aforementioned analysis the following countries were recognised as the first countries : Spain, Portugal, Romania and Cyprus.

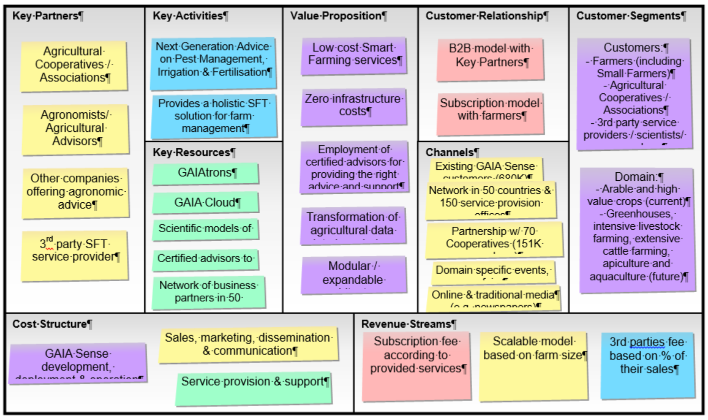
Moreover LIFE GAIA Sense's transferability plan included search of other sectors in which this technology could also be successfully applied. The located potential sectors for applying the gaiasense solution are the greenhouses and the indoor farming while replicating gaiasense to smart livestock was considered as inappropriate as the cost of the investment that is required is prohibitive at the moment and the market - at European level - is quite saturated. Preliminary study on actual physical sites for replicability all over Greece and in specific areas of Cyprus has been conducted.

Having that said, we need to underline that both NP and GAIA developed a plan/strategy for resource mobilization that is expected to lead to creative efforts in using their own local assets to gain support for both organizations. Multiple sources of funding can increase the independence and flexibility to implement of gaiasense's transferability and replicability strategy and reduce reliance on external (or foreign) funding. Possibilities of funding were and will be explored both by GAIA and NP. At this stage, it has to be mentioned that Piraeus Bank- the biggest bank in Greece- is GAIA’s & NP’s shareholder. In particular, NP and Piraeus Bank completed the first phase of their business collaboration, which regards the participation of Piraeus Bank in the company’s share capital. With the completion of the first phase of cooperation, the commercial strategy of NP is confirmed in the most creative and promising way, which has as a main priority the utilization of smart farming in the new productive model of the country. Except banking sector, an alternative financing source could be the co- financed programmes such as EU-funded projects and Bilateral collaborations/ projects. Moreover at a national level, the Rural Development Programme could provide a leading hand regarding financing

For further details please see deliverables in Project’s website:
- Initial replicability and transferability plan
- Final replicability and transferability plan

Action B9: Exploitation and Business Modelling

Foreseen start date: 01/04/2019 Actual start date: 01/04/2019
Foreseen end date: 30/06/2022 Anticipated end date: 30/06/2022



The LIFE GAIA Sense Business Model has been designed in order to support the LIFE GAIA Sense key objectives by describing the sales supportive method in each country/area by GAIA. Different feasible business models for the wide adoption of the gaiasense solution were examined based on the Business Model Canvas methodology.

This Business Model took into account several parameters such us the necessary initial upfront investment for penetrating new countries, the differences between countries etc. According to Business Model Canvas potential partners, services offered, and customer - user added value, projected installation and operating costs were examined. Depending on the country of application, the way the key parameters (different partners, custom pricing, etc.) are approached is modified but the central philosophy of the project remains the same. All in all, the gaiasense solution takes into consideration both the demands for solutions on the environmental problem, as well as the unique characteristics of the agricultural sector. The decision on finding measures to minimize the environmental impact of the agricultural sector in EU is final, but the methodology is under consideration. The proposed solution, measures the impact of any action taken in the field and counts the results of these action on behalf of productivity and safety. Moreover, the farmers have personalized information on how to use the resources in order to maximize productivity also protecting the environment. Also, the methodology used in the project, to collect data and provide consultation, can be widely spread with no limitation on environmental or other barriers. Also, the commercial approach means that each farmer is part of this solution through subscription and not by investing on hi tech solution. Finally, this holistic approach can lead to a wide network of partners, which can guarantee the sustainability of the project long after the end of project

An in-depth market analysis was carried out as it is an essential component of an integrated effort towards the successful launch and marketing of the gaiasense smart farming system in the markets of the target countries identified, namely Greece, Spain, Portugal, Cyprus and Romania. These countries exhibit different characteristics regarding the potential level of adoption of the gaiasense smart farming system. For example, gaiasense has already been commercially available in Greece and relevant marketing activities have taken place, while in the case of Spain and Portugal, gaiasense has been applied in the context of the LIFE GAIA Sense project only. In Cyprus, gaiasense has only been applied in the context of EU projects like the IoT4Potato Use Case of Internet of Food and Farm 2020, and now in the context of the Ploutos project, while Romania will be a brand new market for gaiasense, with no previous experience nor application.

The market analysis undertaken in the relevant sub task provided an overview of the competition landscape in the target markets. Due to the high dynamics of the smart farming market, with new companies and startups appearing and disappearing from the ecosystem, this work should be considered as “work in progress”. The initial information about the competition has been acquired from desktop research, existing market analysis reports and input from key partners in the targeted areas. When gaiasense gets closer to being introduced to the target markets, the analysis will go into more depth focusing on the competition that will exist at the specific time. What needs to be underlined is that the placement of a smart farming solution like gaiasense in existing and new markets needs to be carefully planned and implemented as the smart farming market is still under development and a significant percentage of potential customers are not yet familiar with the concept of smart farming, the marketing strategy will have a dual role: (a) to educate stakeholders of the agricultural sector about smart farming (what smart farming is, what are the benefits of smart farming, how is smart farming implemented in the case of various crops, etc.) and (b) to inform potential customers specifically about gaiasense, its benefits, advantages compared to the competition, pricing policy etc. The LIFE GAIA Sense project has provided us the opportunity to identify possible key partners in each country and recognise all possible means available for introducing the proposed SF solution. Moreover, through the dissemination events that have been realized, we have managed to network with other projects and see from a closer eye the technologies used and managed to adapt our marketing approach for each target market and stakeholder.

For further details please see deliverables in Project’s website:
- Initial business model
- Initial marketing plan, including market analysis & initial recommendations
- Market analysis & initial recommendations
- Final business model
- Final marketing plan

Action C1: Monitoring impact of the project actions

Foreseen start date: 01/07/2018 Actual start date: 01/07/2018
Foreseen end date: 30/06/2022 Anticipated end date: 30/06/2022

Action C1 was led by the Laboratory of Heat Transfer and Environmental Engineering (LHTEE) of the Aristotle University of Thessaloniki and aimed at a holistic assessment of the project's impact.

The work that has been accomplished focused on the monitoring of environmental, social and economic indicators, in view of formulating best agricultural practices promoting sustainable agriculture. As part of the process to obtain the essential data for calculating the indicators, questionnaires were developed and distributed to farmers of the Use Cases for both cultivating years. During the first year 33 questionnaires were gathered and analysed while for the second year 21 were gathered. The completed questionnaires from the farmers participating in the SF application of the project were collected from GAIA and shared with AUTH. The received questionnaires were then studied in detail and the containing information was organized in .xls sheets. The selected questionnaires contained all necessary data, including quantitative data required for the calculation of indicators. In the case of missing data, the quantities in the questionnaires were completed, when available, with data from ICM in order to include them in the analysis.

The analysis of the results has been performed on the total no. of replies for socio-economic indicators and for both the total no. of replies but also separately for each crop type (based on replies from all farmers cultivating each crop type) for environmental indicators.

It should be mentioned that a number of issues were identified in the review of the replies, in regard to data quality and missing data. Missing data were more common in the case of financial questions, including income, cost and yield, but also in some of the responses in the case of questions requiring from the farmers to report analytical quantitative data, such as the quantities of pesticides or fertilisers used. On the other hand, considerations regarding data quality related to the difficulty of farmers to provide quantitative data in the specified units was addressed to Neuropublic, as an issue to be taken into consideration. Both these issues were addressed by using the data provided by farmers in their logbooks in ICM for cross-checking with questionnaire data, in collaboration with GAIA.

Realistic emission data are a pre-requisite for reliable modelling estimation of the agricultural activities on local air quality and climate. Availability of high temporal and spatial resolution of pollutant emissions in smart farming applications is of particular importance in order to assess the local impact on the atmospheric environment. Atmospheric pollutant emissions are calculated by multiplying the activity rate with an emission factor. In the suggested methodology, emission factors from the EMEP/EEA air pollutant emission inventory guidebook 2019 (EMEP/EEA, 2019) and particularly of the 1A (mobile machinery) and 3D (Crop production and agricultural soils) NFR categories were used for most of the studied pollutants. In particular, for calculation of N2O emissions resulting from fertilisation of agricultural soil, the IPCC reference emission factor of 1% of kg N fertiliser applied is used. The proposed modelling methodology relies on the calculation of realistic emissions data following a combined Tier 1 and Tier 2 approach for emission calculation. For this purpose, detailed activity data of the specific SF application areas related to agricultural activities were acquired from the questionnaires to farmers as describe above.

The following KPIs, comparing 2019 (baseline cultivation year) and 2021 (second/last cultivation year) (‘’change expected (in %) compared to the initial situation’’), averaged from all pilot areas into a single score for each air emission, show that the targeted reductions were accomplished (and surpassed) for most of them (PM10, NOx, NMVOC, CO2 and CH4), while NH3 and N2O emission targets were not managed to be reached, but their emissions showed high/significant reductions, close to targeted ones. As for phosphorus inputs to field through fertilization, a decrease of 18.6% was calculated, while regarding phosphorus losses in water from fertilization, they have shown a decrease of 3.5%. Difficulties were faced collecting waste data (management and quantities). As a result, no relative KPI could be calculated and presented, in order to make conclusions.

KPIs	ALL PILOT AREAS		
	Targeted Reduction (%)	**Real Change (%)**	**Actual Values**
Air quality and GHGs (emissions)			
PM10	**-10**	-48.5	1.02kg/day
NOx	**-15**	-48.5	5.2kg/day
NMVOC	**-15**	-48.5	0.9kg/day
NH3	**-30**	-20.5	2.1kg/day
N2O	**-32**	-20	0.41kg N/ha/year or 231kg N/year
CO2	**-32**	-48.5	-
CH4	**-32**	-48.5	-
Irritant/Corrosive/Toxic			
Phosphorus losses in water	-11	-3.5	-

Regarding the legal nature of each farm, 90.4% were of single farmers, while only 9.6%of cooperative. 22.16% of farm managers belonged to the age group of 25-35, 29% to the group of 35-45, 16% to the 45-55, while the rest of them (39%) exceed the55 years of age. As for the educational status of the farm managers, 40% of them graduated from high school without pursuing higher education, 50% got a B.Sc. degree while 10% of them obtained a M.Sc. degree. None of them has experience less than 5 years, 19% of them from 5 to 9 years, 33% from 10 to 14 , 12% from 15 to 19 , 24% from 20 to 24 years, while the rest of them (14%) from 25 years of experience and more. As for the farm managers’ occupation scheme the following two observations are made:

a) 74% of them are considered to be as full-time farmers , 21% as part-time, while only 5% are retired.

b) The majority of the farms (83%) is family business, while only 17% are non-family

Another social index that has been under study is the technology index. The results show an increase in the index between the two cultivational years almost in every pilot area. Moreover, the correlation of the technology index with other factors, such as the age of the farm managers, as well as their educational status, was set under examination and as observed, the technology use seems to show some correlation with both (not in all pilot areas). In some pilot areas, in which the mean age of the farmers is high, the technology index is of a low value, while the opposite happens with younger farmers. Finally, in many cases it was noticed, the higher the educational level of the farmer, the higher the technology index was, while the opposite can also be observed in some pilot areas. Last but not the least by analysing the questionnaire replies, economical indicators were also calculated.

Sub-action C1.2 was led by the Laboratory of Heat Transfer and Environmental Engineering of AUTH and focused on the integrated assessment of environmental and socio-economic impacts of the suggested SF solution in agricultural practices in regard to its sustainability potential and facilitate decision making. The most suitable tool for performing this analysis is LCA. For this purpose, the openLCA software v.1.11.0 was used, in combination with the AGRIBALYSEv.3.0.1 database on agricultural processes and the ReCiPe20016 Midpoint-Endpoint (H) LCIA method. Primary input data on fertilization, pesticide application, irrigation and field processes were derived from field calendars regarding the pilot areas that a reference-treatment LCA-results comparison was applied. The results show the potential environmental benefit of the SF solution.

For further details please see deliverables in Project’s website:

- Questionnaire for farmers participating in pilot applications
- Reports on indicator values for environmental and socio-economic impact after each pilot application
- Report on Life Cycle Analysis

Action D1: Dissemination planning and execution

Foreseen start date: 01/07/2018 Actual start date: 01/07/2018
Foreseen end date: 30/06/2022 Actual (or anticipated) end date: 30/06/2022

The dissemination of LIFE GAIA Sense activities started with the development of the project Dissemination plan and material by GAIA.

Dissemination material was developed including dissemination templates, 2 brochures (in 3 national languages and English with the valuable help of the consortium members) 4 posters, and 4 roll up – banners.

A total number of:
- 4700 brochures
- 100 posters

were printed and distributed to members of the consortium for dissemination purposes.

The project website and social media profiles were released and regularly updated. The website had more than 15.000 hits during the 1st year of the project. At the 2nd year, the website had more than 9.000 hits form 69 countries. At the 3rd year it had more than 11.534 hits from 59 countries.

As far as social media is concerned, LIFE GAIA Sense project has active Facebook, Twitter and LinkedIn accounts which are linked to the project's website
Social media (status 30.06.2022):

- Twitter- 325 Tweets- 218.497 Impressions- 4.204 Engagements
- LinkedIn-163 Posts – 30.123 Impressions- 1.429 Engagements
- Facebook- 213 Posts – 237.990 Impressions- 134.961 Engagements

In addition Greek, Spanish and Portuguese versions of Notice Boards have been printed, distributed and placed to either pilots or the agricultural cooperatives offices for both 1st and 2nd wave of Use Cases. GAIA has also designed and printed stickers that were placed on the telemetric stations, with the logo of the project that was accompanied with the following text: ‘The LIFE GAIA Sense project has received funding from the LIFE Programme of the European Union under contract number LIFE17 ENV/GR/000220’.

Moreover, 5 Newsletters have been created by GAIA and were circulated to all subscribers, as well as to GAIA’s mailing list (~ 40.000) that is in line with the GDPR requirements

Regarding the dissemination of the project following can be noted:

- Online greek magazines/newspapers:
    - 11 Ypaithros, 1 green agenda, 1 DealnNews, 1 Messinia Live
- Online Portuguese magazines/newspaper
    - 1 Campo, 1 Inovacao para a agricultura
- 1 EC website
- Print press
    - 7 YPaithros Chora, 1 Eleftheria, 1 Lacticoop, 1 Espaco rural

LIFE GAIA Sense was also displayed in the main newscast of the Peloponese Regional Television Station, Mesogeios Tv, in the video "The Union of Agricutrural Cooperatives of Messinia pearticipates in the LIFE GAIA Sense smart farming program" but also in the regional radio programme of ERT Komotinis where the final results of the projects were discussed.

Synergies with other initiatives were also pursued in order to maximize the impact of the project to assist in optimization of the use of resources by exchange of knowledge and technology. The sub acion D1.2 has provided the opportunity for significant interaction with other EU funded projects such as DataBio POlirural, IPM decisions and Tomres, thiw the RESEARCH-CREATIVITY INNOVATION programs, "Symbiot Incoroporating GNSS capabilities into field telemetry stations to deliver high quality navigation and precision farming services" and "SmartPEACH: Developing Intelligent Agriculture Techniques to Optimized the Application of Inputs to Cone and Peach cultivation", GATES, OPTIMA, Smart AKIS, LIFE GREEN GRAPES, LIFE Cyclamen and ORGANICO LIFE+.

LIFE GAIA Sense was in total presented in 15 conferences/fora and symposia, 6 fairs/exhibitions and 8 workshops. This has provided the opportunity for executive public information and networking of LIFE GAIA Sense with other funded projects from the European Union.

Moreover 18 webinars have been prepared for all Use cases and 2 informative videos in English (and subtitled in Spanish, Portuguese and Greek) have been created and uploaded in the LIFE GAIA Sense Youube channel.

The LIFE GAIA Sense project's outcomes and results were promoted presented by PC during the 1st day of the 8th edition of annual Congress of GAIA EPICHEIREIN which was attended by more than 1,000 participants that have registered and joined the online event, representing the whole spectrum of the primary and agri-food sector in Greece as well as the national and regional government. Laymans report.

For further details please see [Project's website]:
- Dissemination plan and material
- Project website
- Notice boards
- Layman's report

Action D2: Policy Uptake

Foreseen start date: 01/01/2019 Actual start date: 01/01/2019
Foreseen end date: 30/06/2022 Actual end date: 30/06/2022

The project demonstrated a management approach, based in Smart Farming (SF) Technology, for better use of resources in the agricultural sector, in support of EC resource efficiency related policy and legislation. LIFE GAIA Sense undertook a comprehensive evaluation of the environmental impact of demonstrator areas aiming to identify, quantify and categorize possible environmental benefits and burdens in order to recommend best management practices but also support policy progress on the matter through acknowledgement of SF economic and environmental/climate benefits, as well as adequate support/funding tools for farmers within the Common Agricultural Policy, which is the main policy instrument targeting the farming sector.
Taking into account the policy context and the strategic planning of the policy uptake activities and the concrete policy outputs, the implemented activities have contributed significantly in:

- making the LIFE GAIA Sense project recognizable among EU decision and policy makers as one of the EU programmes contributing to the green and digital transition of the EU primary sector;
- educating" policy makers both at a theoretical and technical level based on the developments taking place on the field, among which, LIFE GAIA Sense smart farming pilots, on the sustainability benefits of smart farming;
- spreading the key messages and achieving concrete policy outputs.
- eproposing and supporting policies of introducing innovative efficient methods of managing resources in agriculture.

The main messages communicated to EU policy makers are the following:
KM 1 - Smart farming can bring concrete sustainability benefits to all EU farmers, whichever the size & production orientation of their farm;
KM 2 - Smart Farming needs to be understood as a holistic process that involves Precision Farming as part of the process. Smart Farming regards the use of digital technology to improve the overall decisions taken in a farm while Precision Farming focuses on application methods;
KM 3 - Smart Farming is closely linked with the provision of smart advice to farmers: it is a human-centered approach where the agricultural advisor plays a key role in the systematic diffusion of knowledge to the farmer, accompanying his sustainability efforts all along the way, based on accurate data and scientific knowledge. The agricultural advisor also acts as innovation broker bringing together knowledge & data from all involved stakeholders & machinery (scientists, agronomists, farmers);
KM 4 - Smart Farming is not competitive but compatible to other sustainable agricultural practices (ie organic farming);
KM 5 - Collective farmers' schemes (agri-cooperatives, producer organizations) are advantageous platforms for the diffusion of knowledge & innovation to farmers in an environment of trust, thus contributing to speeding up the digital transition of the EU farming sector;
KM 6 - Smart Farming needs to be explicitly recognized as a sustainable practice & be supported with suitable policy tools and financing as such;
KM 7 - Smart Farming should be enabled and supported not only within the CAP policy toolbox, but also in the context of other EU policies.

As far as national level lobbying activities our Lobbying activities focused on the Ministry on Rural Development and Food in charge of the preparation of the Geek CAP Strategic Plan and on all relevant entities and consultation structures.
Meetings have been held with the Minister's cabinet, the Secretary General in charge as well as with Ministry officials responsible for the CAP preparatory work. GAIA EPICHEIREIN has also participated in the 2 Online Public Stakeholder Consultations organized by the Ministry:
· 01/03/2021-05/03/2021 1st Online Public Stakeholder Consultation: SWOT Analysis
· 01/12/2021-03/12/2021 2nd Online Public Consultation with interested parties: Content of interventions

Finally, the Covid-19 pandemic has forced Parliament to limit physical meetings and function remotely. Thus it was deemed more appropriate instead of organising an event with physical presence, to held an online event where all the interested parties from the targeted policy areas related to the project were brought together. The LIFE GAIA Sense: Smart Farming for Sustainability digital event, organized by GAIA EPICHEIREIN with the support of FARM EUROPE and within the framework of the LIFE GAIA Sense project, was successfully concluded on Wednesday 11 May 2022. The event had secured the participation of high-level representatives of the EU institutions and the farming world, that exchanged views on the opportunities presented by the green and digital transformation of the European and Greek agriculture. The event was hosted by Member of the European Parliament and former Minister of Agriculture of Italy, Paolo de Castro. In particular, at his opening remarks, Mr. de Castro highlighted the importance of the project in the effort to reduce the environmental footprint of agricultural production and achieve the environmental and climate objectives set by the EU's new Common Agricultural Policy (CAP). "Projects such as LIFE GAIA Sense are important to support farmers and cooperatives in order to ensure productivity and quality, enhance competitiveness and mitigate climate and environmental impacts," he stated. The event programme continued with speeches by Maria Spyraki, Clara Aguilera and Alvaro Amaro, all Members of the European Parliament from the three respective project partner countries: Greece, Spain and Portugal. Pierre Bascou, Director, Sustainability Directorate-General for Agriculture & Rural Development, European Commission, discussed the importance of biodiversity and the role of the farmer in its protection and conservation. "Farmers depend on natural resources and environmental degradation affects them directly," he said. At the same time, Mr Bascou presented the tools available in the new CAP to support the green and digital transition.
Daniel Azevedo, Director, Commodities, Trade & Technology, COPA-COGECA, explained that some regions have limited resources and, therefore, limited capacity to contribute to the sustainability objective. He stressed that that "technology must offer clear benefits to farmers, and all farmers must have access to it."
The speeches were concluded by Yves Madre, President of FARM EUROPE, who referred to the objectives of the EU's "Farm to fork" strategy and argued that they should be re-evaluated in line with current events and in particular the impact of the war in Ukraine. "To support the digital transition of EU farms and their training, an additional investment plan of at least €30 billion –in addition to the one provides by the CAP– supported by the EU at 50%, is needed," he said.

For further details please see deliverables in Project's website:
- First policy uptake activities report and material
- Final policy uptake activities report and material

Action E1: Project Management

Foreseen start date: 01/07/2018 Actual start date: 01/07/2018
Foreseen end date: 30/06/2022 Anticipated end date: 30/06/2022

From the very beginning of the project a clear and efficient management structure and plan as well as a quality assurance and risk management strategy was defined by NP. Moreover the technical means for sharing data and information (google services), communicating (skype, phone) and organizing meetings (doodle) were proposed by NP and accepted by all the partners.

Regarding changes, the project coordinator Mr. Kostas Mastrogiannis was replaced by Mrs Alkyoni Baglatzi in December 2018 but remains as a Project Manager in the project. This was due to changes within the company and didn't influence the progress of the project as both project coordinators have similar experience and qualifications. Mrs Baglatzi, had to leave the company on March 2020 for personal reasons and was replaced by Mrs Tina Katika for a few months until Mr Vasileios Pyrgiotis took over the relevant role.

As far as COSTEIRA is concerned, there was also a change in personnel as Mrs Susana Gulin Martinez left COSTEIRA and Mr Carlos Alberte took over her position in March 2019. Mr Carlos Alberte was brought up to date in the project by NP via several email and skype calls.

Eight project meetings have been organized since the beginning of the project five of which were held physically and three online due to Covid-19 pandemic and the ongoing travel limitations.

Physical meetings:

a) the Kick-off meeting in Athens (25-26/07/2018),
b) the 2nd Project Meeting in Athens (14-15/01/2019),
c) the 3rd Project Meeting in Lisbon (03-04/07/2019),
d) the 4th Project Meeting in Velventos (08-09/01/2020),
e) the 8th project Meeting in Piraeus (3-4/3/2022),

Online meetings

f) the 5th Project Meeting (26-27/6/2020),
g) the 6th Project Meeting (03/03/2021),
h) the 7th Project Meeting (09/09/2021).

Three monitoring visit were co-organized with the 2nd, the 4th and 8th Project Meeting.

Every three months all partners prepared and uploaded to the google drive folder of the LIFE GAIA Sense project the financial report and all relevant supporting documents.

As far as the communication with the project monitor is concerned, the initial submission of monthly reports were replaces by trimester telcos. During the telcos, the Project coordinator (NP) discussed with the Project Monitor the progress of the project, challenges or delays and suggestions for overcoming them.

For further details please see deliverables in Project's website:

- Project management plan & tools
- Quality assurance & risk management plan

- First Progress Report
- Mid-term Report
- Second Progress Report
- After-LIFE Plan including exploitation plan
- Final quality assurance & risk management report

7. Analysis of benefits

Environmental benefits

a. Direct / quantitative environmental benefits:

A large scale SF infrastructure for data collection and analysis in 18 Use Cases has been deployed in Greece, Spain and Portugal. Cooperation with scientific experts has been established in order to apply the SF services to 9 crops . After the completion of the LIFE GAIA Sense project the following changes can be noted:

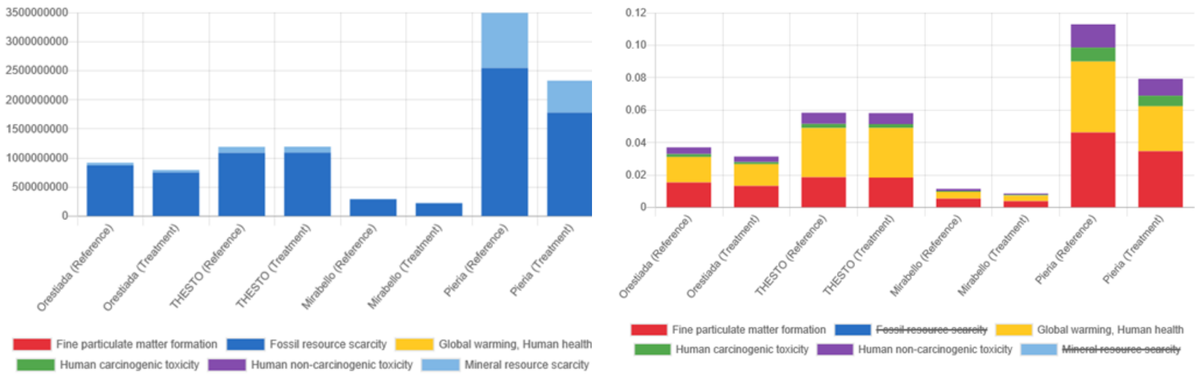
KPIs	ALL PILOT AREAS		
	Targeted Reduction (%)	**Real Change (%)**	**Actual Values**
Air quality and GHGs (emissions)			
PM10	**-10**	-48.5	1.02kg/day
NOx	**-15**	-48.5	5.2kg/day
NMVOC	**-15**	-48.5	0.9kg/day
NH3	**-30**	-20.5	2.1kg/day
N2O	**-32**	-20	0.41kg N/ha/year or 231kg N/year
CO2	**-32**	-48.5	-
CH4	**-32**	-48.5	-
Irritant/Corrosive/Toxic			
Phosphorus losses in water	-11	-3.5	-

b. Qualitative environmental benefits

Similarly to the quantitative environmental benefits, the qualitative environmental benefits have been studied within the framework of the Life Cycle Analysis (LCA) utilizing field measurements and numerical modelling results to analyse and evaluate the environmental benefits of the proposed SF solution.

The LCA study aimed to demonstrate the comparative advantage of the SF solution in regard to its sustainability potential and facilitate decision making. For this purpose, the openLCA software v.1.11.0 was used, in combination with the AGRIBALYSEv.3.0.1 database on agricultural processes and the ReCiPe20016 Midpoint-Endpoint (H) LCIA method. Primary input data on fertilization, pesticide application, irrigation and field processes were derived from field calendars regarding the pilot areas that a reference-treatment LCA-results comparison was applied.

The results show the potential environmental benefit of the SF solution:



Impact assessment comparison between the reference and treatment areas for each pilot case for 2020

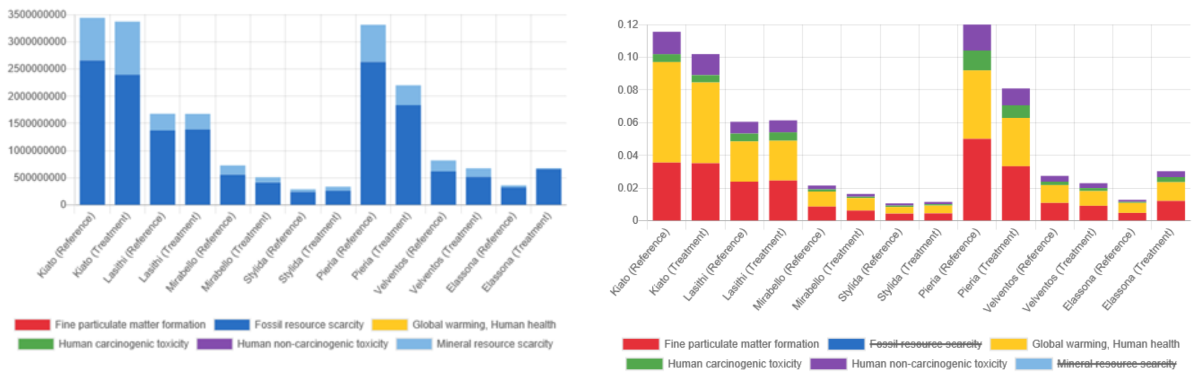


Figure 4.2. Impact assessment comparison between the reference and treatment areas for each pilot case for 2021

Important note : The figures include only the pilot areas for which a change in input data between the reference and treatment areas was reported in the calendars, as for some pilot cases, particularly for the year 2020, no differences were reported in the inputs between the reference and treatment areas. In the figures on the left, only the difference in Fossil and Mineral resource scarcity can be observed, as all other impacts are many times of magnitude lower. These two most important impact categories are omitted in the figures on the right, so that the difference between reference and treatment areas in the other impact categories can also be seen.

In the year 2020, impacts are reduced in all four pilot cases as a result of the SF solution application, with Pieria pilot case showing the highest reductions. In the year 2021, a decrease in impacts is achieved in five out of the seven pilot cases, with PESKO demonstrating the most efficient SF application. In the case of ELASSONA, a noted increase in impacts is noted, while in STYLIDA, a marginal increase in impacts is observed.

Economic benefits

Regarding economic benefits, no costs are related to the deployment of the stations on behalf of the involved stakeholders. In such a way, with zero investment, all the required base is set for increasing farmer's income with the reduction of inputs while achieving at least the same productivity. Although the gaiasense SF solution is suitable for both large and small farms, it has a competitive advantage in small farms, since it offers inexpensive advice with zero infrastructure costs. Actual economic benefit for the farmers was achieved due to lower (-21,11%) production costs. Moreover 25 people were hired by the end of the project by members of the consortium (9 at GAIA, 16 at NP). It is estimated that 3 years after the project the number will reach to 400 new jobs due to the full market launch of gaiasense in a total area of 77227.7 ha

Social benefits

A social index that has been under study is the technology index, which expresses the use of technology as an aid to everyday agricultural practices. The results showed an increase in the index between the two cultivation years almost in every pilot area. This fact can be attributed to the introduction of the technological background of the smart farming system of gaiasense to the farmers' agricultural practices.

Moreover, the correlation of the technology index with other factors, such as the age of the farm managers, as well as their educational status, was set under examination and as observed, the technology use seems to show some correlation with both (not in all pilot areas). In some pilot areas, in which the mean age of the farmers is high, the technology index is of a low value (e.g., LASITHI, MIRABELLO and PESKO pilot areas), while the opposite happens with younger farmers (e.g., THESTO, ELASSONA pilot areas). Finally, it was noticed that the higher the educational level of the farmer, the higher the technology index was while the opposite can also be observed in some pilot areas (e.g., LASITHI, STYLIDA).

Also, the information about the labor force of the farms gathered via showed some more interesting benefits. It was noticed, that in the smart farming years compared to the baseline one:

1. Permanent staff: there was a small increase in the numbers of men and a decrease of women.
2. Temporary staff: there was a small decrease in the numbers of men, while an increase of women.
3. Family staff: there was hardly any change in the numbers of working men(-0.01) and women (+0.01).
4. Technology knowledge: both non-family men and women employees with background knowledge and education on technology happened to increase in numbers.

   This is to be attributed either in hiring new employees with technology knowledge, or/and enhancing the technological skills of the already existing staff in the context of the smart farming practices.

Replicability, transferability, cooperation:

The replicability and transferability of the project has been defined within the scope of Action B8. Five (5) new Use Cases were identified to replicate the gaiasense SF solution in the context of the project, All farmers participated in the lifetime of the project, will continue receiving SF solution for 2 more years after the end of the projects, according to the contracts signed. Initial discussions for continuation of cooperation after the end of this period has been undergone with all 18 Use Cases and initial agreements have been reached with 9 of them.

Two further domains that are envisioned to replicate the gaiasense solution were investigated namely greenhouses and internal farming. Cooperation with the banking sector has been established and is expected to be the main source of funding the following years.

Among the barriers identified as the most important for the adoption of Smart Farming solutions, is the cost for establishment of the necessary technological infrastructure which not all farmers (especially small farmers) and/or cooperatives are able to cover. In other cases, while farmers are able to cover the costs, they are not persuaded as to the potential profitability of the technology and hence unwilling to adopt the new farming practices. Finally, one of the most important barriers for replication is related to farmers' acceptance, as studies show that farmers are risk averse by nature and show increased resistance to change and technology adoption.

The likelihood of replication of the project results is high, since the gaiasense SF solution is designed in a way that addresses these barriers. It is being built especially for small farmers that have limited resources, removing the cost of investment for them, by offering inexpensive advice with zero infrastructure costs. In addition LIFE GAIA Sense (as a demonstration project) will help demonstrating the benefits of gaiasense for the farmers and producing results that will help persuade them about the profitability of applying the SF advice to the field. Finally, the human component of the system, the gaiasense advisors that support the farmer in applying the advice in the field, are essential for building farmers' trust and increase acceptance.

Although it covers real market needs, helping reduce production costs, and the market in the identified attractive countries is currently mostly untapped, the replication is mostly policy-dependant. Farmers' resistance to change makes it difficult for them to realise the need for smart farming, even with the measures explained above. It is expected that the main force that will help with the replication of the project results, is the new European Policies and regulations, such as the future Common Agricultural Policy (CAP) which ties subsidies with the adoption of technology solutions and advisor services to help with the application of sustainable practices on the field. The new CAP and the national strategic plans will provide an extra financial motive that, combined with the environmental regulations and the consumers push for sustainable products, will push the farmers into using smart farming solutions. The considerable competitive advantage of gaiasense solution in small farms, is expected to guarantee its replication in the targeted countries.

Best Practice lessons:
During the lifetime of the project, valuable knowledge about improvements was gained. First of all, the field work (for the deployment of the stations) turned out to be more time and resource demanding than described in the proposal. Particularly due to the nature of the work which is highly weather dependent, the schedule for the deployment of the stations had to be readjusted several times. Moreover, the placement of the gaiatrons was sometimes very cumbersome due to hard soil. Also, on yearly cultivations and in the cases that a replacement took place (eg KIATO- KASTORIA), gaiatrons had to be relocated. As a result, more time and persons were needed to successfully complete the deployment.

In general, more effort is needed in arable cultivations that follow crop rotation practices (every year the crop on a field is changed), as there is the need to remove the stations and place them at another location once the new cultivation period starts. Same applies also to the soil sensors which are removed after the end of the cultivation period.

Innovation and demonstration value:
The proposed gaiasense solution is a very innovative approach (at the moment gaiatron stations are at TRL8 while GAIA Cloud is at TRL8 and it's being further enhanced) as it aims at producing scientific advices and alerts regarding irrigation, pest management and fertilization resulting from a broad range of data from the stations, scientific knowledge and experience. Producing an advice which is being fed by this broad range of data, powered by both scientific knowledge and human experience and supporting its application, is the single most important

innovation. This holistic approach is unique and can be regarded as the main differentiation from the competitors on the European level.

In addition, its unique characteristics make it possible to be used even by small farmers and at a variety of conditions, maximising its impact beyond this of the state-of-the-art competition:

1. Gaiasense is investment free, independent of any supplier and a certified advisor supports the farmer in using the service and applying the advice on the field. The farmer doesn't need to invest in money, time or know-how. The service is inexpensive even for small farmers' standards, where the usage of advanced/expensive machinery is not an option.
2. The deployment of such a large scale infrastructure covering whole regions (and countries), will allow gaiasense to have an impact that cannot be achieved by any other of the existing State-of-the-art solutions.

Policy implications:

The Action D.2 Policy Uptake of the LIFE GAIA Sense project started being implemented in December 2019, right at the moment where the newly appointed European Commission published the European Green Deal Communication , the overarching EU growth strategy for the decades to come, aiming to transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy where there are no net emissions of greenhouse gases in 2050 and where economic growth is decoupled from resource use.

To achieve these aims, it is essential to increase the value given to protecting and restoring natural ecosystems, to the sustainable use of resources and to improving human health. Digital technologies are a critical enabler for attaining the sustainability goals of the Green deal in many different sectors.

It should be mentioned that in terms of most recent policy developments the war in Ukraine has raised issues when it comes to Europe's energy dependence, environmental protection and biodiversity conservation, disruption of supply chains, etc. Digitalisation came forth in the present policy context as well as a catalyst in order to achieve the complex balance between economic and environmental/climate and social concerns in terms of food supply in the EU.

To address the aforesaid challenges, the Commission will support work to unlock the full benefits of the digital transformation to support the green-ecological transition. As explicitly mentioned in the Communication Shaping Europe's digital future, "the digital component will […] be key in reaching the ambitions of the European Green Deal and the Sustainable Development Goals. As powerful enablers for the sustainability transition, digital solutions can advance the circular economy, support the decarbonisation of all sectors and reduce the environmental and social footprint of products placed on the EU market" .

The LIFE GAIA Sense project being structured around Smart Farming (SF), as a solution that reduces the impact of agricultural production practices on natural resources and thus protects the environment and contributes to tackling climate change, is placed at the heart of the main EU policy initiatives at present and for the next decades.

The main agriculture-related European Green Deal policy initiatives, such as the Farm to Fork and Biodiversity strategies and the reform of the CAP as the main policy vehicle for the implementation of those strategies, as well as a policy explicitly involving digitalization of the agricultural production process, remain at the epicenter of the LIFE GAIA Sense project's policy focus. Nevertheless, it was considered equally important to monitor policy developments in all EU Green Deal related fields mentioned above.

Having that said, the principal focus of our policy uptake activities lied on the digitalization dimension of the future CAP that is mainly linked with:

- the promotion of digital technologies in the production process in order to achieve balanced economic and environmental sustainability and contribute to tackling climate change as well as to the quantified reductions in plant protection products (1st pillar green architecture and eco-schemes, 2nd pillar rural infrastructure measures);
- the achievement of the Farm to Fork strategy objectives as regards the sustainable use of pesticides (reducing by 50% the use and the risk of chemical pesticides by 2030 and by 50% the use of high-risk pesticides) and the improvement of water quality (reducing nutrient losses by at least 50% in 2030);
- the integration of the digital dimension in the provision of technologically enhanced "smart" advice to EU farmers (Farm Advisory System, Agricultural Knowledge and Innovation System);
- the contribution to the transparency & traceability of the food system as a whole from farmer to consumer.

Taking into consideration the policy context described, the challenges identified and the core objectives & tools of the LIFE GAIA Sense project, a selection of key messages have been put forward in order to serve the strategic objectives of the policy uptake activities, presented in the below:

KM 1 - Smart farming can bring concrete sustainability benefits to all EU farmers, whichever the size & production orientation of their farm;
KM 2 - Smart Farming needs to be understood as a holistic process that involves Precision Farming as part of the process. Smart Farming regards the use of digital technology to improve the overall decisions taken in a farm while Precision Farming focuses on application methods;
KM 3 - Smart Farming is closely linked with the provision of smart advice to farmers: it is a human-centered approach where the agricultural advisor plays a key role in the systematic diffusion of knowledge to the farmer, accompanying his sustainability efforts all along the way, based on accurate data and scientific knowledge. The agricultural advisor also acts as innovation broker bringing together knowledge & data from all involved stakeholders & machinery (scientists, agronomists, farmers);
KM 4 - Smart Farming is not competitive but compatible to other sustainable agricultural practices (ie organic farming);
KM 5 - Collective farmers' schemes (agri-cooperatives, producer organizations) are advantageous platforms for the diffusion of knowledge & innovation to farmers in an environment of trust, thus contributing to speeding up the digital transition of the EU farming sector;
KM 6 - Smart Farming needs to be explicitly recognized as a sustainable practice & be supported with suitable policy tools and financing as such;
KM 7 - Smart Farming should be enabled and supported not only within the CAP policy toolbox, but also in the context of other EU policies.

All these key messages were communicated in all policy uptake opportunities.

The following table presents an overview of all the events that took place during project, where GAIA and NP representatives were invited to participate as speakers.

DATE	ORGANISER	EVENT/TITLE/CONTENT	GAIA/NP presentation	AUDIENCE/IMPACT
18-02-2020	European Parliament Agriculture & Rural Development Committee	Public Hearing "EU Support for innovation in agriculture" Innovation within the Common Agriculture Policy and the AGRI-EIP and second, in the EU Framework programme for Research and Innovation (Horizon Europe) and the future Mission "Soil health Food"	"Digital Innovation for Sustainable Agriculture : the Greek Approach" Elli TSIFOROU, Director General, GAIA EPICHEIREIN	Members of the European Parliament European Commission Representatives (DG AGRI, DG RTD) Representatives of agri-food EU lobbying organisations
16-09-2020	COGECA - General Confederation of Agricultural Cooperatives	COGECA Business Forum "Agri-food and forestry cooperatives heading towards climate neutrality"	"Greek & EU Agri-Coops towards climate neutrality : best practices, challenges & prerequisites for the transition" Elli TSIFOROU, Director General, GAIA EPICHEIREIN	Member of Cabinet of Executive Vice-President of the European Commission Mr Frans Timmermans Members of COGECA
13-11-2020	DG Agriculture & Rural Development	Civil dialogue group on horticulture, olives and spirits Working Group on Olives	Greece: Olive oil production forecast 2020/21; Area developments; State aid to the olive oil sector Vasilis PYRGIOTIS Head of Olive Division, GAIA EPICHEIREIN	DG AGRI representatives Representatives of the olive oil/olive sector of the EU (production, processing, marketing) Representatives of NGOs
08-02-2021	DG Agriculture & Rural Development	Workshop "Conversion of Farm Accountancy Data Network into the Farm Sustainability Data Network"	"Smart farming data for farmers and policy makers" Elli TSIFOROU, Director General, GAIA EPICHEIREIN Fotis CHATZIPAPADOPOULOS, President, NEUROPUBLIC	DG AGRI, DG CLIMA, DG ENVI representatives Representatives of national FADN networks Private sector companies NGOs
11-03-2021	Croplife Europe (formerly known as ECPA)	Virtual Conference 2021 "Sustainable solutions to protect crops"	"Smart farming for a more sustainable agriculture" Elli TSIFOROU, Director General, GAIA EPICHEIREIN	EU Institutions representatives Representatives of EU and national agri-food lobbying organisations Representatives of the European crop protection industry

Moreover, we had the opportunity to participate in the following meetings of Working Parties of Copa – Cogeca:

- WP Research & Innovation (met on 23/9/2019,24/6/2020, 15/12/2020 and 16/3/2021)
- WP on the Common Agricultural Policy (met on 13/1/2020, 6/2/2020, 12/10/2020, 10/12/2020 and 17/3/2021)
- WP on Environment (met on 3/6/2020 (Exchange of views with DG Environment), 30/9/2020, and 3/11/2020)
- Task Force on Agricultural Technology (met on 6/12/2019 and 9/12/2020)

But also in the Cooperative Coordination Committee (CCC) of COGECA during its regular meeting on June 1st 2022, where the outcomes of the project were presented. During the meeting a thorough dialogue took place among the participants concerning the importance of agri-cooperatives when it comes to effectively disseminating knowledge and innovation, thus making possible a swift green and digital transition for the EU agricultural

It should be noted that Copa-Cogeca's position on the Farm to Fork strategy and on the future CAP, reflect the successful communication of LIFE GAIA Sense's activities, goals and results, as it is clearly mentioned at their relevant position papers 3 :

Copa and Cogeca support the nine specific objectives established for the CAP. [….] In particular, we welcome the greater focus on technology, digitalization and the bioeconomy. Concentrating on these areas will not only encourage the competitiveness and growth of the sector, but will also foster sustainable development and efficient management of natural resources. It is also positive that fostering and sharing knowledge and innovation in agriculture is a cross-cutting objective.

In this context, cooperation among farmers is critical for accomplishing economic, environmental and social goals [...] Cooperation between farmers needs to be supported by being more efficient and sustainable in many sub-systems (e.g. farming system, waste management system, input supply system, packaging, etc.). This is because it is the tool allowing interactions with other key systems (e.g. energy system, manufacture system, transport systems etc.), and boosts the uptake of digital solutions and novel technologies in the primary production sector. Agri-cooperatives require in this respect a supportive legislative environment to further develop innovative business models that can deliver on the objectives of the Farm to Fork Strategy and contribute to the achievement of the UN Sustainable Development Goals.

Having that said the main policy uptake output at EU level can also be depicted in the following table:

[3] https://www.copa-cogeca.eu/Publications

Policy Measure	Initial EC proposal COM(2018) 392 final	Policy Output	LGS Key Message
Recognition of smart farming as a sustainable farming practice	**X**	Reg. 2115/2021, Recital(26) The Union needs to improve the response to societal demands on food and health, including high-quality, safe, and nutritious food produced in a sustainable way. In order to advance in that direction, specific **sustainable farming practices**, such as organic farming, integrated pest management, agro-ecology, agroforestry or **precision farming, will need to be promoted.**	KM1 Smart farming can bring concrete sustainability benefits to all EU farmers, whichever the size & production orientation of their farm KM 6 Smart Farming needs to be explicitly recognized as a sustainable practice & be supported with suitable policy tools and financing as such
Voluntary schemes for the climate, the environment and animal welfare ('eco-schemes') ***Payment under Pillar I (direct payments) granted either for incentivising and remunerating the provision of public goods by agricultural practices beneficial to the environment and climate, or as compensation for carrying out those practices, that go beyond the mandatory requirements***	Recital (31) Member States may decide to set up eco-schemes for agricultural practices <u>such as</u> the enhanced management of permanent pastures and landscape features, and organic farming.	On 14/01/2021, the Commission published a list of potential agricultural practices that the eco-schemes could support. Precision farming has been included in the list.	KM1 Smart farming can bring concrete sustainability benefits to all EU farmers, whichever the size & production orientation of their farm KM 6 Smart Farming needs to be explicitly recognized as a sustainable practice & be supported with suitable policy tools and financing as such
Farm Advisory Services	Article 13 shall cover at least (f) digital technologies in agriculture and rural areas	Reg. 2115/2021, Article 15 shall cover at least (f) digital technologies in agriculture and rural areas AND at the latest as from 2024 the use of a Farm Sustainability Tool for Nutrients, which is any digital application	KM3 Smart Farming is closely linked with the provision of smart advice to farmers

This deliverable was produced under the co-finance of the European financial instrument for the Environment (LIFE) programme during the implementation of the project "LIFE GAIA Sense" (LIFE17 ENV/GR/000220).

Investments in digital technologies	Recital (31) Such investments may concern, inter alia, infrastructures related to the development, modernisation or adaptation to climate change of agriculture and forestry, including access to farm and forest land, land consolidation and improvement, agro-forestry practices and the supply and saving of energy and water.	Reg. 2115/202, Recital (78) Support for **investments in installation of digital technologies in agriculture**, forestry and rural areas, such as investments in precision farming, smart villages, rural businesses and information and communications technology infrastructures should be included in the description in the CAP Strategic Plans of the contribution of those plans to the cross-cutting objective.	KM 6 Smart Farming needs to be explicitly recognized as a sustainable practice & be supported with suitable policy tools and financing as such