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DELIVERABLE

Market analysis & initial recommendations

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Executive Summary

The market analysis 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 presented in this deliverable provides 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. At that time, various aspects presented in this document, such as the setting of milestones will be more detailed, taking into consideration all the relevant data available.

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Definitions, Acronyms and Abbreviations

Acronym/Term	Explanation
CAP	Common Agricultural Policy
CDG	Civil Dialogue Group
CE	Circular Economy
COMAGRI	Committee on Agriculture & Rural Development of the European Parliament
DG AGRI	Directorate-General for Agriculture and Rural Development

DG CLIMA	Directorate-General for Climate Action
DG ENVI	Directorate-General for Environment
EC	European Commission
EIP-AGRI	European Innovation Partnership for Agriculture Productivity and Sustainability
EP	European Parliament
EU	European Union
GAIA	GAIA EPICHEIREIN ANONYMI ETAIREIA PSIFIAKON YPIRESION
KM	Key Message
NP	Neuropublic Ae Pliroforikis & Epikoinonion
SF	Smart Farming
TF	Task Force
WP	Working Party

1. Introduction

1.1 Project Summary

The main objective of the LIFE GAIA Sense project is to demonstrate gaiasense, an innovative "Smart Farming" (SF) solution that aims at reducing the consumption of natural resources, as a way to protect the environment and support Circular Economy (CE) models.

More specifically, this project will launch 18 demonstrators across Greece, Spain and Portugal covering 9 crops (olives, peaches, cotton, pistachio, potatoes, table tomatoes, industrial tomatoes, almonds, kiwi) in various terrain and microclimatic conditions. They will demonstrate an innovative method, based on high-end technology, which is suitable for being replicated and will be accessible and affordable to farmers either as individuals or collectively through Agricultural Cooperatives.

Moreover, LIFE GAIA Sense aims 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 will demonstrate a method on how the farmer will be able to decide whether to use or avoid inputs (irrigation, fertilizers, pesticides etc.) and more specifically how to apply them in a most efficient way, without risking the annual production. The focus is on the resource consumption reduction side of CE, and the results will be both qualitatively and quantitatively, considering the resources' efficiency in agricultural sector.

1.2 Document Scope

This deliverable presents an initial market analysis focusing on the target markets, namely Greece, Spain, Portugal, Romania and Cyprus.

2. Customer need elicitation and prioritisation

As defined in **Deliverable B9 - Initial Business Model**, the potential customer groups of the gaiasense smart farming solutions are the following:

1. Farmers (including smallholder farmers)
2. Agricultural Cooperatives & associations, referring to various levels of organizational schemes of farmers
3. Third-party service providers
4. Scientists / researchers

The main target group of gaiasense consists of farmers and agricultural cooperatives, as they are the ones expected to become paying customers. Researchers and other user types identified are expected to have a dual role, significantly contributing to the development and customization of gaiasense in each country, while at the same time benefiting from its offerings that are tailored to their needs. Each country will utilize one or more of the above-mentioned potential customer groups, depending on its unique characteristics.

The successful marketing of gaiasense in the target countries identified, namely Greece, Spain, Portugal, Romania and Cyprus, significantly depends on the precise and complete identification of each target group's user requirements, and for each country specifically.

In the following paragraphs, the main needs of each customer group are described and analyzed.

2.1 Farmers

Farmers are the end users of the gaiasense smart farming services, which are pilot tested in the context of the LIFE GAIA Sense project in Greece, Spain and Portugal.

Nowadays, farmers are required to produce sufficient and high-quality food for the constantly growing global population, addressing food security and safety while facing the adverse weather effects due to climate change. At the same time, farmers need to minimize the impact of their agricultural activities on the environment, ensuring the financial, environmental and social sustainability of their production. The sustainability aspects of agricultural production are highlighted in the EU Green Deal and the Farm to Fork strategy, among others, which define the framework in which farmers will need to produce our food in order to be eligible for the new Common Agricultural Policy measures.

While farmers need to adopt modern approaches for managing their farms and more specifically their production, based on data and technological tools, their financial capacity is usually limited. As a result, the majority of farmers cannot invest in expensive equipment and the infrastructure needed by typical precision agriculture solutions.

In general, farmers need a system that will help them manage their production more efficiently and sustainably. They need to reduce their production costs, meet the needs of their crops in terms of irrigation water and soil nutrients, and at the same time better manage pests and diseases that threaten the health of their plants.

Coming down to details, farmers are especially interested in a precise weather forecast, as their daily activities and production in general heavily depends on the weather. Extreme weather phenomena like high temperatures, long drought periods, heavy rainfalls and snow, extremely low temperatures, which become more and more often, may have a significant impact on production. Therefore, farmers need a reliable weather forecasting service and early warnings for such extreme weather phenomena so that they can organize their activities accordingly and take the necessary measures to reduce their impact on their production.

Farmers also need a tool that will help them optimize the use of resources like irrigation water and fertilizers, based on the actual needs of their crops. This will help them reduce their costs and at the same time the impact of their activities on the environment. For this, they need to know the exact needs of their plants and avoid both deficiency and excessive use of both natural resources and agrochemicals.

Farmers, especially the ones whose farms consist of parcels that are remotely located at different areas, would like to have a tool that will allow the remote monitoring of these parcels. In this way, they could identify early enough problems caused by e.g. irrigation, fertilization or infection/infestation by a pest or a disease. Based on this information, they could plan a visit to the specific parcel, confirm the cause of the issue and take the necessary measures to address it. This will save them time and effort from unnecessary visits to remote parcels, while at the same time reducing transportation costs.

Another important requirement of farmers is the ability to monitor the growth progress of their crops. Useful parameters like growth degree days and chilling hours needed mostly by trees to exit the winter lethargy and enter the blooming stage are handy tools for farmers who need to

estimate how early or late this year's production will be, so that they can take the necessary measures, if needed, and plan their corresponding activities like harvesting.

A requirement that is of high importance to farmers is the simplicity and user-friendliness of the proposed technological solution. Younger farmers, who are familiar with new technologies, the use of computers and smartphones and at the same time they are more open to new farm management approaches, are the vast minority in the agricultural sector. As the majority of elderly farmers lack the digital skills needed for operating even basic digital tools, the proposed solution must be easy to use.

Preliminary feedback from Vina Costeira, the Spanish partners of LIFE GAIA Sense, mentions that Spanish farmers expect to be more competitive in terms of efficiency and sustainability in their farms, wishing to reduce the use of more inputs (e.g. fertilizers and pesticides) than their fields really need. The main objective for environmentally-conscious agricultural cooperatives and companies like Vina Costeira, is to make producers think before they act. The transformation to this mentality, which faces some challenges in its implementation, is expected to significantly contribute to the wider application of smart farming in general.

2.2 Agricultural Cooperatives

Agricultural cooperatives and other types of farmers' organizations have the same needs as individual farmers, as they represent a group of farmers. However, thanks to their organization and the availability of more resources, they have better financial and technical capacity to support the introduction of new farm management approaches such as smart farming.

Of specific interest to agricultural cooperatives are tools that allow them to monitor the parcels of their member producers. This allows them to have an overview of the expected yields, estimate harvesting times and organize activities like harvesting. In addition, the digital recording of all activities taking place in the farm, such as seeding/planting, irrigations, fertilizations, crop protection measures, is essential for the operation of traceability systems as part of the agricultural cooperative's integrated management system. This can provide added value to the product and help towards achieving higher prices in the market.

The agronomists of agricultural cooperatives are responsible for many, if not all, producers-members of the cooperative. While they have the experience needed to guide producers, they still need a useful and easy to use tool for taking notes, recording observations and other

information from each field. The ideal tool would come in the form of a mobile app, as smartphones are widely used by agronomists and agricultural advisors.

While individual farmers are more focused in local markets, agricultural cooperatives have the capacity to address regional, national and even international markets thanks to the higher volumes of products accumulated and the lower bulk prices achieved. These markets are especially interested in achieving lower prices, constantly high quality and, in many cases, they are also interested in sustainably produced products. So they need to ensure low production costs, high quality of products, high yields and traceability which will facilitate the identification of practices followed in the whole life cycle of the produced fruit.

2.3 Third-party service providers

There are many providers of agricultural services and the number is constantly growing. This is due to the vital role of the agrifood sector in the sustainability of the global population and the need to digitize the agricultural sector so that it remains sustainable and profitable.

Such service providers require access to high quality data from the field and the whole agrifood value chain in general, so that they can build and offer their data-powered services. Some data may be available from generic sources, like the satellite data from the European Space agency (ESA) portal, raising the need for data processing and analysis.

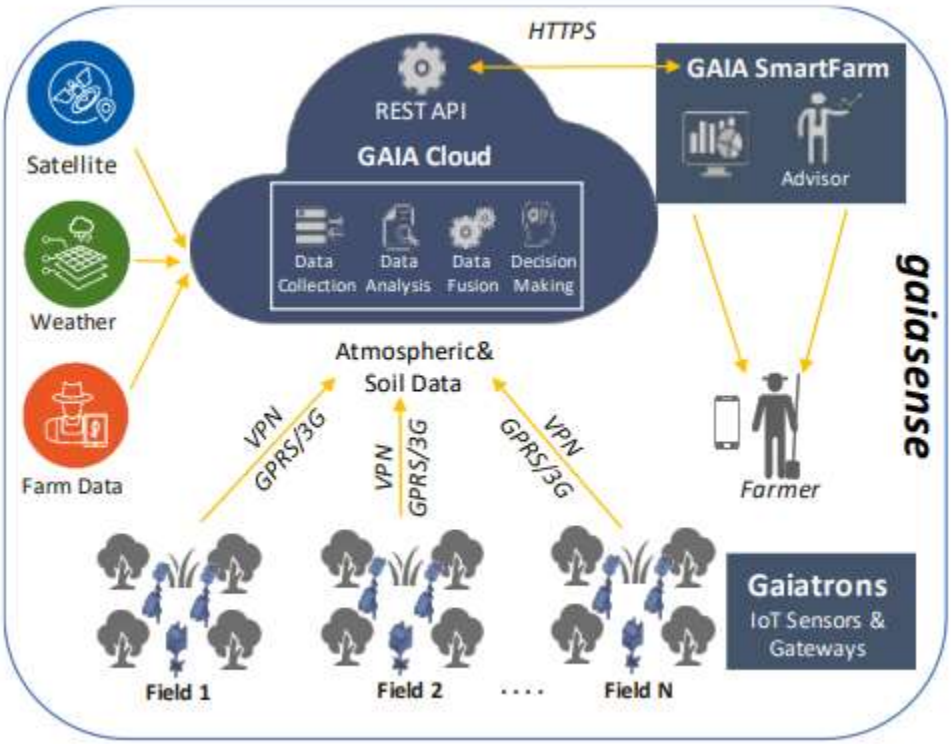

Figure 1: **Data flow and interconnectivity of the gaiasense smart farming system**

The data available through gaiasense provide an added value to third-party service providers, as they come from a trusted source and have been processed in order to be useful for the specific agricultural applications. In addition, there are huge volumes of relevant and valid data that can be processed, analysed, combined and used for the development of services that are useful for farmers.

At the same time, the open hardware architecture of gaiasense provides an opportunity for third parties to design and build specialized hardware components that can be integrated in the gaiasense technological infrastructure, like the gaiatron telemetric stations, in order to provide new functionalities.

The telemetric agrometeorological stations of gaiasense is an example of this approach: they are an integrated part of the gaiasense smart farming system, ensuring the recording and transmission of data from the atmosphere, the soil and the plants. Still, they support the integration of additional sensors in order to expand their functionality. For example, in the context of the SymbIoT project (www.symbiot.gr), the gaiatrons - the agrometeorological

stations of gaiasense - were properly modified and new components were integrated, so that the station could function as a GNSS base station, enhancing the accuracy of the positioning system in the area and allowing the implementation of precision farming applications and services.

In the same category fall the providers of agricultural advisory services. We are referring to agronomists with specialized knowledge in the irrigation, fertilization and crop protection of specific crops. They use their eyes for making observations within a given field and identify the needs of a given crop in terms of water, nutrients and protection from pests and diseases respectively.

Agronomists need a digital tool for recording their observations, measurements and information about samplings (e.g. water, plant tissue and soil, among others). They also need a portable and reliable tool that provides them with information about each field they visit, to view their previous notes and compare information. Last but not least, they need a user-friendly tool for recording farm-specific information of their clients' parcels as well as a digital diary of the agricultural activities undertaken by the farmers. While there is a wealth of available software solutions in the market, the offerings are rather fragmented with each one serving only a part of the total requirements of the agricultural advisors.

2.4 Scientists/ researchers

Many scientists and researchers active in the agricultural sector are working on the development of algorithmic models for fertilization and irrigation that aim to estimate the needs of a specific crop under specific conditions in terms of nutrients and irrigation water, respectively. Similarly, crop protection researchers develop similar models that correlate the environmental conditions with the risk level of infection or infestation of a specific crop by a specific pest or disease.

In all cases, these researchers need access to high volumes of reliable data so that they can test and validate their models. As a next step, and after their models have been validated in the lab, they need access to experimental fields where they can test their models under real conditions, outside the controlled conditions of their laboratories.

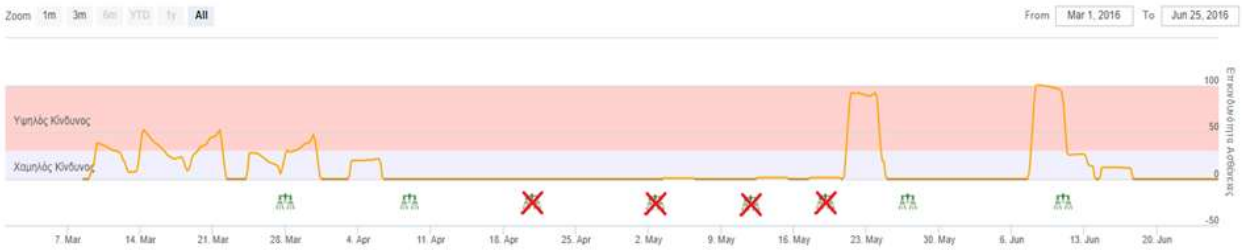

Figure 2: **Visualization of the infection risk level of a vineyard by powdery mildew through the gaiasense web interface, resulting from the corresponding scientific model fed with local atmospheric data.**

The gaiasense smart farming system acquires huge volumes of data (big data) from the agro-environmental telemetric stations of gaiasense, satellite data and information from the various water, soil and plant tissue analyses performed in various fields. It provides access to historical data about various meteorological parameters, satellite images of fields and the information provided by the agricultural advisors and farmers. This data can be provided, under specific conditions, to researchers who need to validate their research models and test them under real conditions. In the first case, researchers have access to a wealth of data that can be used to simulate real conditions in the laboratory and help researchers to develop an accurate scientific model.

The next step is to validate the accuracy of these models in the fields under real conditions. The gaiasense system can provide researchers with the necessary testbeds in the form of pilot fields, in which these models are applied in practice and the results are compared with the untreated fields and the typically treated ones, in order to showcase their effectiveness.

3. Detailed design of the value ecosystem

Smart farming provides value to a wide variety of stakeholders, such as farmers and agricultural cooperatives, agricultural advisors and agronomists, agricultural researchers etc. At the same time, it provides value to the environment, and the society in general. This multi-actor ecosystem will be presented in the following sections.

3.1 Economic, environmental and social value of the smart farming ecosystem

The economic, environmental and social value of the smart farming ecosystem provides the context into which the gaiasense smart farming system, along with the competitive smart farming systems and services exist, operate and compete with each other.

3.1.1 Economic value

Each farm is nowadays considered as an enterprise and farmers are not only managers, but also entrepreneurs. Farmers need to maintain their profit, and even increase it to the extent possible, in order to maintain the sustainability of their farms. Acting as entrepreneurs, they need to keep the expenses of their farms under control while at the same time optimizing the sale of their products to existing and new markets.

The gaiasense smart farming system allows farmers to increase their profit, as they can better manage their inputs, avoiding excessive use of inputs like agrochemicals, irrigation water and energy, among others. With the help of gaiasense, farmers can achieve higher yields and better quality of products, therefore enjoy higher prices for their production. The digitization of their production is also a feature required by major retailers, as it allows the traceability of the process, so they are willing to pay more for it. The same applies for products produced with reduced environmental impact, which are usually better marketed in large, specialized markets compared to traditional ones.

The innovative “Smart-Farming-As-A Service” business model of gaiasense allows farmers to reap the benefits of smart farming at a low cost, through an annual subscription fee. With this model, farmers can get access to the smart farming services of gaiasense through a small percentage of the increased profit they achieve through the use of its services.

3.1.2 Environmental value

The environmental impact of agriculture is a major concern for a variety of stakeholders, as agriculture has a significant impact on the environment; for example, agriculture is a major consumer of available water resources, while the use of agrochemicals and agricultural activities contribute to the greenhouse effect. As a result, during the last few years there has been an effort towards more environmentally-friendly food production approaches. This effort is now officially a mandate from the EC, through the recent announcement of the EU Green Deal and the "Farm to Fork" strategy, among others, that formalize the transformation of traditional food production systems into more environmentally-sustainable ones.

Smart farming addresses these challenges, as it helps farmers optimize the use of agrochemicals and natural resources like irrigation water. So, through better management of inputs, the pressure on the environment becomes significantly lower and so does the impact of agricultural activities. An example is the more efficient crop protection enabled through smart farming: The corresponding service of gaiasense informs farmers when there is a high risk of infection by a specific pest or disease so they can take the necessary measure only when there is an actual risk. This means that with gaiasense, farmers can avoid preventive sprayings and apply them on the optimal period. In this way, farmers not only minimize the number of applications with pesticides, but they also improve the effectiveness of the ones they actually perform, so they minimize the use of pesticides and therefore the residues on the environment.

3.1.3 Social value

The development and operation of a smart farming system like gaiasense requires the collaboration of a number of different experts, like technology providers, specialized agricultural researchers, agronomists, agricultural advisors and farmers, to name a few. This engagement of different stakeholders has a significant impact at local, regional, national and even international level.

In many cases, gaiasense operates as a Digital Innovation Hub that engages different types of stakeholders who collaborate in order to provide data-driven solutions to farmers and the agricultural sector in general. The outcome of such collaborations frequently aims at addressing challenges faced by farmers at local or regional level.

From a different point of view, gaiasense has an important social value to conscious consumers who demand agricultural products that have been produced with reduced environmental

footprint. By addressing the needs of this consumer segment, gaiasense serves an important social role fulfilling the needs of consumers.

3.2 The value ecosystem of gaiasense

The ecosystem of the gaiasense smart farming system consists of specialized hardware, technological infrastructure, software and other components that provide value to the system and the smart farming sector in general. The following sections provide an overview of the major components of gaiasense that comprise its value ecosystem.

3.2.1 gaiatron telemetric stations

The telemetric agroenvironmental stations of gaiasense, named gaiatrons, are a core component of the gaiasense smart farming solution. They are designed and manufactured by NEUROPUBLIC, which is also responsible for the operation of the network of stations in Greece and abroad, for recording the values of a high number of atmospheric and soil parameters, as well as specialized meteorological parameters such as leaf wetness.

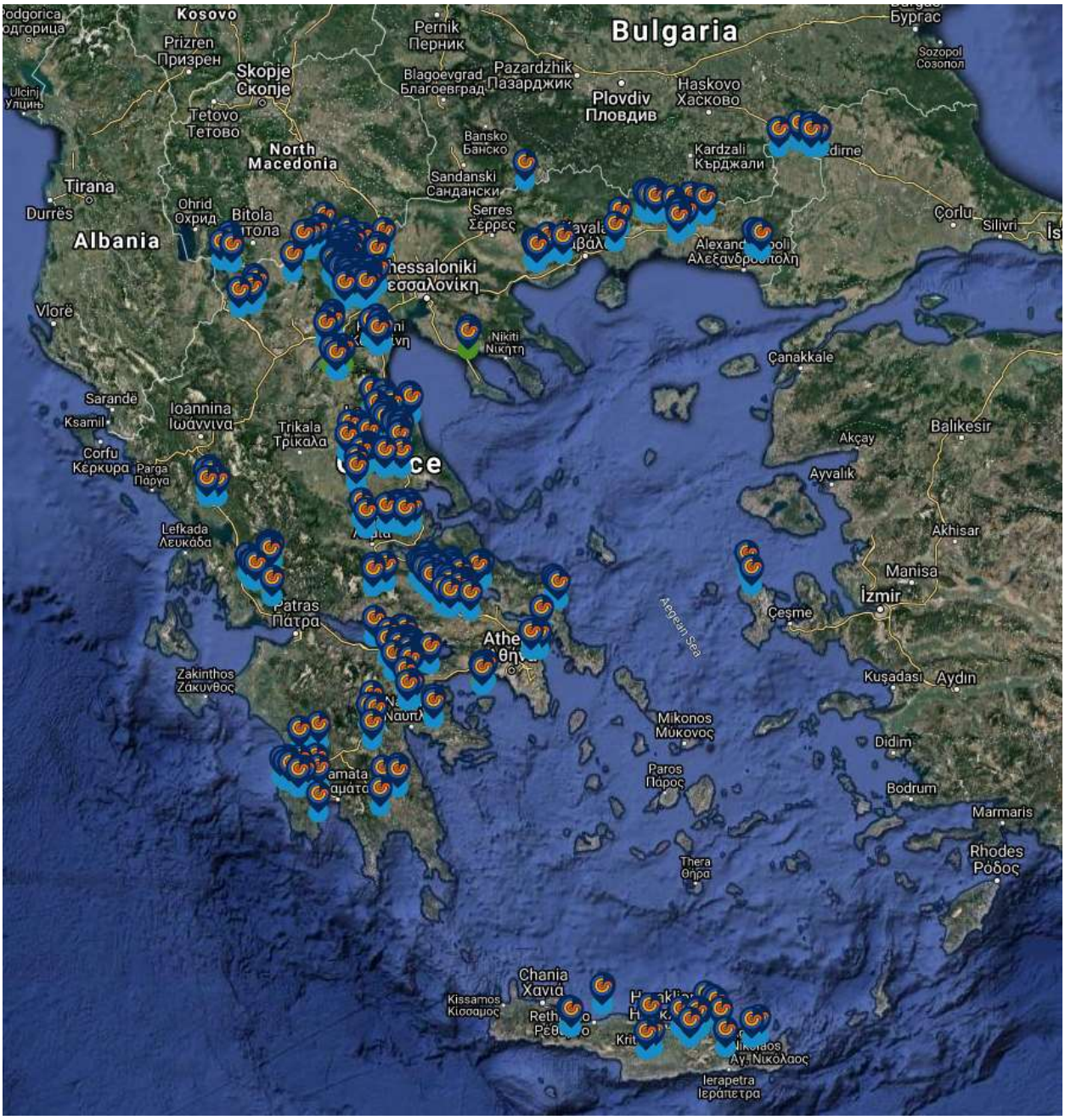

Figure 3: **Spatial deployment of the gaiasense telemetric agrometeorological stations in Greece**

The gaiatrons have been designed in order to meet a number of different challenges related to the installation of hardware in the field, frequently exposed to extreme conditions. They are portable, they require minimum maintenance, they do not require power supply - thanks to their integrated solar panel and battery, they are expandable in terms of new functionalities with the integration of new sensors, real-time transmission of data using existing cellular networks etc.

These features make the gaiatron stations a perfect match for diverse environmental conditions and virtually any crop available.

3.2.2 gaiasense cloud infrastructure

The gaiasense smart farming system is based on the availability of large data volumes, acquired from the gaiatron telemetric stations, the satellites and other sources. All of these data must be available in real time and without interruptions or other failures in order to exploit them. The high quality standards of NEUROPUBLIC's owned data center ensures the availability of this data 24/7, and the cloud computing power required for the data processing.

The gaiasense smart farming system uses NEUROPUBLIC's cloud infrastructure, which is certified by EN ISO 9001:2015 (Quality Management Systems) and ISO/IEC 27001:2013 (Information Security Management Systems), a fact that ensures security and availability of data and its data-powered services. In addition, there is no dependence on third parties for the storage and computational power needed for the management of the gaiasense big data, therefore minimizing all related risks.

3.2.3 Scientific models for smart farming services

A crucial component of gaiasense is the availability of scientific models for irrigation, fertilization and crop protection. These models are crop specific and take into consideration all the necessary parameters (i.e. atmospheric, soil and biological) in order to help farmers optimize the use of inputs, avoiding stress and waste / excessive use.

The procedure to be followed, consists of the following 5 stages:

1. Identification of the needs and characteristics of each use case, in which a gaiatron is installed
2. Acquisition of data (atmospheric, soil, etc.) from the area where the gaiatron is installed.
3. Development of a scientific algorithmic models for the irrigation, fertilization and crop protection of the specific crop. If the scientific model already exists, then it only requires a period for the adaptation in different conditions and validation of their proper operation.
4. Test the effectiveness of the scientific models in different soil climatic zones.
5. Final development of the scientific model after a pilot implementation under the specific microclimatic conditions of the specific area, and extension of its implementation to the wider area with the same conditions (within the same soil-climatic zone).

The development of these models is undertaken by specialized agricultural researchers with experience on the corresponding topic, in collaboration with specialized researchers of NEUROPUBLIC.

3.2.4 Certified agricultural advisors to finalize the smart farming advice

In various cases, farmers are the recipients of the smart farming advice of gaiasense; however, in other cases, the role of the agricultural advisor in the process is essential. An experienced agricultural advisor has the experience to evaluate the smart farming advice, adjust it if needed, and then guide the farmer into its implementation in the field.

The specific type of advisor needs to have specific knowledge of a given crop and in addition, experience in the area where he / she operates. On top of that, the agricultural advisor working with gaiasense will be required to participate in training sessions that will lead to his certification on the capacity to utilize the information he gets through gaiasense and to provide the smart farming services to farmers.

This process helps gaiasense maintain consistently high level of the services it provides to farmers, therefore making it more effective and reliable.

4. Detailed definition of the value proposition

As mentioned in the Deliverable B9 - Initial Business Model of the LIFE GAIA Sense Project, the value proposition of the gaiasense smart farming system is to provide a low-cost smart farming solution with multiple benefits for the farmers, their production and the environment, among others.

4.1 The main components of the gaiasense value proposition

The breakdown of the gaiasense value proposition is as follows:

Low cost Smart Farming services - Zero infrastructure costs

The gaiasense smart farming solution has been developed so that it is affordable even by smallholder farmers. There are two possible ways that farmers and agricultural cooperatives can have access to the smart farming services of LIFE GAIA Sense:

1. Through a small annual subscription fee, by installing a central network and consulting fees per year,
2. Through the sale of the necessary infrastructure (in the form of leasing) and a lower management fee per year.

The former is the innovative "Smart-Farming-As-A Service" model through which the farmers only need to pay a fee for using the smart farming services of gaiasense. While the former model is the only one applied in the collaborations of gaiasense in Greece, in the case of other countries the most appropriate/appealing corresponding solution will be applied, depending on the country and its particular characteristics.

The most distinct advantages of the "Smart-Farming-As-A Service" approach of gaiasense are the following:

1. More complete data of higher quality
2. No need for investment in infrastructure, equipment etc.
3. Helps reduce the gap between small and large farms
4. Relatively lower cost compared to competitive solutions
5. A sustainable model for countries with fragmented agricultural land

As smallholder farmers are the basis for food production systems, the approach of the gaiasense smart farming system that removes the need for investment in expensive and complex technological infrastructure and tools, makes the specific solution more appealing and affordable to smallholder farmers.

A custom-made solution for each crop in each area

The gaiasense smart farming system does not offer pre-made "one-size-fits-all" services. Despite the fact that thanks to its architectural design it can easily adapt to different crops and microclimatic conditions, each new application requires a period for the adaptation of the scientific models to the new condition in order to maximize the effectiveness of the services and the benefits for the farmer.

Before the smart farming services of gaiasense become commercially available in a given area for a given crop, a period between one and three cultivation periods is required, depending on factors like the crop type and the availability of scientific models for the irrigation, fertilization and crop protection services, among others. This transitional period is required for setting up the data acquisition infrastructure of gaiasense, the validation of the scientific models using data from the area, and the pilot testing of the gaiasense smart farming services in the field.

Services based on robust technological infrastructure

NEUROPUBLIC, the company that designed, develops and evolves gaiasense, has its own technological infrastructure on which gaiasense is based. This eliminates the use and dependency on infrastructure owned and operated by third parties.

More specifically, thanks to the technological infrastructure of NEUROPUBLIC, gaiasense is based on:

- In-house cloud infrastructure
- In-house IoT development (sensors and telemetric agrometeotrological stations)
- In-house scientific model development (for irrigation, fertilization, crop protection, weather forecast etc.)
- In-house software development
- In-house earth observation department and EO-data management platform
- The largest ground-truthing network for remote sensing in the EU

In-house cloud infrastructure

NEUROPUBLIC has its own modern cloud-computing infrastructure, located at its corporate office building in Piraeus, Greece. This allows gaiasense to have the storage and computing power needed for storing and processing the huge volumes of data it requires for its operation.

NEUROPUBLIC has designed, established and applies an integrated Information Security Management System (ISMS) which is certified by TÜV AUSTRIA HELLAS for meeting the requirements of relevant international standards: EN ISO 9001:2015 (Quality Management Systems) and ISO/IEC 27001:2013 (Information Security Management Systems) and is certified regularly.

In-house IoT development

The Research & Development department of NEUROPUBLIC designs and develops all hardware components of the gaiatron telemetric agrometeorological stations. A team of engineers with specialization in microelectronics and sensors, networks, IoT etc. are working on different aspects of the gaiasense stations, evolving the original designs and making them more diverse and efficient. This provides a competitive advantage to gaiasense, as it does not depend on external collaborators for the specific activity.

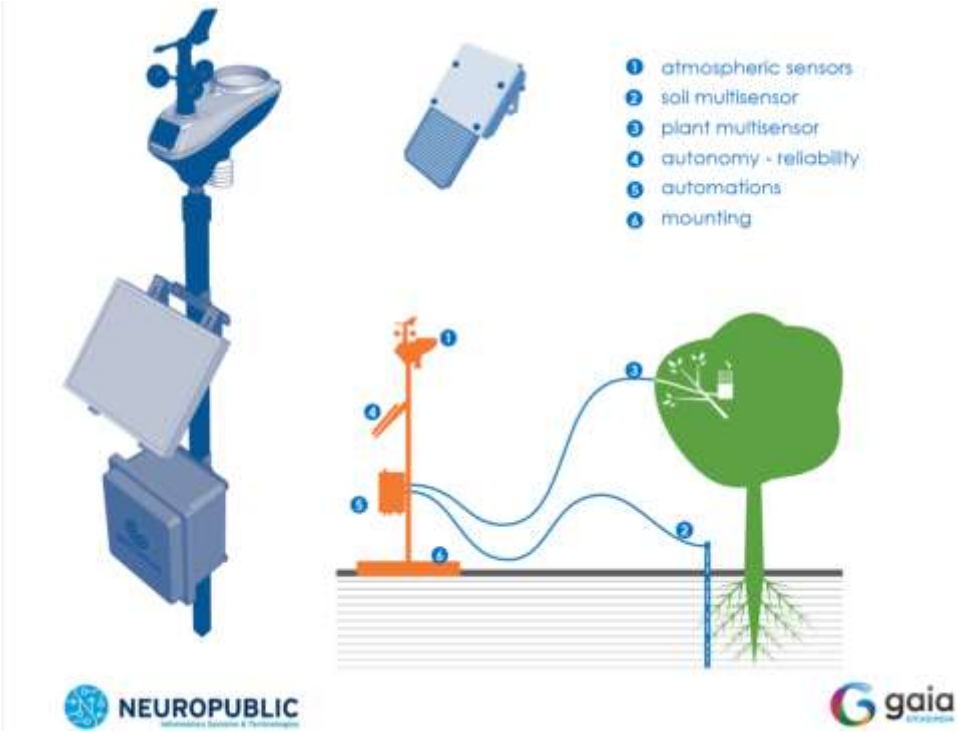

Figure 4: **Overview of a gaiasense agrometeorological station**

In-house scientific model development

A core component of the gaiasense smart farming system consists of the scientific models for the irrigation, fertilization and crop protection of a given crop supported by the system. Additional models for parcel-level weather forecasting and early warnings for extreme weather phenomena are also developed in-house.

For the development of these scientific models, specialized researchers of NEUROPUBLIC work closely with experienced scientific collaborators from academic and research organizations on irrigation, fertilization and crop protection models. These are based on valid scientific outcomes and are specialized for each different crop. The forecasting models used for the forecasting service of gaiasense are developed by meteorologists, taking into consideration the specificities of the agricultural sector.

In-house software development

NEUROPUBLIC has a large team of experienced software developers, front- and back-end developers, mobile app developers etc., which collaborate for the development of web and mobile applications and services.

This provides NEUROPUBLIC with the flexibility to develop custom software solutions, be responsive to any revisions/adjustments needed, based on the feedback received by the users of its services, like the smart farming services and apps of gaiasense.

In-house earth observation platform and department

NEUROPUBLIC has a dedicated Earth Observation team that works on the development of solutions based on geospatial technologies and data. The gaiasense smart farming system makes use of satellite data for various purposes, including but not limited to the extraction and visualization of the NDVI index from satellite images.

Figure 5: **Comparison of NDVI average values for different cultivation periods of a given parcel through a gaiasense web service**

The gaiasense smart farming system is backed by the EarthInsight engine developed by NEUROPUBLIC's engineers, allowing fast processing, analysis and classification of satellite images. Using satellite images from various sources, the EarthInsight engine delivers the necessary EO-based input when needed. This means that the gaiasense system does not depend on external collaborators for addressing its needs in terms of satellite data.

The largest ground-truthing network for remote sensing in the EU

NEUROPUBLIC has developed the first and only large-scale Internet of Things infrastructure in Greece, installing thousands of wireless sensors, which are designed and manufactured by its Research & Development Lab, on agricultural land. This is coupled with the constantly growing Earth-Observation team of NEUROPUBLIC, which focuses on the development of innovative EO-based services for the agricultural sector.

The gaiasense smart farming system benefits from both, and the combination of EO data with atmospheric and soil data, along with other types of data, distinguishes gaiasense as a holistic approach in the smart farming ecosystem.

In addition, NEUROPUBLIC has more than 15 years' experience in digital services for the Common Agricultural Policy, a fact that provides a significant competitive advantage to gaiasense.

4.2 Additional aspects of the value proposition of gaiasense

Additional aspects of the value proposition of gaiasense are the following:

Employment of certified advisors for providing the right advice and support

The role of agronomists and agricultural advisors is crucial for the successful operation of gaiasense, as they are the ones to acquire data from the field (e.g. on farm observations, measurements and samplings), evaluate the smart farming advice and guide farmers towards the proper application of the advice in the field.

In the case of agricultural advisors, each and every provider of the gaiasense smart farming services will be certified for their services and the competences they have. The certification will assure producers of the degree to which advisors are familiar with innovative technologies and it will be provided by qualified staff, scientific partners and experienced producers.

The training will be implemented to the standards of lifelong learning programs and the curriculum will be prepared by training experts. The course will be tailored to the learning needs and background of the participants (scientists, professionals, producers, etc.).

Depending on the country and the structure to be utilized, the training and certification process will be adapted accordingly. In all cases, this will ensure a constantly high quality and accuracy of the services offered in any country, by any service provider.

Transformation of agricultural data into knowledge

One of the innovative aspects of the proposed smart farming solution is that it is a holistic approach; it combines scientific knowledge from specialized researchers, the crop-specific experience of agricultural advisors and producers, with environmental data collected by the gaiatrons and satellite data acquired by satellites and properly processed. This unique combination is necessary for the provision of services that optimize the management of inputs and more generally the farm management; and this unique feature characterizes gaiasense as a Digital Innovation Hub in various cases, also allowing it to act as innovation broker when needed,

facilitating the transfer of innovation from one partner (innovation holder) to another (issue holder).

Despite the fact that this combination of data and information requires the use of advanced tools like Big Data Analytics, Artificial intelligence, Machine Learning etc., which is difficult to use and time consuming for the average user, the gaiasense platform manages to address this complexity without affecting the user experience. In this way, all farmers can benefit from the data- and science-driven smart farming advice without having specialized knowledge.

Modular / expandable architecture

The gaiasense smart farming system has been designed with expandability and adaptability in mind, in order to meet the diverse needs of different crops under different microclimatic conditions. Its modular construction allows the addition of new features when they become available and needed.

Regarding the gaiasense telemetric agrometeorological stations, this approach also makes it easier to service the station if needed.

The structure of gaiasense, the collection of data from different sources and the real-time processing of the data collected, allows for spatial and temporal expandability of the solution, even in the case of new crops, without compromising the quality of the services offered.

4.3 Sustainability aspects of gaiasense

The value proposition of gaiasense also focuses on the sustainability aspects of farming, including but not limited to, financial, environmental and social, while at the same time, the sustainability of gaiasense as a product is also of high importance.

4.3.1 Sustainability achieved through gaiasense

The following paragraphs provide insights on the contribution of gaiasense in these different sustainability aspects.

Financial sustainability

Farmers need to make a profit in order to maintain the financial sustainability of their farms. One of the ways to achieve this is through the optimization of the financial aspects of their farms, by increasing their profit and minimizing production costs.

The smart farming services of gaiasense help farmers make the most out of their inputs, thus avoiding excessive use and waste, leading to the minimization of their production costs. With the use of the gaiasense smart farming services, farmers can optimize the use of irrigation water, fertilizers and pesticides, with significant savings on agrochemicals and irrigation water.

In addition, the gaiasense system allows farmers to know the precise needs of their crops in terms of fertilizers, pesticides and irrigation water. Farmers can meet the needs of their crop precisely, and this results in the optimization of the yield in terms of quality and quantity as the crops can provide their best in terms of production.

Last but not least, smart farming provides added value to the products, as all steps of the production are digitally recorded. This allows the application of traceability which is a prerequisite for many large retailers and in many case, the “passport” for agricultural products to travel and enter new markets.

Environmental sustainability

The recently announced EU Green Deal and the From Farm to Fork strategy of the EC set the framework for a more sustainable food production system. In this context, farmers need to minimize the impact of their agricultural activities on the environment, producing “more with less”, in order to be eligible for EU subsidies and funding. This is also a requirement by major retailers all over Europe, which set strict limits to the residue levels in the agricultural products and in many cases they even require a related certification.

Smart farming allows the production of food with a reduced environmental footprint, and this comes in accordance with the recently announced EU strategies. Therefore, the gaiasense smart farming system comes as an environmentally-friendly approach to manage agricultural production, supporting among others circular economy models and the reduced use of natural resources and agrochemicals.

The use of the gaiasense smart farming services inform farmers about the exact needs of their crops in terms of irrigation water and fertilizers, so farmers can reduce the use of natural

resources and agrochemicals to the minimum required. On top of that, the smart crop protection service of gaiasense informs farmers at a timely manner about the increased risk of infection or infestation of their crop by pests and diseases respectively, so they can avoid unnecessary application of pesticides and thus minimize the impact on the local ecosystems.

Social sustainability

Despite the increased mechanization of agriculture and the introduction of various types of automations in the fields, the role of farmers and farm workers is irreplaceable. At the same time, one of the major issue that agriculture faces is the lack of manpower; more and more young people leave rural areas in favor of urban ones, abandoning agriculture as their main occupation and looking for alternative professional options.

The gaiasense smart farming approach encourages the development of ecosystems at local level, engaging individual farmers and agricultural cooperatives, agronomists and agricultural advisors, researchers with specialized knowledge on irrigation, fertilization and crop protection, agricultural service providers and other types of stakeholders. In various cases, as mentioned earlier, gaiasense functions as an innovation broker that facilitates the diffusion of innovation and therefore the development of innovative solutions that meet the needs of farmers as the end users.

This approach supports the social sustainability of agriculture, even at farm level, as the digitization of agriculture makes agriculture more appealing to existing and potential farmers, especially the younger ones. In the case of EU projects like PoliRural (www.polirural.eu), the smart farming approach of gaiasense is among the tools used for making rural areas more attractive to both existing populations and newcomers.

4.3.2 Sustainability of gaiasense as a product

Another important aspect of the sustainability of gaiasense has to do with the sustainability of the gaiasense system itself. Seeing gaiasense as a product, or service, it is important to ensure its sustainability for the future.

The gaiasense smart farming system is designed, developed, evolved and supported by NEUROPUBLIC, one of the largest and more financially-healthy informatics companies in Greece, with a leading position in the agricultural sector. The strong background of NEUROPUBLIC, combined with the resources of its strategic partner GAIA EPICHEIREIN and other collaborating companies, ensures the financial & technological sustainability of gaiasense. In addition, the

longtime collaboration of NEUROPUBLIC with research organizations ensures its access to the necessary scientific results. This is further supported by the specialized researchers on topics like crop protection, irrigation, fertilization and agrometeorology that already work for NEUROPUBLIC, so they can provide the necessary input in-house.

The gaiasense smart farming system has been commercially available in Greece for the last years, and the development of a constantly growing customer base provides an income for the maintenance of the service. Additional revenue funds for the development and evolution of gaiasense comes through the participation of NEUROPUBLIC in Research & Development EU projects in which gaiasense plays a key role. In addition, the participation in such projects allows NEUROPUBLIC to establish collaborations with agritech companies, solution providers for the agrifood sector and foreign research organizations, among others.

5. Contours of the relevant market

5.1 Industry background

The technological advancements in areas like earth observation / remote sensing, the introduction of big data analytics, data science methods, artificial intelligence and machine learning, among others, along with the quick transfer of research outcomes to the field thanks to the advances of science, helped the application of technology-based approaches in agriculture.

Precision agriculture was only recently introduced thanks to the use of satellites for purposes other than military ones. This definitely provided a boost to the agrifood systems; however, the technological tools and infrastructure required for reaping the benefits of precision agriculture made the approach too expensive for the majority of the farmers, especially the smallholder ones.

Smart farming came as the response to the need of farmers for an affordable way to optimize the management of their agricultural production. Smart farming uses components from precision agriculture and brings specialized agricultural researchers and agricultural advisors at the heart to the approach, while at the same time moving the necessary technology to supporting roles. In the smart farming concept, technology is used for the acquisition of data, the management of scientific knowledge and the implementation of the agricultural activities in the field.

5.2 Positioning of the gaiasense smart farming system in the market

The smart farming market is a relatively new market, with a low but constantly increasing number of companies activated in the field. It aims to address the need of farmers to produce “more with less”, i.e. to improve their production in terms of quality and quantity while at the same time reducing the use of inputs (agrochemicals, irrigation water, energy etc.) to the extent possible.

As a result, the smart farming market consists of companies providing various types and levels of services, components and other types of offering of interest to the smart farming end users.

Providers of integrated smart farming solutions

The specific segment consists of companies that provide integrated solutions based on smart farming. They may provide smart farming services for any agricultural activity like irrigation, fertilization, crop protection or weather forecast, to name a few. They may also use a specific

data source and type for that, like satellite images for the extraction and visualization of the NDVI index

Providers of smart farming hardware

This market segment consists of developers and providers of hardware used in the smart farming solutions. For example, manufacturers of agrometeorological stations and individual sensors, GNSS / GPS specialized systems for tractors and other agricultural machinery etc. Even though the majority of this hardware can operate individually, the added value comes when it becomes part of an integrated smart farming solution.

Providers of smart farming software

In this case, there are software developers or data-driven startups that develop smart farming applications based on data openly and freely available, like satellite data, meteorological data etc. While the offerings may be still useful for farmers, open data is usually only a fragment of the data available, some of which are essential for providing integrated smart farming solutions.

Providers of scientific results

This segment typically consists of research institutions such as research centers, agricultural universities, individual researchers etc. whose research interests are on topics of interest for the smart farming community, such as crop irrigation, fertilization and crop protection. When their work is transformed into algorithmic predictive models, they are an essential component of smart farming services. These models are “fed” with the necessary data acquired from various sources, so that they can finally lead to the provision of smart farming advice, like the one provided by gaiasense.

While these scientific models have limited interest as long as they remain in the laboratory, they are the basis of smart farming services when they become available to stakeholders outside the academic institution.

Market positioning of gaiasense

The gaiasense smart farming system is positioned at the core of the smart farming market, and more specifically in the segment of providers of integrated smart farming solutions. NEUROPUBLIC’s gaiasense smart farming solution provides a holistic farm management approach based on smart farming, thanks to its features:

1. It provides different services that help farmers optimize the irrigation, fertilization and crop protection activities and strategy in general;
2. It provides a high accuracy, 3-day weather forecast at parcel-level, using atmospheric data collected by its ever growing network of telemetric agrometeorological stations that are installed in agricultural land;
3. The design, development and evolution of the gaiasense stations takes place in-house, by its Research & Development department.
4. The development of web and mobile applications takes place in-house, by its team of software developers;
5. It does not depend on third parties for the necessary cloud infrastructure for the storage and processing of big data acquired, as it uses the certified cloud infrastructure of NEUROPUBLIC;
6. Its smart farming offering is not a "one-size-fits-all" service; instead, it is highly customizable so that it meets the diverse needs of various end users.

6. Analysis of the competitive forces in the market arena

The need for solutions that contribute to the sustainability of the agricultural sector along with the mandate of the EC for a more sustainable food system in the EU, as depicted in the recently announced EU Green Deal and From Farm to Fork strategies, has increased the interest in such solutions. As smart farming combines the use of modern technologies with the scientific knowledge and the personalized agricultural advice for each farmer, it is considered the most appropriate approach for enabling sustainability in agriculture.

The smart farming market consists of a wide variety of offerings for farmers, agricultural cooperatives and other potential users, provided by both SMEs and startups. The deliverable B8 "Initial replicability and transferability plan" provided an overview of the main direct and indirect competitors of gaiasense at higher level, with a brief description and main characteristics of each competitor.

As the potential target markets for the launch of the gaiasense smart farming system have been defined, deliverable B9.3 "Market Analysis and Initial Recommendations" focuses on the competition in these countries, namely Greece, Spain, Portugal, Cyprus and Romania.

6.1 Comparing gaiasense with other solutions

There is a wide variety of smart farming offerings in the constantly growing smart farming market in general. This also applies in the target markets mentioned earlier. In the following sections, an initial comparison of gaiasense with other competitive solutions per country is presented, in order to help the identification of the strengths and weaknesses in each case.

6.2 Appraisal of competitive strengths and weaknesses

The gaiasense smart farming system is a holistic approach, based on data, scientific outcomes and technology. It allows farmers to benefit from smart farming at a low cost and hides any complexity from its end users, allowing them to benefit from an easy to use smart farming information and/or advice.

6.3 Financial validation

One of the most important aspects of the sustainability of a smart farming offering like gaiasense is the validation of its financial aspects. The gaiasense smart farming system needs to generate income and bring profit so that it remains financially sustainable.

The gaiasense smart farming system is supported by NEUROPUBLIC, one of the largest and more financially-healthy informatics SMEs in Greece. NEUROPUBLIC invests significant amounts in the development and implementation of gaiasense, contributing to the sustainability of the solution. The necessary technological infrastructure, like the telemetric agrometeorological stations and the cloud computing infrastructure are constantly updated, in order to meet the needs of an even more diverse customer segment.

An additional revenue for gaiasense comes from the sales of its smart farming services and apps. The customer base of gaiasense is constantly growing, and includes a number of agricultural cooperatives and individual farmers, companies of the agrifood sector like wineries and olive / olive oil companies etc.

Last but not least, a part of the gaiasense income comes from the participation of NEUROPUBLIC in EU- and state-funded projects. Through its participation, NEUROPUBLIC has the opportunity to develop, test and validate new functionalities of the gaiasense system. After their successful validation, these functionalities may become commercially available and create an added value to the services offered by gaiasense. On top of that, in the context of such projects new collaborations with research institutes, both agricultural and technological, are established and further improve the agricultural and technological capacity of gaiasense.

The innovative “Smart Farming as a Service” model designed and implemented by NEUROPUBLIC, allows gaiasense to be provided at a pretty competitive low price. Through this model, farmers can get access to the smart farming services of gaiasense through a relatively small annual fee, while all the technological infrastructure costs that incur (like the cost of the manufacturing of the gaiasense stations, the operation of the gaiasense network, the cost of the cloud computing infrastructure etc.) are undertaken by NEUROPUBLIC in the form of an investment. This allows gaiasense to be competitively priced compared to the competition, offering “more for less”.

The specific model has been designed with the smallholder farmers (who are the largest farmers’ segment) in mind, so that they can also benefit from smart farming without investing in expensive infrastructure. This approach has been acknowledged as an innovation at EU level by EC officials,

think tanks of the farming sector etc. This approach has allowed a high number of smallholder farmers, along with their agricultural cooperatives, to benefit from smart farming, improving their production, reducing their costs and minimizing the impact of their agricultural practices on the environment.

Overall, the financial model of gaiasense has already been validated in Greece and will be carefully implemented in the target countries as well, in order to contribute to the success of its entry in the new markets.

6.4 Dynamic perspective & growth opportunities

There is a strong pressure towards farmers - as food producers - to produce more with less. Therefore, farmers need to change their agricultural practices into more efficient ones, which will allow the production of even more food of high quality, while at the same time minimizing the impact of their activities on the environment. The environmental sustainability of agriculture has been raised as a major issue, and the recently announced EU Green Deal and the Farm to Fork strategy define the framework for a more sustainable food production system.

In addition, the digitization of agricultural production is not considered anymore a nice-to-have feature; instead, it is a core component of the new era of agriculture, allowing the implementation and operation of traceability systems that are essential for food safety purposes and other applications as well.

Smart farming comes to address the sustainability issues of agriculture, including the environmental one, and help farmers to join the digital transformation of agriculture. It allows them to benefit from scientific outcomes without having a specialized researcher next to them, to have better control over their production, inputs and farms in general, and at the same time increase their profit thanks to better farm management. All these features make the smart farming offerings really popular among farmers and agricultural cooperatives.

This increased demand for smart farming offerings has a positive impact on the dynamic of the corresponding market, and this is highlighted in various market analysis reports. According to domain-specific reports, the smart farming market is a constantly growing one, with the potential to reach USD 22 billion by 2025. At the same time, it is expected to grow at a Compound Annual Growth Rate (CAGR) of 9.8% from 2020 to 2025[1]. Despite the recent COVID-19 pandemic and the

[1] https://www.marketsandmarkets.com/Market-Reports/smart-agriculture-market-239736790.html

financial crisis a few years earlier, the latter affecting especially Mediterranean countries like Greece, Spain and Portugal that are among the target countries of gaiasense, the smart farming market remained unaffected, as it was considered as a valuable tool by farmers in order to achieve their production and sustainability goals.

The gaiasense smart farming system has been an early entrant to the smart farming ecosystem, and had the time to work on the development and validation of its services, optimization of its hardware and infrastructure and development of the necessary ecosystem of collaborators and providers. In addition, it has already an established and constantly growing customer base in Greece, along with pilot applications in other countries. This provides gaiasense with a competitive advantage compared to the competition.

Thanks to its design architecture, the gaiasense smart farming system has the potential for rapid growth in different areas. Its diversity and expansion options are crucial factors that ensure a quick transfer to new contexts, referring to new areas, new microclimatic conditions, new crops etc.

7. Milestone setting

The marketing of the gaiasense smart farming system will support the introduction of the system in the target countries and its penetration in the corresponding markets. As described in the initial project proposal, 3 years after the end of the project an envisaged replication will take place across Greece, Spain and Portugal with penetration rates for Agricultural Warnings' Services expected to reach 13,5%, 3,5% and 1,5% respectively. Additional effort will be put in the introduction of gaiasense in Romania and Cyprus at a later stage, with variable penetration rates.

The definition of milestones in the gaiasense marketing plan will allow the tracking of progress towards the goals defined in the proposal. As part of the marketing plan implementation, milestones can also be used to indicate the completion of a specific goal. A detailed definition of milestones for the marketing plan will be available in the next iteration of the deliverable.

At this point, there are **three major milestones** that will be the basis for the introduction of gaiasense in the envisaged target markets:

1. Validation of the existing business model and adaptation (if needed)
The "Smart Farming as a Service" business model of gaiasense, through which it becomes available to farmers has been successfully used in Greece. However, different countries with different characteristics of their markets and agricultural sector may require a slightly different approach for attracting new customers.

A detailed market analysis will be required for each country, in order to identify the major differences with the Greek market; this will define the points to be taken into consideration for the adaptation of the approach. The analysis will also help towards identifying the profit margins for each country and potential adjustments in the pricing policy, referring to the annual fee for the subscription to the gaiasense services. Other aspects, such as the duration of the contract, will also be considered in collaboration with NEUROPUBLIC's sales team.

2. Definition of a custom marketing strategy
The marketing strategy for gaiasense that has been put in place in Greece by NEUROPUBLIC has been tailored to the specific needs of Greek farmers. In this sense, minor or even major adjustments to the marketing strategy may be need in order for it to be successful in the other target markets. Different marketing channels, type of messages, tools etc. may be required for

maximizing the efficiency of the marketing strategy and facilitating the engagement of potential customers.

This milestone includes the identification of the competition in the target market. Based on the preliminary analysis, the potential of each competitor will be assessed using information available from the Web, as well as information sourced from local partners in the country. The marketing strategy in each country will focus on the strong points of gaiasense and the weak points of the existing competition, filling the available gaps.

The adaptation of the marketing strategy heavily depends on the Identification and evaluation of the main marketing channels in each country. This refers to the analysis of the channels mostly used by farmers in each country that will be used for the marketing of gaiasense in the new target market, such as digital and printed press, TV and radio channels, social media to be used in local language etc.

3. Development of a critical mass of customers

The first step for penetrating a new market is the acquisition of even a small group of customers, the positive experiences of whom (high satisfaction level) will be used for attracting a constantly growing customer base. These are usually the innovators[2] and early adopters[3], the ones who typically use a new product, innovation, or technology before others.

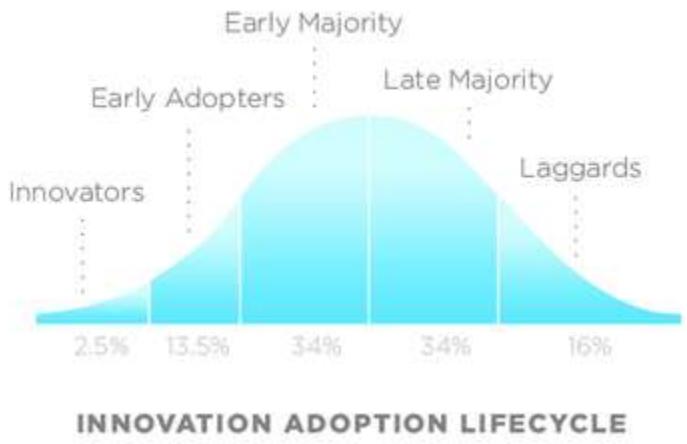

Figure 6: **Early adopters as shown in the Rogers' bell curve. Source: Wikipedia**

[2] https://en.wikipedia.org/wiki/Technology_adoption_life_cycle
[3] https://en.wikipedia.org/wiki/Early_adopter

An early study by agricultural researchers Beal and Bohlen[4] for the North Central Rural Sociology Committee (Subcommittee for the Study of the Diffusion of Farm Practices) on the demographic and psychological (or "psychographic") profiles of each adoption group for the agricultural sector characterizes **innovators** as farmers with had larger farms, more educated, more prosperous and more risk-oriented and **early adopters** as younger, more educated, usually community leaders and less prosperous.

The identification of farmers belonging to these two groups will allow a direct contact with them, custom presentation (per case) of the gaiasense smart farming services and the benefits for each case, so that the offerings will be more attractive to them. As soon as a critical mass of early adopters of the gaiasense smart farming services, their successful use cases will be publicized in order to attract more customers.

[4] Bohlen, Joe M.; Beal, George M. (May 1957). "The Diffusion Process". Special Report No. 18. 1: 56–77.

8. Marketing strategy

The placement of a smart farming solution like gaiasense in existing and new markets needs to be carefully planned and implemented, taking into consideration the specificities of each country, region and area.

The marketing strategy is a core component of such an effort, and will aim at introducing the newcomer in the market, highlighting the strengths of the gaiasense smart farming solution, in the context of the specific area.

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 gaiasense smart farming system is currently marketed in Greece, using a variety of approaches, including printed (e.g. newspapers and magazines) and digital (e.g. social media, blog posts etc.) means, participation in online and physical events of interest, TV commercials and radio spots, interviews etc. The experience gained from marketing gaiasense in Greece will be used for the definition of the marketing strategy in the target markets.

The marketing strategy to be applied in all target markets will have some key components in common, like the key messages it needs to transfer to each audience group; at the same time, it will take into consideration the specific characteristics of each market and will be adapted accordingly. In each case, the marketing strategy will use the means that are most commonly used by potential customers in each country (e.g. newspapers, websites and news portals, TV and radio channels). This will significantly enhance the outreach of gaiasense and will contribute to the optimization of the related efforts towards the marketing of gaiasense.

A detailed description of the marketing strategy of gaiasense is provided in the deliverable **B9.4 Initial Marketing Plan**.