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SmartPeach: Smart Farming Practices Enhance the Adaptation of Peach Crops to Climate Change †

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Abstract: Nowadays, peach farms, and agriculture in general, face intensified challenges linked to pest control and irrigation needs, due to the effects of climate change. A contemporary and effective approach to these challenges is presented herein, which is based on the utilization of a smart farming system specialized in peach cultivation, in the framework of the SmartPeach project. A significant feature of the proposed smart farming system is its service-based approach, as its application does require technological investments from the farmers. The current research indicates a potential reduction of up to 25% of the total production cost due to optimization of irrigation and pest control applications, as well as an increase in farmers' income up to 10% linked to improved product quality and yield.

Keywords: smart farming; climate change; irrigation; pest control; peach productions; Greece

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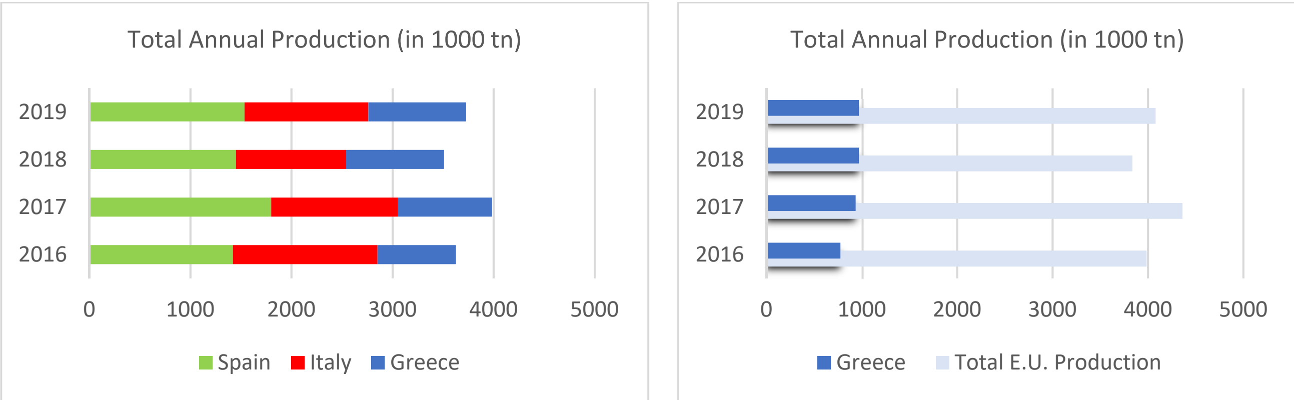
1. Introduction

This paper presents the implementation of an innovative smart farming project in peach cultivation in the region of Central Macedonia within the framework of the SmartPeach program, as an answer/solution to the contemporary challenges faced in peach production.

Greece is one of the leading peach and nectarine producing countries in the European Union, with an average production of 911,700 tons, which corresponds to 22.42% of the total production of the countries of the European Union [1]. According to Eurostat, peach cultivation is the third most important crop in Greece and a significant export product, as the value of the total annual production amounts to USD 379,886,480, from which USD 93,504,000 is related to exports [2]. All the above facts are presented in Figure 1a,b.

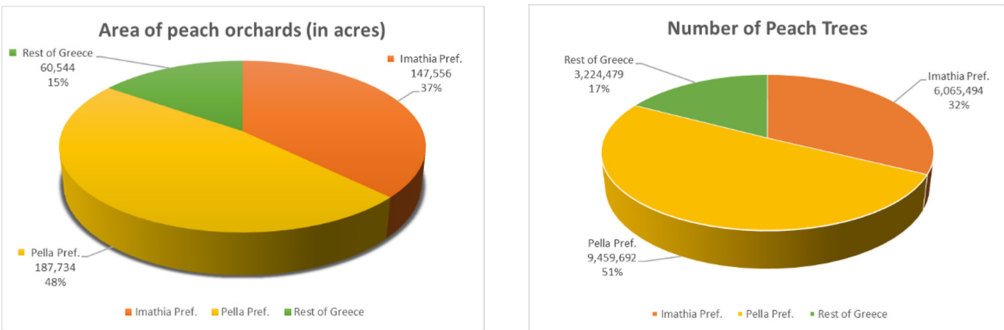
In total, in Greece, there are 20,192 peach orchards, which are mainly located in the Prefectures of Imathia and Pella, according to data gained from the Hellenic Statistical Authority [3], which are presented in Figure 2a,b. Peach cultivation has a long tradition in these areas and it is very important for the local as well as the national economy [4].

Peach crops are considered to be one the most demanding cultivations for crop protection as they are susceptible to a great variety of insects and fungi [5]. Moreover, low water availability affects peach fruit growth and quality to a great extent [6]. The challenges of pest control and irrigation needs are intensified by the effects of climate change. The traditional approach of peach farmers is based on empirical decision-making which leads to increased use of inputs (plant protection products, fertilizers, water) increasing production costs, jeopardizing the overall quality of products produced, but also causing pollution of the aquifer and reduction of aquifer natural resources.



(**a**) (**b**)

Figure 1. Average annual production of peaches and nectarines for the years 2016–2019: (**a**) for the three most important producing countries of the European Union, (**b**) for Greece in relation to the total production of the member states of the European Union (source: Eurostat).



(**a**) (**b**)

Figure 2. Data concerning peach production in the Prefectures of Imathia and Pella in relation to the rest of Greece: (**a**) Area of peach orchards in acres and (**b**) the number of cultivated peach trees for the year 2018 (source: Hellenic Statistical Service).

In this study, a more contemporary and effective approach is presented, which is based on the implementation of a smart farming system that is specialized in peach crops. The proposed smart farming system is based on the Smart Farming as a Service (SFaaS) approach, in which smart farming is offered as a service taking over the technological investment burden from the farmers [7].

2. Materials and Methods

2.1. Study Area

For the needs of the SmartPeach project, four farms were chosen as case studies, which are located in the Prefectures of Imathia kai Pella and have average area of 5 acres. These farms are members of the Agricultural Cooperatives of Episkopi in Imathia (ACE) and Kalivia in Pella (ACK). The two Agricultural Cooperatives list a total of 372 growers and 29,000 acres of cultivated area.

2.2. Data Used

As illustrated in Figure 3, SmartPeach utilizes a set of information sources that include IoT-enabled agro-environmental sensing stations, Earth Observation (E.O.) data (mainly Sentinel-2 Copernicus missions), farmer's digital calendar, and on-the-field observations of the cultivation.

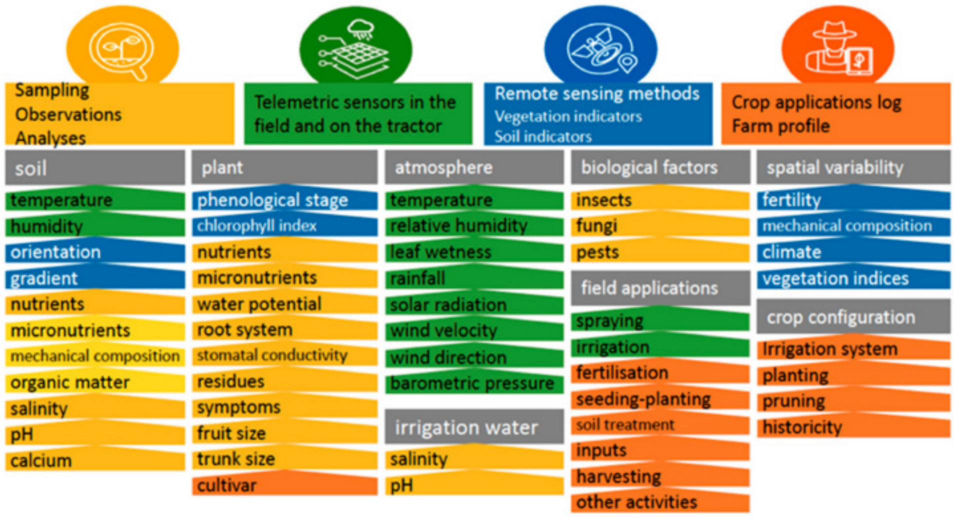


Figure 3. Information sources and data utilized in SmartPeach project.

The agro-environmental sensing stations of the project were installed on March 2019 (one in each pilot farm) and have continuously been collecting data ever since, from sensors installed in the field. These data are related to atmospheric, soil, and plant parameters (e.g., temperature, relative humidity, precipitation, atmospheric pressure, wind speed/direction, soil moisture, leaf temperature, humidity, and wetness).

Furthermore, E.O. data are incorporated in the project, mainly Sentinel-2 imagery. The data are processed in order to produce higher-level products, such as vegetation indices, so as to gain information about the growth of the crops within the pilot farms.

In addition, the digital farmer's calendar is taken into account as it contains recordings of the farmers' applications in the crops (fertilization, pest protection, irrigation, etc.).

Lastly, significant information is gathered through the field observations.

All these data are collected to a central cloud computing repository where they are stored, processed, and combined so as to generate farming advice related to irrigation and pest management applications.

2.3. Methodology

The methodology followed includes the following steps (Figure 4):

- Analysis of the current situation in order to determine the requirements of the crops and determination of the yield indices and the general plan of the research;
- Design and implementation of the network of agro-meteorological stations and continuous data collection and processing;
- Development of specialized prognostic models for the main pests and diseases of peach and adaptation to the microclimatic conditions of the case study areas [8–11];
- Development of specialized irrigation models, which are focused on the active root layer of the plants and the estimation of the optimal time of irrigation and irrigation dose [12–14];
- Design, configuration, and final adaptation of the smart farming platform, after the integration of the specialized models, taking into account the prevailing methodological approaches of the international literature [15,16];
- Evaluation of the results and validation of the proposed cultivation practices.

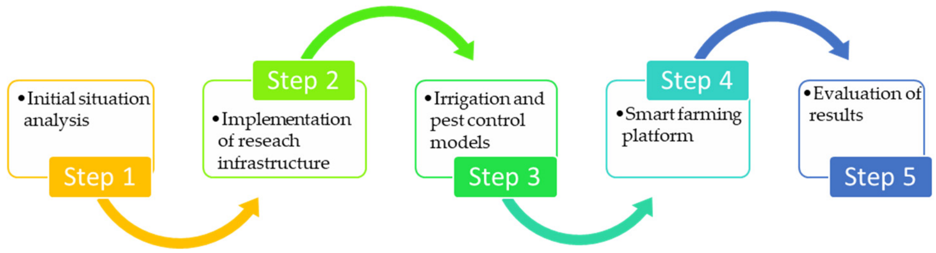


Figure 4. Flow chart.

3. Results

SmartPeach is an ongoing project, expected to be completed in June 2022. The overall results of the project will be available on the completion of the project, although the results up to now are very encouraging.

SmartPeach aims to adapt and extend existing smart farming best practices to the needs of peach cultivation in Greece. To this end, the appropriate pest infestation and irrigation needs prediction models are researched in order to be integrated within a decision support system that will predict and notify farmers accordingly.

The current research indicates a potential reduction of up to 25% on total production cost due to the optimization of irrigation and pest control applications, which amounts to EUR 4500 per acre (Figure 5). In addition, an increase in farmers' income up to 10% is projected to be achieved, due to the improved product quality and yield, which corresponds to EUR 11,200 per acre.

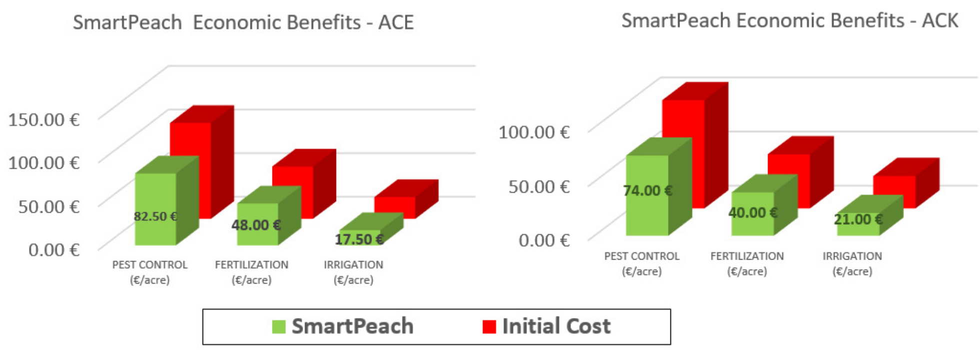


Figure 5. Estimated economic benefit of the implementation of SmartPeach in the Agricultural Cooperatives of Episkopi (ACE) and Kalivia (ACK), in the prefectures of Imathia and Pella respectively.

The total economic benefit of the farmers is estimated at EUR 15,700 per acre annually, which corresponds to an amount of EUR 62,541,772 in case of nationwide implementation of the proposed smart farming system on the total areas of peach orchards.

In addition to the significant economic benefits from the implementation of the proposed Smart Farming System, the enhanced adaptation of the farms to the ever-changing climatic conditions, due to climate change, and the minimization of the ecological footprint of the farms are of crucial importance and is worth emphasizing.

Furthermore, in SmartPeach a service-based approach is implemented, aiming to support small-scale farmers, by taking over the technological investment burden and offering next generation farming advice through the combined utilization of heterogeneous agro-environmental information sources. Considering the small and fragmented holdings of farmers in southeast Europe, the approach presented herein is innovative, as the farmers have the ability to subscribe to specific farming advisory services with an annual subscription per acre of arable land [7].

4. Discussion and Conclusions

The aim of this study was to present the implementation and potential advantages of adapting smart farming in peach crops, in the framework of SmartPeach project. In SmartPeach, the optimization of input application and the reduction of production costs are achieved in an environmentally friendly way, while the quality of the products is improved, due to the minimization of pesticide residues and the environmental footprint of the crop. In addition, an important feature of the specific smart farming system is its service based approach (SFaaS); its application does not require technological investments from the farmers. All in all, the current work presents an affordable solution that enhances the ability of peach farmers to adapt more efficiently to climate change while upgrading the yield and the income of their farms.

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