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Original article

In Rural Areas Internet Connection Problems and Solution Recommendations Experienced in The Process of Using Smart Agriculture Methods in Olive Farming

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Abstract

The olive is one of the most important crops grown in the Mediterranean region, both in terms of total surface area and its socioeconomic and environmental impacts. Olive and olive oil are the essential components of the Mediterranean diet and are largely consumed in the world. It is very significant to provide economic and environmental sustainability by better managing scarce natural resources in olive farming. Modern planting systems, mechanization and digitalization are taking place rapidly in olive farming around the world. In Türkiye, olive production mostly is done with traditional methods, and most producers belong to rural communities. The rise of new technologies, such as the Internet of Things, is expected to contribute to the increase of the productivity of agricultural and farming activities by improving yields and reducing cost. Olive fruit fly is the primary pest of olive and causes a significant amount of yield and quality losses. Using early warning systems could accurately determine the spraying times by using climate data in the control of diseases and pests in olive orchards. In this research; at the workshop organized within COMMECT, an EU HORIZON project (Project aims to contribute to a balanced territorial development of the EU's rural areas and their communities by making smart agriculture) the views of 65 selected olive producers on the use of early warning systems, their connection status and the problems experienced were evaluated. As a consequence in this study connection problems and solution recommendations were underlined and recent developments in this area were discussed with cost-effective and environmentally friendly approaches.

Keywords: Olive Farming, Smart Agriculture, Early Warning Systems, Rural Development, Olive Producers.

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INTRODUCTION

Agricultural development has an important role in general economic growth, poverty reduction and achievement of agricultural practices in rural areas. Technological developments that have progressed rapidly in recent years have also become an important part of the agricultural sector (Aydemir, 2008). With the raising of new technologies, such as the Internet of Things, improving the productivity of agricultural and farming practices is crucial to increasing crops quality and cost-effectiveness. The modernization of agriculture and the use of digital technology has caused new concepts to emerge such as precision farming, digital farming, and smart farming. The most widely used one is smart agriculture. It can develop the effectiveness of agriculture and farming practices by eliminating human intervention through automatization. Collecting data using new agricultural technologies is useful in terms of changes in climatic conditions, soil fertility, the amount of irrigation water requirement for products and the detection of insects and pests (Rehman et al., 2022).

Smart agriculture should increase economic viability and food sustainability in agriculture sector. In recent years, terms such as "sustainability," "sustainable use of natural resources," and "ecological balance" have been widely used. For a long time, these concepts have guided maintaining a permanent living environment for humans, the environment, and other living species, along with use and protection (Francis et al.,1990). Sustainable agriculture creates a structure that protects natural resources using non-harming farming techniques. Sustainable agriculture is a control environment architecture that uses non-destructive operating technologies and long-term natural protection (Turhan, 2005).

Modern planting systems, mechanization, and digitalization are rapidly occurring in olive agriculture worldwide. But Türkiye lags behind developed countries in integrating technology and digitalization into olive farming. Olive production is done with traditional methods and olive farming is generally carried out in the form of small-scale family businesses. Some factors, such as educational level, employment status, monthly income, household size, being part of a cooperative, age and lack of telecommunication coverage in the countryside affecting perceptions of smallholder farmers digital technologies (Pakdemirli et al., 2021; Saygılı et al., 2019).

In addition to its economic and agricultural importance, olive cultivation in the Mediterranean regions also plays a role in the protection of biological diversity in rural areas and in providing benefits in economic and social dimensions (Maesano et al., 2021).

There are many types of pests that cause significant quality and yield losses in olive. The most important of these pests is the olive fly, and it has economic importance as it causes a significant amount of yield and quality losses (Topuz, H., & Durmusoglu, E., 2008).

An early warning system is a vital tool in combating diseases like cherry leaf spot, powdery mildew, apple scab and olive fly. These systems offer numerous benefits to farmers and orchard owners, helping to mitigate the impact of these diseases on crop and ensuring a healthier yield. Firstly, an early warning system provides timely information about the presence and spread of these diseases and insects (Xu X and Robinson, 2005).

By monitoring environmental conditions and potential carriers of pathogens, farmers can detect signs of disease emergence before it reaches a critical stage. This early detection allows for prompt intervention, preventing the diseases from taking hold and causing widespread damage (Rossi et al., 2003). Secondly, early warning systems enable more precise and targeted treatments. Instead of applying broad-spectrum pesticides or treatments across the entire orchard, farmers can focus on the specific areas or trees that are at risk. This approach reduces the overall use of chemicals, minimizing environmental impact and reducing production costs. Secondly, early warning systems enable more precise and targeted treatments. Instead of applying broad-spectrum pesticides or treatments across the entire orchard, farmers can focus on the specific areas or trees that are at risk. This approach reduces the overall use of chemicals, minimizing environmental impact and reducing production costs (Atlamaz et al., 2007; Blauw et al., 2006).

Farmers can access information about weather patterns, humidity levels, and other environmental factors that contribute to disease development. Armed with this knowledge, they can make informed choices about when to apply treatments, irrigate, or adjust their farming practices to create less favorable conditions for disease spread (Atlamaz et al., 2007; Blauw et al., 2006). Furthermore, early warning systems help in disease prevention through integrated pest management (IPM) strategies (Friocourt et al., 2012).

The most important disease seen in olive trees in Turkey is *Spilocaea oleaginea* (Castagne) S. Hughes (ring spot). This disease causes leaves to fall, making trees unproductive. By using data from weather stations to estimate when the climatic and olive plant conditions are suitable for diseases to occur, a warning could be sent to the olive farmer or orchard manager (Cahit, T., & Onoğur, E., 2013).

In conclusion, the benefits of an early warning system against olive fly are numerous and significant. These systems empower farmers to detect and address disease threats proactively, minimize chemical usage, make informed decisions, and implement effective disease and insect management strategies. By harnessing technology and data, early warning systems play a pivotal role in safeguarding orchards and ensuring sustainable agricultural practic (Pontikakos et al., 2012).

In light of this information, one of the most critical developments that come to mind is using digital traps and climate devices in olive farming. A wide variety of traps have been designed and evaluated over the past 30 years. The ability of these devices to turn into early warning systems and identify diseases and pests depends on the ability to receive large-scale data without any connection problems instantly. Data should be moved from harsh terrain conditions to improved conditions and processed by artificial intelligence to activate early warning systems (Burrack et al., 2008, Doitsidis et al., 2019).

This study has been prepared using the studies carried out within the scope of COMMECT, an EU HORIZON project. In Türkiye, COMMECT project aims at improving olive farming in rural areas by using smart agriculture devices. A workshop on "Digitalization in olive agriculture, problems and solution proposals" was held with participants of producers and producer representatives engaged in olive farming in Turkey. 36 people attended this workshop from 19 different cities. Survey data was collected by means of questionnaires. The research discussed how early warning systems against pests and diseases that affect olives could be used to increase the economic and social opportunities for olive farmers who reside in rural areas. Also it aimed to determine the factors that influence the perceptions of olive farmers towards the adoption of digital technologies. In addition, connection problems of existing early warning systems were investigated. Where connectivity is possible, 5G and other connectivity options, XG, have been evaluated.

MATERIALS and METHODS

The material of this study consisted of data obtained from primary and secondary sources. The main material of the study consists of secondary data sources consisting of other studies, statistics, articles and theses related to the research subject. In addition, interviews with olive farmers within the scope of COMMECT, an EU project, were used as the original data source.

In this study, 65 olive farmers were interviewed about digital connection problems and usage information. Producers are randomly selected individuals from 36 districts of 8 different olive producing provinces (Bursa, Balıkesir, Çanakkale, İzmir, Manisa, Aydın, Denizli, Muğla).

The experience of olive farmers on the use of early warning systems is presented. The problems experienced by olive producers were discussed. Opinions were received on how digitalization can contribute to agriculture.

RESULTS

Profile of Olive Farmers and Use of Technology of Olive cultivation

In the first part of the interview, questions are about their personal socio-demographic characteristics (age, profession, income class) for finding out the characteristics, the habits and the choices of region users.

In this study, total 51% of the olive farmers interviewed were between the ages of 51-65, and 34% were between the ages of 36-50 and the rest between the ages of 21-35 (Table 1). Özaltaş et al. determined the average olive producer age as 54.65 (Özaltaş et al., 2016).

Table 1. Age range of participants

Age	Number	Percentage
Less than 20	0	0%
21-35	10	15%
36-50	22	34%
51-65	33	51%
More than 66	0	0%
Total	65	100%

They all knew about Narrowband-IoT (NB-IoT) and enhanced Machine-Type Communications (eMTC) digital farming systems and early warning systems. However, only about 1,5% of them use these systems due to the lack of technical and financial equipment (Table 2). The rest of the olive farmers interviewed indicated the willingness to use NB-IoT and eMTC digital farming systems and early warning systems, indicating that their network connectivity needs will increase.

Table 2. Using digital farming systems

Farmer's view	Number	Percentage
Doesn't and know digital farming systems	25	38,5%
Planned in the near future	39	61%
Using digital	1	1,5%
Total	65	100%

According to the weather information questionnaire, it was determined that the most important sources of information were television and radio, followed by XG network-connected smartphones. Older farmers need to learn how to use their XG connected smartphones as they also view weather reports. Among olive farmers, the rate of using XG network-connected smartphone applications was 69%, the rate of using television and radio was 94%, and the rate of using computers was 8% (Figure 1).

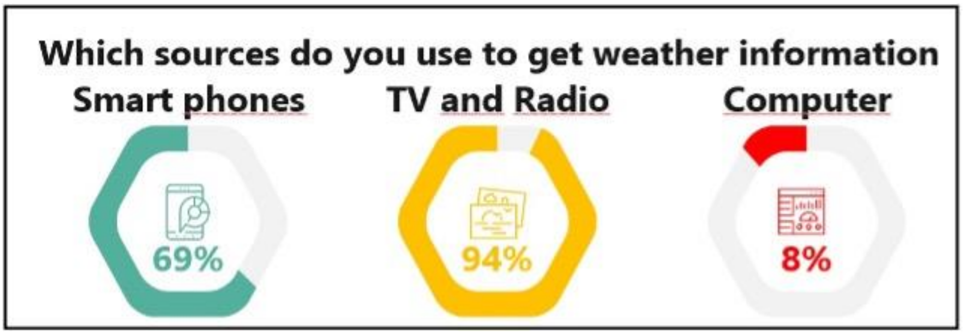

Figure 1. The source of weather information.

Agricultural control for olive fly

It is thought that the most important pest for olives is the olive fly. Many methods are used to control this pest. There are many studies related to the fact that controlling these methods with digital traps directly affects the success.

In a study conducted in Portugal, it was determined that the first adults of the olive fly were 64.10±13.77 days-degrees from January 1, the peak point of the first flights was 241.64±15.97 days-degrees, and the first onset of the second flights was 1837.20±35.82 days-degrees. It also states that the larvae of the first progeny of the pest could not develop in the area where the study was carried out due to the temperature, so the spraying of the adults should be done at 1837.20±35.82 days-degrees when the second flights start (Goncalves et al., 2008).

In a study conducted in Greece for the integration of computers and technology with agriculture; It has been shown that the LAS (Location Aware System) system, in which olive fly population dynamics are evaluated together with meteorological data, is a useful tool for olive producers, scientists or organizations that increase efficiency in olive fly control, protect the environment and reduce the cost of pesticides (Pontikakos et al., 2012).

Agricultural control for diseases

It is known that the most important among olive diseases is ring spot (*Spilocaea oleaginea*) disease. Early detection of this disease with early warning systems is of great importance. There are also early warning systems that have a similar structure to this disease and are used in different fruits. Many studies on the subject have contributed to the solution of the problem.

This study used a dynamic early warning model to combat powdery mildew in cucumber. The time of infection of the pathogen was accurately determined using real-time measured weather forecast data for two months. For the weather forecast, a web-based model based on the REST API service provided by Weatherbit was used (Liu et al., 2022).

The most important disease affecting grape production is vineyard mildew caused by Plasmopara viticola. Narrow Band IoT (NB-iMetos IoT) early warning system was used for the time of infection caused by the disease. The meteorological parameters in the study were determined by following the parameters such as precipitation/leaf wetness and hourly monitoring, which are critical for sporangia spread, such as "suitable night conditions" and "wind speed", from models based on early temperature and humidity. (Mezei et al., 2022).

In conclusion, the benefits of an early warning system against cherry leaf spot, powdery mildew in cucumber, grape, apple scab and olive fly are numerous and significant. These systems empower farmers to detect and address disease threats proactively, minimize chemical usage, make informed decisions, and implement effective disease and insect management strategies. By harnessing technology and data, early warning systems play a pivotal role in safeguarding orchards and ensuring sustainable agricultural practice.

The following results, in Table 3, were obtained by ranking the methods olive farmers will use in decision-making processes for applications such as plant protection, irrigation, and fertilization in the future according to their importance. The six-point Likert Scale was used to measure the producers' views regarding the use of which devices to use in the future.

Table 3. The overall ranking of devices for use with decision-making in olive cultivation (6 likert scale).

Subject	Average score (1-6)
Recommendation was determined by sensors and sent directly to my phone.	5,83
Trap images were send to my phone to determine when to protect olive fly and olive moth pests	5,72
Ringspot disease sensors and air temperature measurements in the stand to determine the infection status of peronospora.	5,63
High-resolution data on soil water content during vegetation.	5,05
A denser network of weather stations.	4,83
High-resolution soil information for more accurate determination of irrigation needs.	4,62
Regular drone images to determine the vigor of the olive yards.	4,51

The item that stands out as the most important topic in the Likert evaluation made with olive farmers is "Direct recommendation determined based on sensors and sent to my phone" (5,83/6). These devices provide their own energy through solar panels. Electronic traps are yellow sticky traps that contain pheromones that attract adults. With electronic traps instead of traps for manual inspection, olive fly control randomly located in olive orchards will be monitored remotely without frequent supervision. It will be ensured that the olive fly population is constantly monitored and sprayed at the right time. Digital traps are insect traps with integrated electronics (camera system, modem, power source with solar panel) and sticky plate. This will enable the transfer of data from soil-plant-atmosphere sensor stations comprising information about soil water content, soil and air temperature, precipitation, and other relevant parameters (Figure 2).

Figure 2. Climate station, Digital trap with solar panels.

The digitalisation has benefits such as efficiency in agricultural production, less pesticide use, protection of human health and the environment, labor savings, prevention of excessive use of pesticides, reduction of pesticide and labor costs, protection of a biological balance and diversity, prevention of pesticide resistance, and improvement of product quality.

There are low-income levels of rural communities. In addition, the labor force in agriculture do not have sufficient knowledge about farming. There are difficulties with socio-economic integration. Even if the information is available, more literacy is needed to allow farmers and workers to use the available technologies and methods. The low literacy rate is one of the main challenges to disseminating olive farming practices in Türkiye. Farm management and the economy are also negatively affected by faults and imperfections by workers. As reported by Dhehibi et al. (2020) the adoption of the technology depends on the knowledge, perception, and acts of the end-users as well as the characteristics of the technology.

As a result; In addition to the coverage area problems, it was determined that training studies on digitalization should be carried out. Rural communities should be given specialized training on olive cultivation, which could for instance be training in olive disease and pest control, olive pruning, olive harvest, irrigation, fertilization, and tillage.

All the subjects were set significantly by olive farmers. Using this XG techonologies with non-terrestrial network support for taking recommendations about agricultural practices and learning control time of disease and pests attacks are found more important than other questions. It has been determined that early warning systems are useful, but the solution can be achieved through organization, not individual action. In all the answers to the related question, olive farmers do not use prediction models in their plant protection decisions.

The view that the environmental effects of digitalization in agriculture would be positive came to the fore. It was also thought that its social and economic impact would be positive. As a result of the interviews with the participants, it was decided to prepare a new questionnaire and to get the opinions of the producers on the subject.

Conclusions and Suggestions

The sustainability of agricultural production and sufficient supply of food to the world population are among the priority subjects. Countries, such as Turkey, where production costs are increasing and decreasing employment in agriculture, sustainability of production depends primarily on reducing costs and increasing profitability. The application of smart agriculture techniques has been identified as an important aspect in proffering solutions for most of the challenges to climate change mitigation as well as environmental and agricultural sustainability.

Besides that, the environmental load of calculations resulting of production and environmental sustainability principles should not be compromised. Therefore, it is extremely important to determine adequate and timely agricultural practices to be done. Using early warning systems for the purpose of olive farmers to make timely and adequate control practices against diseases and pests attacks will be an effective method.

The farmers' awareness of this subject means that spreading of it will be quick. While the early warning systems are designed, it is essential producing its own energy, being compatible with rugged terrain conditions and having artificial intelligence definitions completed. Correctly positioned units will help to save a significant amount of sources and also to increase efficiency and quality. The success of all these systems to be installed depends on the quality of the connection. The most important criteria are; getting off the uninterrupted and momentary data, taking and analyzing large data files from the field, and doing the correct definitions of them. Even small-sized data received at certain times of the day must be transmitted by taking care of energy savings. As a result, in this study, connection problems and solution suggestions were emphasized, and the latest developments in this field were revealed.

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