Irrigation Advisory Services

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The EU research project OPERA—"Operationalizing the increase of water use efficiency and resilience in irrigation" focuses on the sustainable management of water resources in agriculture and the use of irrigation advisory services (IASs), and thus, intelligent irrigation systems that provide information to a large number of farmers have become useful tools for irrigation programs. The issue is not new, and extensive research and investments have been made to develop more advanced methods and practices to accurately provide water to the crops based on their needs.

irrigation advisory services   agricultural decision making   economic sustainability

1. Introduction

The interest in promoting a form of agriculture capable of adapting to climate change has made the management of water resources one of the key points in the reform of the CAP 2023–2027 [1]. As a matter of fact, "*Foster sustainable development and efficient management of natural resources such as water, soil, air*" and "*Fostering knowledge, innovation and digitalisation in agriculture*" have been designated as two of the ten new strategic objectives of the new CAP 2023–2027. In order to pursue more efficient and sustainable water use, EU countries are called, among other things, to encourage research and innovation in the sector by the implementation of "smart irrigation" technologies. An efficient use of water for irrigation is a priority driven by the evidence that many areas in the Mediterranean region suffer structural water scarcity, imposed by the periodic droughts and by the expansion of water demands of agriculture and other sectors of society [2]. With the advancement of climate change, higher temperatures, and changing precipitation patterns, the demand for water by the agricultural sector has increased. It has started to affect not only areas where irrigation has always been an essential element of agricultural production (southern Europe) but also areas traditionally considered not irrigated, such as some areas of central and northern Europe. In this context, the EU research project OPERA—"Operationalizing the increase of water use efficiency and resilience in irrigation", http://opendata.waterjpi.eu/dataset/2a2a87e0-5c84-42cd-a9da-ecac0bbb9257/resource/1b07850f-c7e8-4a0d-86c8-180ff3e1bae5/download/d5.1_inception_report_opera.pdf (accessed on 24 July 2023) is a program financed under ERA-NET, which is part of Water JPI. Water JPI aims to tackle the challenge of "achieving sustainable water systems for a sustainable economy in Europe and abroad". Within the context of a sustainable economy, OPERA focuses on the sustainable management of water resources in agriculture and the use of irrigation advisory services (IASs), and thus, intelligent irrigation systems that provide information to a large number of farmers have become useful tools for irrigation programs. The issue is not new,

and extensive research and investments have been made to develop more advanced methods and practices to accurately provide water to the crops based on their needs.

Technological advances in IASs continue to increase rapidly [3][4][5][6][7][8][9]. Along with it, the behavioral and socio-economic determinants of farmers for the adoption of these efficient irrigation technologies are also evolving. The success of these technologies can be supported by the integration of stakeholders' needs in the design of IASs [10][11].

2. Irrigation Advisory Services

Several factors determine the quantity of irrigation water employed in agriculture, ranging from the variety of crops and cultivation approaches to soil properties and the irrigation method, among others. Hence, agriculture itself presents prospects for improved water administration and conservation, encompassing both conventional farming practices and innovative agricultural technologies. Among the latter, irrigation decision support systems (DSSs) can assist farmers in making informed decisions, leading to enhanced profitability by optimizing water usage and ensuring maximum crop yield in a particular growing season. These systems are primarily designed to simulate or forecast crop water requirements, presenting a range of choices. Under this scenario, irrigation advisory services (IASs) are considered a useful DSS to help farmers achieve the best efficiency in irrigation water use and to increase their incomes by obtaining the highest possible crop yield. Irrigation advisory services are a set of activities that aim to provide technical and professional support to farmers and agricultural operators in the management of cropland irrigation. In recent decades, the research has focused on investigating new IASs tools, which has contributed to the evolution of the performance capabilities of the services. Nowadays, IASs can be implemented in a broad range of agricultural situations, and they can easily be combined with several software programs. IASs are able to deal with the following:

- Satellite-based irrigation volumes are able to perform a site-specific evaluation of irrigation volumes, integrating remote sensing data with a geographic information system (GIS) [12]. In some cases, the research has been focused on quantifying several irrigation and drainage performance indicators with the support of a GIS.

- Development delivery data from a desktop application to via the web, considering that the graphical user interface is a key element for the successful use of the services (PlanteInfo, WIESE, IRRINET, BEWARE, ISS-ITAP, IrriSAT, IRRISAT) [13][14][15].

- Biophysical variables, surface soil water content, and canopy water content; for example, some studies have been inquiring about how to estimate separately determine soil evaporation and crop transpiration [16][17][18].

- In the context of remote-sensing tools, some studies have been carried out as a part of the project DEMETER (Demonstration of Earth observation technologies in routine irrigation advisory services), which deals with the transmission of personalized irrigation scheduling information to the users, related to an extended period of time (e.g., on past, present, and future weather) [19].

- Some studies have investigated the idea of an IAS tailored to the distinct circumstances of farmers. The findings indicate distinct farmers' inclinations, particularly for obtaining weather predictions from the service and for the characteristics associated with water data registration [20][21].

As indicated above, the research has made notable steps forward, progressing in the technical aspects at the basis of DSS programming for irrigation, and has made the use of IASs more and more efficient. It has also made the use of these tools applicable in various agricultural contexts.

The strengthening of the aspects of the research activity mentioned above deserves to be further investigated to understand the judgment of the end users and their needs, with the aim of favoring the implementation of IASs in the management of water resources in the field.

The analytic hierarchy process (AHP) is a decision-making procedure developed by Thomas Saaty and it has been used in the present study to analyze the verbal judgments of IASs end users belonging to four different geographical areas: Italy, Netherlands, Spain, and Poland.

This work contributes to the general issue of water use in agriculture by developing a methodological approach based on the analytic hierarchy process to support the decision-making objective of "improving the use of irrigation advisory services".

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