Report on socio-economic assessment

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	OPERA Consortium partners	Short name
1	Wageningen Environmental Research (Alterra), The Netherlands	WEnR
2	Stellenbosch University (SU), South Africa	SU
3	Evenor Tech (Evenor), Spain	Evenor
4	Instituto de Recursos Naturales y Agrobiologia de Sevilla (IRNAS – CSIC), Spain	IRNAS
5	French National Institute for Agricultural Research (INRA – EMMAH), France	INRA
6	University of Florence (UNIFI – DISPAA), Italy	UNIFI
7	Council for Agricultural Research and Economics (CREA) – Research Centre for Policies and Bioeconomy, Italy	CREA
8	Institute of Technology and Life Sciences (ITP), Poland	ITP

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Executive summary

OPERA (Operationalizing the increase of water use efficiency and resilience in irrigation) is thirty months research and technical development (RTD) project, financed under the ERA-NET Cofund WaterWorks2015 Call. This ERA-NET is an integral part of the 2016 Joint Activities developed by the Water Challenges for a Changing World Joint Programme Initiative (Water JPI). The WaterWorks2015 ERA-NET Cofund, that was launched in support of the Water JPI, is funded by the EC under H2020. WaterWorks2015 aims at tackling water challenges at European and international levels through the development of transnational and transdisciplinary research and innovation actions. In particular, it is designed to stimulate an operative concept for the development of services (Information and Communication Technologies -ICT- and Decision Support System tools -DSS) for irrigation water management.

The OPERA project consists of a network of scientific parties and small and medium enterprise's (SME) that collaborate with the users (e.g. farmers, water managers, policy makers) to increase crop productivity by constructing efficient and sustainable water management in irrigation. Local service providers (LSP) have the main role within the project: their task is to process satellite data and to create and deliver value-added products according to different user specifications. In this production process, the service providers rely on a wide net of external resources, like satellite data providers and local facilities, and the links between the various levels should be neatly defined for allowing an efficient functioning. One way to go is to help the (present and future) providers in finding an efficient line of functioning in terms of necessary and/or desirable characteristics.

In this document, expected by work package 4, we developed a conceptualization of practical service models with specific focus on deliverable D4.1: Report on socio-economic assessment. The specific aim of this document is to provide the results of Strength, Weakness, Opportunities and Treat analysis (SWOT) and Choice Experiment (CE) in order to assess the capability of Irrigation Advisory Services (IAS).

Climate change, water supply limits, and continued population growth have intensified the efforts to conserve water in irrigated agriculture, the world's largest water user. In fact, irrigated agriculture is facing rising competition worldwide for access to reliable, low cost, high quality water.

Policy measures that encourage adoption of water-conserving irrigation technologies are widely believed to make more water available for cities and the environment. However, most farmers' concepts of water efficiency are linked to maximising the farms' economic productivity rather than saving water per se, except perhaps when their own allocated resources may be inadequate. As highlighted in OPERA, one way for increasing the crop productivity is constructing an efficient and sustainable water management in irrigation. In order to achieve this score, some steps are needed. The first step is to look at technological innovations in the agricultural water management for identifying possible sustainable solution. Secondly, practical solutions were selected with the use of two methodologies for socio economic assessment, i.e., a SWOT analysis and a choice experiment for

preferences of the farmers,. The last step was the analysis of willingness to pay for the service identified.

1 Introduction and scope

The escalating water scarcity represents a global challenge today, even for the agricultural sector. In recent years the availability of water resource has been negatively influenced by many factors, including factors related to the climate change and its competitive use among different productive sectors. Climate change limits water availability in many regions of the world. Water limitation reflect his negative effect on the entire economic system, but agriculture is expected to suffer the greatest impact since it accounts for 70% of global freshwater withdrawal (FAO, 2017). Accordingly, the reduction of water availability is due to both the decreasing water reservoirs and the consequent distribution limitations managed by authorities at different levels, and the necessity to deal with tradeoffs in water use and other uses as emerge especially during the summer. However, the agricultural sector both contributes to and faces water risks (OECD, 2017). Due to water constraints, nowadays farmers and different stakeholders that are involved in the agricultural water management are called to rationalize the use of water, for example through the adoption of innovative irrigation practice as Irrigation Advisory Service (IAS). Indeed, until now these represent one of the most important tools to face the challenge of water scarcity in agriculture, due to their potential to achieve a better efficiency in water use for irrigation, while optimizing crop productivity even in terms of cost-effectiveness. Carrying out an efficient and sustainable water management for agriculture means reduce the consumption of irrigation water ensuring a stable food production for a higher food security all over the world. Increasing water and crop productivity through sustainable solutions will increase farmers' resilience.

Today, the need for innovative tools to manage sustainable natural resources as water is central in the EU policy strategies. The strategic objective of the Common Agricultural Policy (CAP) 2014-2020 aims at emphasizing the innovation transfer from the research setting to the agriculture field (Bentivoglio *et al.*, 2016). In the context of the sustainable water management in agriculture, the adoption of irrigation advisory services by farmers is the key.

IASs have already been proved to be effective instruments for increasing water use efficiency and productivity, improving the decision-making process and reducing the information gap among involved players (Mañas *et al.*, 1999). This is particularly true when such services are freely available to farmers and provide simple, readily available information; on the other hand, when the service is charged for and a high commitment in terms of knowledge by the user is required, issues related to cost-benefit balance can become relevant.

Today farms are confronted with a rapidly evolving, increasingly competitive and uncertain economic environment that makes corporate decisions truly complex. Over the last few years, science and technology have shown considerable progress and, therefore, the entrepreneurs have to take the right choice about new technologies (information, communication, marketing, etc.), global markets, etc. Competition pushes farms to pursue profits through innovation and investment. The conquest of new markets by geographical expansion and the reducing costs by adoption of new technologies and new skills are key elements for farmers to be more sustainable.

In Europe, crop productivity is negatively affected by climate change and this is expected to further increase in the next years. Investing in a sustainable agricultural water management system is the preferable way to prevent future food insecurity and economic losses. Knowledge and information are needed to predict water shortage and increase crops resilience. Technology is essential. Despite the progress made in the development and application of sensors and models to analyse soil-crop water dynamics, a significant gap remains in applying the necessary combination of such techniques to predict upcoming water demands.

The OPERA project was developed in this context with a specific aim: to deliver guidelines on the most adequate combination of sensors, remote sensing, weather forecast and simulation models that allow better consideration of rainfall, evapotranspiration and soil moisture in irrigation scheduling. OPERA will strengthen farmers' adaptation to climate change by:

1) Identifying how farmers can react more flexible to predicted water variability;
2) Delivering adequate combinations of ICT tools in irrigation scheduling;
3) Integrating experiences in operationalizing precision irrigation from various climatic zones to identify applicable service models for more robust decision making.

The short-term impact expected from OPERA is the possibility to pick up elaborated combinations of ICT products to forecast agricultural water needs. OPERA will deliver an operational methodology for SME service providers, cooperatives and big agri-food companies, to improve production as well as to reproduce successful cultivation experiences. At the regional level, the administration institutions will have a DSS tool to simulate the water requirements of each location and crop and use it to optimize the crop distribution according to the water supply capacity. The benefits in the medium and long-terms will result mainly from realizing a better advisory service in the agricultural sector that can lead to a better water demand management, to avoid harvest losses, and to a more sustainable socio-economic development in the rural farming areas in times of water scarcity and drought.

The specific aim of this document is to provide the results of Strength, Weakness, Opportunities and Treat analysis (SWOT) and Choice Experiment (CE) in order to assess the capability of Irrigation Advisory Services (IAS). Chapter 2 concerns a stakeholder analysis, and Chapter 3 describes an analysis of farmers' needs including a SWOT analysis and the results of the Choice Experiment. Chapter 4 summarizes the main conclusions.

2 Stakeholder Analysis

The EU project OPERA is based on a transdisciplinary approach to ensure the joint learning and co-development with all relevant stakeholders throughout the project, by identifying the needs and demands of the users, as well as the preferred combinations of information technologies and service models. The transdisciplinary approach of the OPERA project required an appropriate and accurate identification of stakeholders from the outset of the project, including a good understanding of them, their roles and the interactions among them. This is because the general legitimacy of the participatory process and the extent to which the results are widely accepted depends on how the participants were selected and, how well they represent the broad stakeholder context (Dougill *et al.*, 2006; Prell *et al.*, 2009). Stakeholders are defined as anyone who can affect, or is affected by, a decision; they might be individuals or formal organisations and may span a range of interests and sectors (Leventon *et al.*, 2014). Since each case study in the OPERA project is developed in a different geographical location, under different language, cultural and socioeconomic particular traits, a deeper understanding of the soil threat and its context is held by each case study partner, so each of the partners will undertake the particular stakeholder selection for its case study. Thanks to the work conducted in WP1 of OPERA - Identifying sector needs to increase resources use efficiency - the involvement of stakeholders has been analysed, both in the case studies and at national/European level. Stakeholder involvement plays a key role to identify market driven needs and to increase water use efficiency. In particular, in OPERA deliverables D1.1 (Blanco-Velázquez and Anaya-Romero, 2018) and D1.2 (Blanco-Velázquez and Anaya-Romero, 2019), through the document guidelines for analysis and selection of stakeholders, the particular stakeholders could be selected by each case study partner. To this aim, the guidelines provided a common but flexible protocol to be implemented by the case study partner according to their own needs and capabilities, also providing certain degree of harmonisation between case study sites by providing key principles to follow in each site. Following the approach of snowball sampling design, the stakeholders selected are asked to identify further stakeholders, starting with the case study partners.

A total of 123 stakeholders from different sectors were identified and selected to participate in the questionnaires elaborated by identifying the needs and demands in all case study areas of the project during the time covered from 2017 –2018.

In order to rise the farms' competitiveness, several options were developed for the case studies areas. Even though different strategies have been selected for different areas, such as:

- Improving the marketing strategy of the products in France and South Africa;
- Improving the sustainability of the production process in Poland, South Africa and the Netherlands;
- Increasing in professionalism of management in Italy.

The best choice selected by the stakeholders to increase the water efficiency was "improvement of the field infrastructure" in all case studies, "irrigation strategy" in Poland, France, South Africa, Italy, Spain and the Netherlands. A questionnaire was developed, in order to assess information needed to improve irrigation efficiency and to adopt an Irrigation Advisory Service (IASs) for the case study areas selected. The general aims of the survey were to identify jointly:

- The user demands of farmers, farmer associations, extension services as well as water management organizations;
- Best possible combinations of information technologies (sensors, models, remote sensing), and
- Innovative service models to realize a practical transition towards an increased use of precision irrigation in practice.

In the results obtained from questions about an irrigation advice tool, the stakeholders identified cost and benefits as most important. Each case study reported that the cost of sensors or advice tools could be a limitation to implement new technologies. Each case study showed additional singularity requirements for advice tools (advice in alternative crops in Italy and the Netherlands, irrigation strategy in Spain) but the farmers from South Africa were very satisfied with the information they receive from the Water Users Association regarding water availability for the season, restrictions and other regional information. The results of the user needs assessment are taken into account in the development of ICT methodologies to be tested in the case studies and form the basis of the remainder of activities in work packages 1 and 4 within OPERA.

3 Analysis of farmers' needs

There is a growing interest to investigate the farmers' propensity to adopt irrigation systems and their preferences related to different service characteristics in order to face up the new challenges. The goal of the precision irrigation value chain is to define more uniform and sustainable solutions for farmers. The latter, in particular, are always more interested in cost savings and yield-increasing potential of precision irrigation, but the number of farms that use IASs is still limited because they do not want to run the risk of new solutions until they have proof that they work. In this scenario, two methodologies and analysis have been adopted to understand adoption of IASs for farmers: SWOT (strengths, weakness, opportunities and treats) and the Choice Experiment analysis.

The SWOT analysis is a valid tool for examining problems related to water management in agriculture that requires, due to its interdisciplinary approach, valid methodological tools for better known related issues (Kallioras *et al.*, 2010; Mainali *et al.*, 2011). This method is largely adopted because it has the potential to clarify the present conditions with respect to the strengths and weaknesses, and also the future implications of the analysis of the opportunities and threats (Nature *et al.*, 2015). The adoptions of the carry out recommendations can contribute to face off the challenge of sustainable management of water resources.

The choice experiment (CE) method can be used to estimate economic values for several attributes of a product or a service (Mitchell and Carson, 1989; Hanley *et al.*, 2001; Bozorg-Haddad *et al.*, 2016). Among these, price allows an estimation of the trade-offs between attributes in monetary terms, thanks to marginal "willingness to pay" (WTP).

The process of decision-making is bottom-up because farmers, local authorities and consultants are all included in the process of decision and identification.

The SWOT analysis and CE analysis enable farmers to evaluate their choice about changing production practices, irrigation, financial ratios and performance measures.

3.1 Opportunities and challenges of adopting IASs (SWOT analysis)

The SWOT data were collected by questionnaires, interviewing 108 farmers separately at different areas. The survey was conducted between November 2018 and May 2019.

In order to study carefully the challenges of adoption for irrigation advisory service a strengths, weaknesses, opportunities and threats (SWOT) analysis was conducted in Campania, a region located in the southwest of Italy.

It was decided to report here the Italian case study, the Campania Region, because this Region has a lot of experience with Irrigation Advisory Systems and for this reason it could play a key role to well get to know the needs of farmers and transfer knowledge and best practice to the other partners of OPERA consortium.

According to the methodology proposed by I.E Nikolaou, after having presented the SWOT analysis, this methodology is composed by a first section that describes the research question and the second section that is characterized by expert interview and questionaries' collection.

The word strengths include gain and advantages of adoption of the IAS tools. In this regard to facilitate better the comprehensions of strengths, some typical questions were submitted such as what are the economic benefits in IASs utilization. Furthermore, weaknesses aspects that are obstacles to adopt any tool for improving the water management at irrigation levels. In addition, opportunities are related to external benefit for farmers to adopt IAS. Finally, threats are those related to arrest the diffusion of the IAS at farm levels.

The results of this analysis provide indications both for government and for land reclamation consortium which could improve the IASs at farm level. Through a SWOT analysis it was possible to examine the farmers' opinions about IASs implementation within the agricultural sector.

In addition, the study may also provide valuable recommendations to farmers to better understand the potential, strengths and future opportunities related to their use in agricultural water management. The result of a SWOT analysis highlights several aspects for internal parameters: strengths and weaknesses, and for external parameters: opportunities and threats. In the following section, the results of the survey were developed.

Expert farmers were selected in this area because they were involved in adopting the IAS to manage water in their farms. In particular, for Italy, farmers who were interviewed for this study, were the owners of farms that fall in agricultural areas where water for irrigation is managed by land reclamation and irrigation consortia that have an active role to sharing IASs information with farmers.

The survey elaborated present the following research questions that are derived from the SWOT analysis:

Question 1. What are the strengths of farmers when adopting IASs?

This question aims to analyse the internal strengths that farmers can have when adopting IASs. Furthermore, it aims to examine the environment and economic benefits in IAS utilization, reduction of energy costs for pumping water, competitive advantage from adoption of the IAS tools.

Question 2. What are the weaknesses of farmers when adopting IASs?

This question examines the weaknesses that farmers in general may face when adopting IASs. For example, aspects that are obstacles to adopt these tools, lack of funds or negative perception of information provided by IASs.

Question 3. What are the opportunities for farmers when adopting IASs?

This third question aims the opportunities for farmers can face externally when adopting IASs. For example, new financial challenges.

Question 4. What are the threats for farmers when adopting IASs?

This fourth question analyses the threats to companies when adopting such IASs. This question requires information, for example such as those related to arrest the diffusion of the IAS at farm levels.

3.1.1 Internal parameters (Strengths & Weaknesses)

This section describes, first, the strengthening (S) of farmers in the adopting of the IASs and, subsequently, the weakness (W) that entails. The expert farmers gave information that the most important aspect are as follows: water saving, cost reduction, capacity and competence, good network of land reclamation and irrigation consortia, innovation development, water measurements (Table 1).

S.1. Water saving: There is a general consensus among farmers regarding the use of water efficiency obtainable for IASs utilization. In fact, many farmers agreed that the use of these systems can contribute to reduce at least 20% of water consumption for irrigation. These results also provided by many experimental studies at the farm level (Altobelli, 2019) that have furnished very interesting results in terms of excellent use of water in agriculture using IASs, especially for those who are using remote sensing technologies and mathematical models for estimating the crop water requirement. In this regard, it is also very important the cost reducing of energy for pumping water. In environmental terms farmers are also aware that the water saving in agricultural sector is a very important aspect in sustainable terms. The agricultural sector with 90% of water consumption is the main user of water national resources among productive services.

S.2. Cost reduction: Reducing the volume of water in agriculture with the use of expert systems, IASs, has positive effects in terms of saving energy needed to pump water in irrigation networks of farms. On the other hand, water – energy saving has direct advantages in term of cost saving and increasing the economic productivity.

S.3. Capacity and competence: According to the interviewees, there was a common awareness that during the last years in Campania region, within the territory under control of land reclamation consortia has achieved very high levels of knowledge in IASs use and collaborations with farmers have generated a very good application of these techniques and good results in term of water management; this deep competence could be now, transferred not only to the farmers that work in the Campania region but also in others regions of Italy for farmers who want to improve their sustainable use of water in agriculture.

S.4. Good network of land reclamation and irrigation: the successful experiences obtained by land reclamation consortia in water management through the use of IASs represent, for farmers, a good and consolidated model to be exported in other regions in recent years.

S.5. Innovation development: generally, the perception of farmers compared to the results of the research is very good, especially as regards the experimentation in water management in agriculture. From their point of view, the results obtained in research projects and tools that have been developed for water management are ready to be exported even in areas outside Campania region. This increased awareness of farmers over the use of IAS, was reached through their involvement, continuous and constant, in the dissemination and implementation of international projects. In fact, in recent decades in Campania there was a rise in the number of scientific research projects related to water management in agriculture. In particular, in many cases, these studies have been directed to the estimation of irrigation requirements of crops. In addition, it should be noted that this high attention of farmers coincided with both national and European agricultural policies for the conservation of natural resources and in this context the water.

S.6. Provide water measurements: According to the respondents, there is a prevailing perception that IASs, could help farmers and other stakeholders involved in water management practices in accounting water applied for irrigation. This interest is due primarily to the increase of the constant regulations in water use in agriculture sector, which depends on conflicts related to competition for its use in various production sectors such as industry and services. Farmers are awarded that many farms installed a wide range of devices for measuring water flow, but often these measurements are not carried out routinely and results are not useful to define the amount of water used for irrigation. The high attention by farmers for this tool is also due to cost-free useful of IASs at farm level. In fact, in many cases during the recent years the cost for improving IASs at farm level oversaw the projects funded by the European commission.

The Weaknesses‘ section (W) of IASs focussed on their implementation. They face a lack of funds, low levels of diffusion of the information at farm level, negative perception of information provided by IASs, low use of electronic devices among farmers of sharing knowledge provided from IASs (Table 1).

W.1. Low use of electronic devices for water management. The most common shared weakness among farmers is related to their low use of electronics devices (smartphone, computer, *etc.*). This lack is a significant aspect regarding the diffusion and adoption of information provided by IAS, in fact the most common method to share information with farmers by land reclamation consortia of water to apply, coming from IASs elaborations, to crops during the growing season consist in the use of these instruments.

W.2. Negative perception of information provided by IASs. In many cases the high age of farmers that are involved in water management by use of IASs within the areas under investigation in our study showed unfamiliarity with the information provided by IASs. In fact, they are convinced that their knowledge of crops is the best tool for water management practices.

W.3. Poor and less incisive diffusion of information. The expert farmers underline the low diffusion of the information regarding the output of research activities in the research field and in agricultural water management. In this regards the opinion of farmers is that weakness of the information provided by IASs in any case, are poorly documented or difficult to access for small farmers. This results as a significant loss of opportunities for development and improvement of the agricultural context.

W.4. Lack of funds for implementation of the IASs. The implementation of IASs that provides information on farm levels needs funds for its implementation. This issue is well known at farm level and for others stakeholder’s involvement in providing of services for a good management of water.

In this regard, farmers are worried about the future implementation of this service, that actually are in use thanks to the supports offered by European Commission funds.

3.1.2 External parameters (Opportunities & Threats)

This section presents the external factors opportunities (O) and threats (T) achieved by farmers in adopting IASs. In particular, improving agricultural production, increasing the water management cross the ICT, finding new markets and consumers, reducing the environmental pollution (Table 1).

O.1. Improving agricultural productivity: IASs can significantly contribute to increase in water resource management and therefore the increase of the efficiency of farms productive. These alert systems can ensure a constant information about the appropriate management of water resources facing the most common environmental hazards, such as drought. Furthermore, the use of these tools can ensure the optimization of production and standards for quality control.

O.2. New markets and consumers: the farmers are convinced that the adoption of IAS can provide a competitive advantage for their activities not only in productive terms but also in public awareness. In particular, the agricultural sector and farms are pressed from the general public for environmental responsibilities in their production practices. In this regards, adoption of environmental practices as water saving give the possibility to boost the image of the farm in commercial terms.

O.3. Increase the water management troughs the ICT: the farmers say that ICT plays an important role in addressing a good water management challenges and in uplifting the livelihoods in agricultural sector. Additionally, they consider that in recent years, the agricultural world, there has been a greater dissemination of information on broadband and ICT services. This allowed a greater familiarity of farmers with the means. However, there is still much work to do to increase the familiarity and the diffusion of innovation among farmers. Finally, they consider that technological development in place can ensure greater capillarity in the dissemination of information on good irrigation management to a broad group of stakeholders.

O.4. Reducing the environmental pollution: expert farmers are aware that wrong irrigations can have effects on the environment, specifically the deterioration of water quality. This aspect is well known and a large amount of water in addition to adversely affect crop could mobilize sediment loads and associated contaminants and exacerbate impacts on water systems, while less water may reduce pollutant dilution, thereby increasing toxicity problem (European Commission, 2012).

The threats that can be mainly attributed to social and technological aspects: social aspect and education, lack of funding, institutional mechanisms to link rural communities (Table 1).

T.1. Social aspect, education: this expert farmer believes that threat to the spread of the IASs within farms could come by the low level of education and the high level of age of the farmers themselves, who own most of the farms. Additionally, in recent years, this aspect was responsible for determining the leave of the rural areas. The high levels of the innovation could be considered an obstacle for their adoption by farmers that are unfamiliar with an electronic device.

T.2. Lack of funding: other risks to the diffusion of IASs are due to the scarcity of public finances that could give a financial support to a project for improving the services, and important aspects as communication of the results.

T.3. Lack of Institutional mechanisms to link rural communities: there is a deep gap between information residing in agricultural knowledge centers and rural communities. At the local level, multi stakeholder mechanisms are important to make relevant information accessible to end users as a farmer. Intermediary, organizations have to connect rural communities with available knowledge. At the national level and regional level, mechanisms need to be in place to ensure learning and information sharing (Jac Stienen *et al.*, 2007).

Table 1 – Summary of SWOT analysis – internal (present) and external (future) parameters.

Internal parameters (present)		External parameters (future)	
Strength	**Weakness**	**Opportunity**	**Threat**
S.1: Water saving	W.1: Low use of electronic devices for water management	O.1: Improving agricultural productivity	T.1: Social aspect, education
S.2: Cost reduction	W.2: Negative perception of information provided by IASs	O.2: New markets and consumers	T.2: Lack of funding
S.3: Capacity and competence	W.3: Lack of funds for IASs implementation	O.3: Increase the water management through ICT	T.3: Lack of institutional mechanisms to link rural communities
S.4: Good network of land reclamation and irrigation consortia		O.4: Reducing the environmental pollution	
S.5: Innovation development			
S.6: Provision of water measurements			

3.1.3 Choice experiment (CE) and Assessment of Willingness to Pay

This paragraph analyzes the methodology used to define the preferences of the farmers related to IASs adoptions in the areas covered from OPERA project. For this purpose there are three possible methodologies: the Contingent Valuation (CV), the Conjoint Analysis (CA) and the Choice Experiment (CE).

The **Contingent Valuation (CV)** is the most used method for estimating the economic value of an asset without a market and is mainly used in the field of environmental goods assessment. The idea behind this methodology is that to estimate goods/services without a market, one can think of asking individuals/consumers directly which value they would attribute to the good/service, or rather, what monetary value they would be willing to pay for a good and/or service. The main objection to the CV is that a question posed in a hypothetical context, that is, not a real purchase, could provide answers that are not as accurate as in the case of a real market choice. Therefore, it becomes important to carry out a correct formulation of the context (i.e. the scenario in which the contingent market is outlined) and the questions asked from the people interviewed during a survey carried out with the Contingent Valuation method.

The **Conjoint Analysis (CA)** is one of the most widely used methodologies in the last twenty years in marketing research to understand how consumers evaluate the attributes of a given product and/or service. This method consists in presenting the interviewees with different “profiles” of the product under examination. In each profile the product is defined with a certain number of “attributes” or characteristics, which are assumed to have an important role in determining consumer behaviour. In each profile, attributes are assigned a specific value, called “level” (Bennett J., Blamey R., 2001). The consumer is asked to graduate in terms of preference the different profiles or to express a satisfaction score for each alternative on a fixed scale, in this way the probability of purchase is reflected. Thanks to the opinions expressed by consumers to the different configurations that the product/service assumes based on the variation of the levels of its attributes, the technique allows to determine the importance that the individual attributes have in the decision-making process and identifies and evaluates, for each feature, what are the best alternatives or levels.

The **Choice Experiment (CE)** method, which is a variant of CA, more faithfully reflects the decision of choice that the consumer implements in reality. For the different alternatives available the consumer establishes the best and discards the others. As in the CA, also in the CE the product is diversified according to its key characteristics (attributes and levels of the CA). If between the attributes that characterize the product is a monetary attribute (price, tax, *etc.*) the CE allows to find, in addition to the relative importance of each attribute, the marginal contribution of each attribute to the final price/cost of the product.

Summarizing, the CV and the CE can be counted among the methods of monetary estimation, while the CA offers indications of an ordinal nature.

In order to understand the level of importance of technological innovation in the agricultural water management, this project has used the choice experiment (CE) for identifying preferences of the farmers and making analysis of marginal willingness to pay for the service. Because we wanted to estimate a value for each of the site-specific attributes rather than values for services as a whole, the decision to use a CE approach, instead of a Contingent Valuation approach, is well justified. Whereas the Contingent Valuation method produces a single value for an overall change in environmental quality, the CEs provide a value for each individual attribute of services. Hence, alternatives are such that preferences for various attributes can be examined at a more refined level.

In conclusion, the Choice Experiment, an extension of the CA, has the advantage of analysing different influences on the choice simultaneously, allowing the creation of more articulated and realistic evaluation models through the use of not particularly complex methods both for the researcher and for the respondent.

3.1.4 Building a Choice Experiment (experimental design and choice set)

As mentioned above, in this work, therefore, we have applied the Choice Experiment method to estimate the value of technological innovation in the agricultural water management. Specifically, in the CE method, interviewees were presented with a number of choice sets consisting of a menu of alternatives (also called scenarios) relative to service options. They were asked to choose their preferred alternative from each of these choice sets.

As Mitchell and Carson (1989) said, with the tool of choice experiment (CE) it is possible to estimate economic values for several attributes of a product or a service (Hanley *et al.*, 2001; Bozorg - Haddad *et al.*, 2016). The price permits an assessment of the trade-offs between attributes in monetary terms, thanks to marginal "willingness to pay" (WTP).

In particular, the assessment of farmers' WTP for IAS is essential to determine the degree of appreciation of these services and therefore their possible development in the near future (Svendsen and Small, 1990). The use of a CE distinguishes the current analysis from prior studies based on market values to estimate the benefits of irrigation management services (Price *et al.*, 2016). Indeed, in order to allow for wider use of innovative irrigation practices such as an irrigation advisory service, the current method analyses farmers' preferences but, not for the service offered as a whole, however for its different technical attributes and its characteristics with respect to the delivery of the contracts. To this aim, a choice modelling approach was implemented. This approach allowed individuals to select between several service alternatives characterized by different attributes and levels. A "no-choice" option was included among the alternatives (Adamowicz *et al.*, 1998).

In the building a Choice Experiment (CE), an important role is played by identifying the attributes (or characteristics) that describe the service offered. In fact, the first stage of CE involves identifying the attributes relevant to the stated research question and then assigning levels for each of these attributes (Ryan *et al.*, 2001; Hensher *et al.*, 2005). Since these attributes and attribute levels describe the hypothetical scenarios under consideration in the CE, this is a critical aspect of the design. The underlying validity of the study depends, therefore, on the researcher's ability to correctly specify the relevant attributes. Despite the importance of this stage in the design, there is often sparse explanation in the CE literature of how attributes and levels are established (Coast and Horrocks, 2007).

For this form of analysis "conjoint", or multi-attributes, Hanley and Mourato (1999) identified the following features:

- ✓ Breakdown of the asset to be valued in multiple attributes and levels;
- ✓ The interviewee can choose between alternative scenarios that differ in the level of attributes;
- ✓ The interviewee is called to make repeated choices about different situations of choice and composed of at least two alternatives.

At this regard, in order to construct them, we decomposed the service offered according to its attributes, and the combination of various levels of this set of attributes results in a scenario of change in the quality of the service offered to farmers (also called an alternative). One of the main advantages of the CE approach is that attributes can be qualitative or quantitative in nature, and that the method allows to combine attributes of different nature when we construct a scenario. Notice that a baseline scenario, the status quo, is introduced as an alternative in the choice sets; this enables the respondent to choose no change. In particular, therefore, following a CE procedure, farmers were asked to select their most preferred alternative among those present in a choice set.

In conclusion, the implementation of a CE comprises six steps (Figure 1):

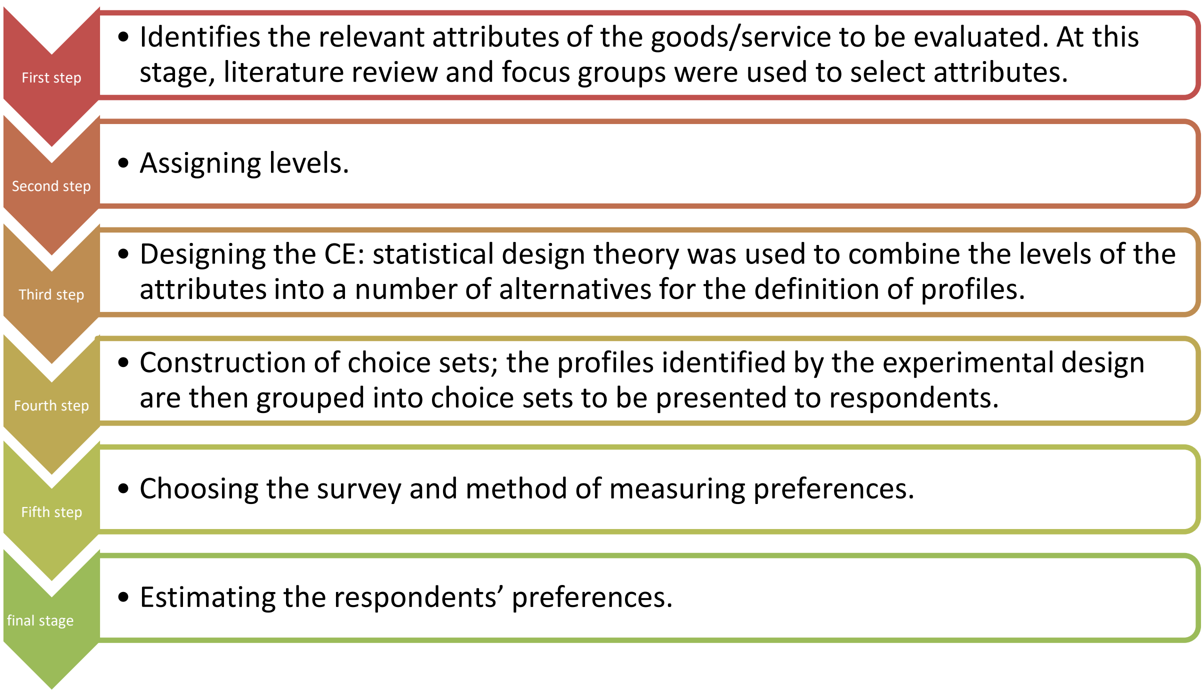

Figure 1 - Choice Experiment steps (Source: own elaboration

Here below are presented the five attributes for developing Irrigation Advisory Services that use smart irrigation technologies to define the crop water requirements. All the attributes were selected with the participation of farmers and consultants.

- ✓ **Weather forecasts.** Weather forecasts with a time horizon of up to five days.
- ✓ **Contract.** It indicates the adoption of IAS for a range of time (for entire crop cycle, two or three years) and for each farm.
- ✓ **Crop Water Requirement.** It indicates a range of forecasting for 1, 2 or 3 days.
- ✓ **Crop monitoring.** A satellite image (i.e. vegetation response to environmental stresses) of your plots every 1, 10, or 15 days.

- ✓ **Registration of irrigation.** Indicates recording the dates and the volumetric water applied (1, 2 or 3 times per month).

The cost of Irrigation Advisory Services changes and it is linked to several aspects of service. The indicated price is an average and indicative value carried out from different European countries.

i. 5 euro / ha
ii. 10 euro / ha
iii. 15 euro / ha

Choice experiments are based on the Lancastrian consumer theory (Lancaster, 1966) and the random utility theory (McFadden, 1974; Hanemann and Kanninen, 1999). The Lancastrian consumer theory assumes that the consumer obtains utility from the goods or services according to their corresponding attributes. The random utility theory assumes that individuals are rational, selecting the most preferred option that yields the highest utility from among the alternatives available.

At this aim, to elicit preferences on service characteristics, respondents were asked to examine a series of hypothetical alternatives of water irrigation service. The experimental design refers to the process of generating specific combinations of attributes and levels that respondents needed to evaluate in choice questions. The choice tasks were constructed by the experimental design conducted with a fractional factorial procedure (SPSS Software). The idea of the fractional factorial design is to include only a sub-set of all possible combinations of considered attributes, which still allows to obtain information of the main effects. The resulting questionnaire is provided in Annex 1.

Following this approach, it was possible to obtain useful information on the main effects and some information about interaction effects. The fractional factorial samples were balanced and orthogonal. There is no agreement in the literature on how many choice tasks should be presented in a CE (Louviere *et al.*, 2000; Hensher *et al.*, 2005). In the current work, respondents faced ten choices of tasks composed of 24 water irrigation service alternatives and a 'no-choice' option. Respondents were asked to choose the most preferred one.

This research uses an expert interview approach in order to get relevant data. Using expert interview is considered a strong method of gathering information in various fields of social sciences, and concentrated method of gathering data especially in exploring phase (Bogner *et al.* 2009).

3.1.5 The survey and statistical model

As previously seen, the choice experiments represent today the most widespread methodology when the objective is the revelation of preferences and the measurement of shadow prices related to multi-attribute goods (Hanley and Mourato, 1999; Pearce and Mourato, 1998; Garrod and Willis, 1999), being preferable to contingent ranking methods thanks to less cognitive complexity for the respondent and estimation for the researcher (Mazzanti and Montini, 2001).

In the Choice Experiment model, the researcher proposes different product and/or service alternatives created following different combinations of attribute levels that lead to the creation of different choice perspectives composed of at least two alternatives, from which the respondent must choose.

The interviewees are in fact asked to indicate the preferred solution between two or more options that are characterized by different levels of the attributes considered relevant (choice experiment). This method of analysis is typically a model of discrete choice, since the decision maker is called to choose between several alternatives. In particular, these tools allow to study how the characteristics of individuals and the alternatives of choice influence the choices and, thanks to these results, it is possible to obtain information on the consumer's willingness to pay for the various attributes that characterize the good and/or service (estimate the implicit prices of the attributes).

The origins of the approach to statistical techniques of choice experiments (CE), underline Hanley *et al.* (1998), are different and have led to the processing of data obtained through the use of discrete choice models (Discrete Choice Models), which refer mainly to the Lancaster value theory (1966), to the theory of random utility (Random Utility Theory (RUM); McFadden, 1974a, Thurnstone, 1927) and experimental designs. The concept of random utility, which is used in the economic field for the development of numerous econometric models, provides for an interpretation of the same as a latent concept, that is, existing in the mind of the consumer and not directly observable, entirely, by the analyst (Stoppa, 2007).

Already in the 1970s, the choice experiment method was used both in the public and private sectors, with applications in the field of transport economics and market analysis (Hensher and Johnson, 1981; Louviere and Hensher, 1982). Since the 1990s and especially in the 2000s there have been several studies carried out in the field of environmental and rural economics (Blamey *et al.*, 1999; 1998; Morrison *et al.*, 1999; 1998; Adamowicz *et al.*, 1998a; Hanley *et al.*, 2001a, 1998; Adamowicz, 1995; Adamowicz *et al.*, 1994) who reconstructed the economic value of mixed natural assets and their attributes in terms of willingness to pay.

In particular, the CEs are based on surveys by means of questionnaires. They consist in presenting to the interviewees "choice task" sets, formed by a predefined number of profiles, each described through all the attributes and levels considered in the experimental design phase. Respondents are asked to indicate which, among the various profiles of each choice set, would choose if at the time of purchase they were faced with those possible alternatives. Among the options of choice, the option "nothing" can also be inserted, which represents the decision not to choose any of the alternatives provided (in our case we have included this option).

Data collection consists of obtaining the objective information of the survey from each of the selected units (the farmers). Data collection is a very delicate phase in which, generally, a high percentage of the available resources is invested and from which the final quality of the data can depend to a large extent.

After being contacted, each farmer is given a questionnaire that represents the typical instrument for detecting information in the context of surveys with representative samples of the population.

There are several ways to submit a questionnaire. A priori it is not correct to establish a hierarchy and to affirm that one modality is better than another. The choice of one type rather than another depends essentially on two factors:

- ✓ subject of the study: refers to the level of complexity of the investigation topic. There are more suitable detection techniques for subjects for which it is necessary to go very deeply;

- ✓ availability of resources: low availability of economic resources and / or specially trained personnel, prevent the realization of surveys which by their nature are complex and delicate.

In summary, the methods of gathering information through a questionnaire are attributable to the following three:

- ✓ face to face;
- ✓ telephone services;
- ✓ postal services.

Each of these has inherent advantages and limitations that guide the choice of which to use.

In our survey we used the face-to-face survey method, because it has some advantages such as the possibility of administering complex and articulated questionnaires and controlling the survey environment given the presence of a qualified interviewer; these two aspects offered us the opportunity to explore and investigate the sensitive issues discussed in the survey that other techniques did not allow us to do.

Therefore, using face-to-face interviews, a questionnaire was submitted to 108 farmers from the different pilot areas of the project OPERA.

In order to estimate farmers' preferences, choice experiments rely on the basic idea that an individual can choose the most preferred product or service, maximizing utility, between sets including different attribute levels (Pearce *et al.*,2006). Respondents will choose the alternative characterized by the most preferred attributes and levels. Specifically, concerning environmental goods, the CE provides four types of information:

- i) which attributes are significant in determining the value that stakeholders (local or national public, farmers, recreational visitors to a site) place on the goods;
- ii) the implied ranking of these attributes among the relevant stakeholders;
- iii) the value of changing attribute in a *ceteris paribus* condition; and
- iv) the total economic value of the goods (Hanemann and Kanninen, 1999). One of the attributes which is typically included in a CE study is price, as a monetary cost/benefit attribute, essential to estimate the willingness to pay for attributes (Hanemann, 1984).

In the current study, a full fractional design that produced ten profiles was implemented and farmers were asked to choose the most preferred. To maximize his/her utility each *i-th* farmer was assumed to choose the *j-th* alternative with the most desired set of attributes. The probability that the farmer chooses alternative *j*, $Y_{i,j} = 1$, among the set of other possible alternatives J is defined by the probability (Pr) that the utility associated with alternative j is greater than or equal to the utility (U) relative to the other J − 1 alternatives within the choice set:

$$Pr(U_{i,j}) = Pr\{U_{i,j} > max(U_{i,k}, ..., U_{i,J})\} \quad (1)$$

According to the random utility model, the farmers' perceived utility associated to the *j-th* alternative is a linear and additive function of the attributes x_j characterizing each alternative:

$$U_{i,j} = \beta x_j + \varepsilon_{i,j} \quad (2)$$

where estimated coefficients β indicate farmers preferences towards each level of the proposed attributes. Empirically, the estimates of the β parameters can be obtained by using maximum likelihood estimate of fixed-effect conditional logit as developed by McFadden (1974). Moreover, in order to take into account the heterogeneity of preferences within the famers, β can be estimated using the random-effect conditional logit (Train, 2009), assuming β distributed within the sample according to a distribution function defined by a location (μ) and a scale (σ) parameter.

3.2 Results of Choice Experiments

In this section, the analysis process and the outcomes of CE are presented. The survey was conducted in different places related to OPERA partners to have a uniform perception about Irrigation Advisory Services. Recommendations were made for each site as to further stakeholders that they may wish to consider in order to fully represent administrative levels and key sectors. Recommendations were also made (where relevant) as to how partners may choose to select which stakeholders (or which representatives of a stakeholder) to invite to on-going stakeholder platforms under the OPERA project. Partners were also encouraged to look at the summaries of other case studies in order to consider a broader range of stakeholders and policies.

Using face-to-face interviews, a questionnaire was submitted to 108 farmers. The request for participation in a questionnaire was for assess information needed to improve irrigation efficiency and to adopt an Irrigation Advisory Service for this.

For the project, the sample was built on 108 farmers whom are from different case study areas selected in OPERA. The highest percentage of interviewees were from Poland with 43%, Italy has the second highest value with 33%, then followed by Spain 16%, the Netherlands with 6% and South Africa with 2% (Figure 2).

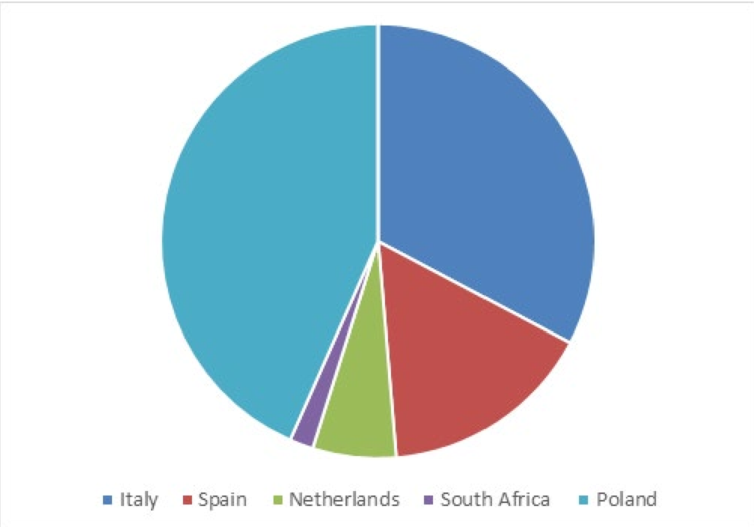

Figure 2 - Nationality of the interviewees.

The major part of the sample was male (Figure 3). The sample was composed of 33 farmers over 50 years old, followed by 17 farmers with age within 40 – 50 year-old. The same number (17) are farmers within 30 – 40 year-old, and 8 farmers are less of the 30 years old. From the total, 16 farmers did not response at the age question.

They have an average age of around 45 years. The youngest is 23 years old and the oldest is 71 years old. both are males, the young is a Dutch farmer while the "old" is Polish. Female farmers represent just over 15% of the sample interviewed. Their age is between 26 and 61 years. The 25% of them have a degree. Instead, among male farmers, accounting for around 85% of the sample, only 15.6% have a degree.

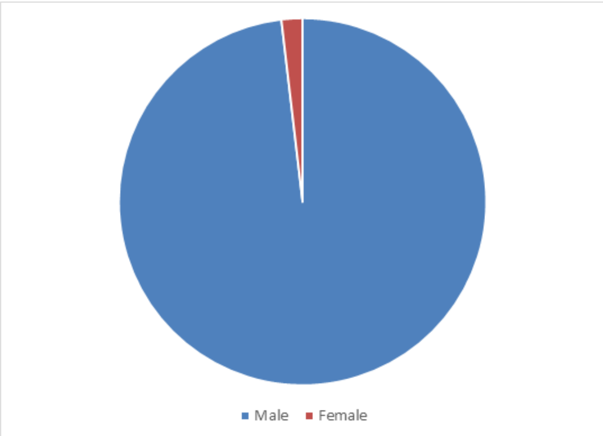

Figure 3 - Gender of the interviewees.

The form of management of farms is mainly family-run with 62.5%. A few farms are managed by professional (24%) while, rarely, there is a mixed management of farms between family and professional (13.5%).

The farms specialized mainly in the production of vegetables are 68%, followed by livestock 14%. The utilized agricultural area (UAA) for these 108 farmers are between 0.5 ha (Polish farm) and 220 ha (South Africa farm). The 20.4% of farms have a UAA below 5 ha, 21.3% between 5 and 10 ha, 26.9% between 10 and 20 ha and 31.5% over 20 ha.

In recent years, 50% of farmers made investment in innovation on their farms. Regarding the effects of this type of investment on product and technological innovation and on farm organization, 44% of respondents stated a 33% increase in production capacity. Nonetheless, investments in innovation have not resulted in increased exports, market share or overall employment.

For the CE a monetary attribute was needed in order to estimate implicit prices for each level that we decompose the service offered attributes. We designed three possible levels for the price level, which were chosen based on average and indicative value carried out from different European countries. Thus the price vector was 5, 10 and 15 euros per hectare. Notice that a null level was associated to the "no choice" scenario; it is not included in the price vector because a 0 € price (namely pay nothing) does not seem realistic in the case of an increasing water use efficiency and productivity.

Attributes and levels were then assigned into choice sets. We, therefore, chose to construct choice sets, to be submitted to the interviewed farmers, each consisting of different combinations of the six attributes identified.

The importance, or weight, of each attribute was assessed by estimating Willingness To Pay (WTP), which measures consumers' preferences in monetary terms. Willingness to pay was estimated as the ratio, changed sign, between the coefficient of each attribute and that attribute related to the price.

Table 2 presents the modelling results. The first column includes the attributes and the price. The model succeeded perfectly with "logical" and consistent results.

Table 2 – Modelling results for the OPERA choice experiment.

Attribute	**Coef (μ)**	**std.err**	**t-stat**	**p-value**
Price (euro / ha)	-0.089	0.022	-4.04	0.000
Time lenght of forecasts (per day)	0.360	0.054	6.72	0.000
Duration of the contract (per year)	-0.247	0.086	-2.86	0.004
Crop water requirement (per day)	-0.055	0.231	-0.24	0.813
Frequency of satellite monitoring availability (per day)	-0.034	0.013	-2.59	0.010
Registration (per month)	-0.314	0.128	-2.44	0.015
No Choice	-0.541	0.411	-1.32	0.188
	Coef (σ)	**std.err**	**t-stat**	**p-value**
Time lenght of forecasts (per day)	-0.090	0.099	-0.92	0.359
Duration of the contract (per year)	0.333	0.097	3.44	0.001
Crop water requirement (per day)	1.740	0.273	6.39	0.000
Frequency of satellite monitoring availability (per day)	-0.036	0.019	-1.91	0.056
Registration of water and data information (per month)	0.494	0.139	3.55	0.000
	WTP (euro/ha)	**std.dev**		
Time lenght of forecasts (per day)	4.11	0.28		
Duration of the contract (per year)	-2.86	1.86		

Crop water requirement (per day)	-0.27	16.59
Frequency crop monitoring availability (per day)	-0.38	0.16
Registration of water and data information (per month)	-3.58	3.00

Source: Our elaboration

In particular, as regards the "reading" of the coefficients, we can say that the choices of the type of service depend on:

- positively from:
  - ✓ Time length of forecasts: the more days available in the future, the more the service is chosen;
  - ✓ Need to record water information: the longer the time interval of the need to record information increases the more willingness to accept the service;
- and negatively from:
  - ✓ price: as the price increases, the probability of choosing the service decreases;
  - ✓ duration of the contract: shorter contracts are preferred;
  - ✓ frequency of crop monitoring availability: when the availability of monitoring changes from 1 day to 7 or 15 days the probability of choice decreases.

Instead, with regard to the needs of water for crops, the interviewes were divided, or rather there were those who prefer two days, or one day. In fact the results on this attribute are a bit ambiguous and probably unclear that this attribute is not really so important for farmers, unlike what emerged in the preliminary phase during the selection and definition of each attribute of the service offered.

In Table 3 the values of the average WTP, expressed in euros per hectare, are reported for each of the attributes and, moreover, the differentiation of the same is also provided between the different countries involved in the OPERA project.

Table 3 – Average WTP, in euros per hectare, for the different attributes and countries for the OPERA choice experiment.

WTP (euro per hectare)	Italy	Poland	Spain	The Netherlands	South Africa	Total
Time length of forecasts (per day)	4.10	4.09	4.05	4.32	4.27	4.11
Duration of the contract (per year)	-2.67	-2.63	-3.50	-3.48	-4.01	-2.86
Crop water requirement (per day)	8.31	-4.04	-10.50	11.98	10.20	-0.27

Frequency of satellite monitoring availability (per day)	-0.37	-0.36	-0.45	-0.40	-0.38	-0.38
Registration of water and data information (per month)	-3.94	-3.41	-4.25	-0.41	-5.28	-3.58

Source: Our elaboration

Considering the irrigation advisory service, it appears with greater evidence how the farmers of the countries involved in the OPERA project have a different behaviour both towards the specific attributes of the service and for the price they would be willing to pay in order to obtain it. While taking into consideration what was said previously, it is clear from the analysis of the table how Dutch farmers (4.32 €/ha) and those of South Africa (4.27 €/ha) are willing to pay a higher price then farmers interviewed in other countries, as their WTP is obviously greater than the average of the entire sample (4.11 €/ha). Spanish farmers have the lowest WTP (4.05 €/ha). The latter, together with the Polish farmers, also present a different attitude about the attribute "Crop water requirement (per day)". In particular, they are not interested (in fact the coefficient takes a negative sign) to this attribute in the choice of the type of irrigation service required.

4 Summary and conclusions

During the last years the environmental risks link to the water in agriculture are increasing. Droughts are common in Europe during the cropping seasons, floods are common in different areas of the central and north Italy especially during spring and autumn seasons, and the latest events that took place during this last summer (2019) show that Spain (and other areas of the EU) are not immune to these environmental catastrophes. Furthermore, management of water is currently being challenged by population growth and urbanization, climate change, and increased water withdrawals for agriculture. In this context it becomes really difficult to find the right balance between the needs of agricultural and urban water uses, guaranteeing an adequate supply for all uses, and maintaining stocks and flows for environmental needs. Currently, tourism industries, environmental groups, electrical companies and many other stakeholders who have an interest in the water resources for their activities are challenging agricultural interest claimed to share of the limited available water. In this context, the farmers' preferences concerning drought response plans and competition for the use of water resources are important for managing water demand.

To deal with this complexity, water resource managers often rely on decision support tools (including hydrological models) but, water resource management also requires an improvement of water use efficiency which, in its view time, it should be one of the most important drivers for research and innovation in irrigated agriculture. In response to the emerging needs of stakeholders (farmers, land reclamation and irrigation consortia, extension services, distribution sector, *etc.*), irrigation advisory services (IASs) for optimizing water management have shown rapid growth in different areas. In fact, the introduction of IASs could progress irrigation practices and water efficiency, in advance an economic benefit for farmers while also reducing environmental responsibility.

In environmental terms, more inclusion and adoption of advisory systems for irrigation could provide an improvement of irrigation management with clear benefits in terms of sustainable use of water resources in agriculture and production related to them.

In economic terms, the increase IASs for the appropriate management of water resources could contribute to a substantial reduction of the energy prices linked with irrigation. The effects of careful irrigation management can be successful in terms of increasing the income of farmers and to diminish the energy costs incurred by the managing bodies of water resource in the field.

The analysis of the context of supply and demand of irrigation advisory services and SWOT analysis conducted in this study has provided an interesting framework to correctly understands as the large share territories and farms do not utilize IASs. The low adoption of this service represents a very great opportunity to increase the use of IASs.

However, the concentration of population over 65 years is very high in rural areas, and increases in time (Trapasso, 2009). The aging population is a national trend. For example, in Italy as at 1th January 2019, the population over age 65 represent 22.8% of the total population. The ratio between this population and the population of 0-14 years, multiplied by 100 (old age index), in 2018, was equal to 168.9. The high age of farmers and a minimum education among farmers' difficulty entails the transfer of information developed by the IASs. Therefore, it is necessary to develop efficient systems of communication that go by on the information generated by irrigation services to farmers.

The level of diffusion of the IASs is still very limited to ensure effective support to environmental and economic sustainability. It's well known that the agriculture is among the sectors of production that mostly use water in production processes. Need to reduce the environmental impact of water resources determined by agricultural production. Therefore, it emerges the need to increase the use of IASs within the agricultural areas of the country. This objective could be achieved with a greater diffusion of technical assistance for irrigation in rural areas. A deeper presence of technicians in the area may help to increase the understanding of farmers on the real economic and environmental benefit from this kind of agricultural assistance.

Given the scenario in which we find ourselves in irrigation management, it becomes important for policy makers to understand the economic value that farmers will attribute to irrigation water as well as the factors that influence these values. At this regard, the analysis of the preferences of the farmers we perform plays a crucial role. In fact, the Choice Experiment as used in this study, which represents a quantitative method for assessing various factors that influence choices, represents a very interesting method for both researchers and policy makers. This is because it provides quantitative information on the relative importance of the various features of the services that influence the service choices for farmers, as well as trade-offs between these factors and the likelihood of using defined services. It follows that this analysis methodology provides quantifiable data that can better guide the selection of the most appropriate business strategies to “sell” the service offered. Also provides an assessment of the strength of the preferences expressed by the interviewees, as well as the probability of using the service itself. The information thus gathered is a valid aid for political decision makers who need and want to implement the right water resource management policies in order to ensure their sustainable and efficient use.

The methodology of economic evaluation by using CE has allowed to estimate economic of farmer’s acceptance and adoption of irrigation water supply management policies “regulated” by the adoption of advisory system (IAS) for irrigation. In particular, on the basis of the trade-offs that respondents make among attributes, we managed to estimate the mean WTP value (implicit prices for irrigation advisory service) of the proposed improvements in irrigation (IAS) for the whole sample. Therefore we found that people place significant positive values, which means that they are willing to pay for the service described in the questionnaire. It is possible to use these estimated economic values to design pricing policy which accounts for the different attributes and countries of the farmers.

Our results, obtained through the econometric model, showed that farmers are actually willing to pay to introduce an irrigation support system that results in an economic advantage over their current situation. On the other hand, it has been shown that farmers’ willingness to pay change in according to the attributes that characterize the service offered and on the basis on the country of origin.

Implicit prices estimates enabled us to measure the non-market benefits that would arise from an improvement in the water use efficiency and productivity. Then using estimates made, we will carry out a business model of the IAS (for more details on the business model please see the deliverable D4.2 Business Model).

There are important policy implications for our results. The results, in fact, suggest that the policy makers, rather than following conventional command-and-control method of irrigation management, will have to take into account the preferences and associated WTP values of the farmers in a meaningful way while formulating irrigation policies.

Finally, it is necessary to propose and support at the government level for the adoption of innovative irrigation assistance. This activity should be pursued through the integration of functions and powers of the different stakeholders at the public level. Moreover, improve communication within the systems are served by the IASs, one could argue the greater involvement of associations in the agricultural world that often have affiliated farms that do not fall within the areas covered by land reclamation and irrigation.

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ANNEX 1

GROUP 1 - Mark with an X the number of the box between 1 and 4

	1	**2X**	**3**	**4**
weather forecasts	4-5 days	1 day	4-5 days	NOTHING
contract	3 years	crop cycle	per year	
crop water requirement	one day	one day	one day	
crop monitoring	per day	per day	15 days	
registration of irrigation	2 times per month	One time per month	3 times per month	
price	15 €/ha	5 €/ha	15 €/ha	

GROUP 2 - Mark with an X the number of the box between 5 and 8

	5	**6**	**7**	**8**
weather forecasts	2-3 days	4-5 days	one day	NOTHING
contract	crop cycle	crop cycle	3 years	
crop water	one day	two days	two days	
crop monitoring	7 days	7 days	7 days	
registration of irrigation	3 times per month	3 times per month	One time per month	
price	15 €/ha	10 €/ha	5 €/ha	

GROUP 3 - Mark with an X the number of the box between 9 and 12

	9	**10**	**11**	**12**
weather forecasts	2-3 days	4-5 days	one day	NOTHING
contract	3 years	per year	crop cycle	
crop water	one day	two days	two days	
crop monitoring	15 days	per day	15 days	
registration of irrigation	3 times per month	3 times per month	2 times per month YES	
price	5 €/ha	5 €/ha	15 €/ha	

GROUP 4 - Mark with an X the number of the box between 13 and 16

	13	14	15	16
weather forecasts	one day	4-5 days	2-3 days	NOTHING
contract	per year	3 years	crop cycle	
crop water	3 days	3 days	3 days	
crop monitoring	per day	7 days	per day	
registration of irrigation	3 times per month	One time per month	One time per month	
price	15 €/ha	15 €/ha	10 €/ha	

GROUP 5 - Mark with an X the number of the box between 17 and 20

	17	18	19	20
weather forecasts	one day	4-5 days	2-3 days	NOTHING
contract	3 years	crop cycle	per year	
crop water	3 days	3 days	3 days	
crop monitoring	15 days	15 days	7 days	
registration of irrigation	3 times per month YES	2 times per month NO	2 times per month YES	
price	10 €/ha	5 €/ha	5 €/ha	

GROUP 6 - Mark with an X the number of the box between 21 and 24

	21	22	23	24
weather forecasts	one day	2-3 days	2-3 days	NOTHING
contract	per year	per year	3 years	
crop water	one day	two days	two days	
crop monitoring	7 days	15 days	per day	
registration of irrigation	2 times per month YES	one time per month NO	2 times per month	
price	10 €/ha	10 €/ha	15 €/ha	