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Willingness to pay for irrigation advisory services: based on integrated use of earth observation data and information technologies

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To Pietro, Carlotta and Stefania for their affect and support.

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SUMMARY

The present research by the use of discrete choice model (CM) has analysed the willingness to pay for satellite based of irrigation advisory services in an area of Italy characterized of intensive use of water for irrigation. One original aspect of this study concerns the case study where our work has been implemented. In fact, several studies that used CM have been implemented in agricultural areas and considered water resources management, but we do not fund studies concerning the irrigation advisory service (IAS), specially characterized by a i) highly innovative and technological value offering by the use of Earth Observation (EO) techniques for water saving. The innovative approach of this work was to understand and learn about the different expectations of farmers than consulting services for irrigation in an area of Italy where such services have achieved levels of excellence.

The study was carried out in the Campania region in area of Italy covered by IAS called IRRISAT.

In 2013, the service has provided support for three Irrigation and Land Reclamation Consortia (ILRC), with 669 farmers and extension of 55.03,57 hectares. Based on these considerations, the specific aims of this work has been i) to analyse the importance of technological innovation in the agricultural water management ii) to define throughout the use of choice experiment (CE) the preferences of the farmers regarding the main characteristic, attributes, of the IRRISAT, iii) to analyse marginal willingness to pay for this service.

The main results of the research have confirmed that water is a primary asset for farms and the most important factor in agricultural production. Therefore, there is a clear need for greater use of tools and methodologies to account for water use in irrigation practice. The results have shown the general appreciation for IRRISAT and their willingness to pay for this service.

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CHAPTER I
INTRODUCTION

1.2 STATEMENT OF THE PROBLEMS

In many areas of the world agriculture is the main economic sector. In these regions, agricultural water management is the main natural factor that can lead to the diminution of poverty and fight the food insecurity.

The Comprehensive Assessment of Water Management in Agriculture has answered to the question: is there enough land, water and human capacity to produce food for a growing population over the next 50 years - or will we "run out" of water? In this way: it is possible to produce the food, but it is probable that today's food production and environmental trends, if continued, will lead to crises in many parts of the world. Only if we act to improve water use in agriculture will we meet the acute freshwater challenges face humankind over the coming 50 years.

Water resources in Italy are recognized as a natural resource of great importance, given the adverse natural events such as climate change and strong competitiveness with the different sectors of production. In recent years, climate change has imposed on the agricultural world of courageous choices in the context of sustainability of agricultural systems and for better management of water resources. The availability of water can be directly influenced by the quantity and quality of the distribution of rainfall. Indirectly, through changes in reserves of groundwater, stored in the snow and glaciers. Therefore, in this context, it is necessary to adopt measures of adaptation to climate change. The effects of climate change on water availability in agriculture have an impact on irrigation, which is powerfully influenced by farming.

Today, many changes and adjustments are needed in agricultural water management, but mostly need specific water policy actions. In fact, is necessary to consider water not as isolated resources, but as part of the system of environmental factors.

The result of these preliminary considerations shows that climate changes and their effects on water resources undoubtedly accelerate the debate of good water management in agriculture. However, other factors, not strictly dependent on environmental events influence the availability of water for irrigation.

The investments in the irrigation sector, for example, should be considered more than in the past. They should be carried out considering the whole agricultural sector, taking into account the changing demand of water resources, not only in agriculture, but also for other productive sectors.

Increasing water productivity could be another possible actions to consider the water resources in agriculture, producing more with less water for irrigation. Today, many agronomic techniques such as the improvement of soil fertility, soil conservation are spreading quickly to ensure good water management in agriculture. Therefore, a good management of this productive factor in agriculture must be addressed in an integrated, holistic approach, which takes into account the technological elements, farming practices and policy actions.

Considerable attention should be addressed to improve cropping systems that use rainwater. The rainwater is an additional tool for water management in agriculture and an important resource available for farmers who live in areas where agriculture is the main source of business. Moreover, this approach to water management could be a valid opportunity to produce most food for poor countries. Improve the management of rainwater and soil moisture, could be crucial to enhance availability of water in agriculture. Despite many studies confirm the improvement of rain-fed agriculture.

Water management in agriculture through efficient irrigation systems is still one of the safest systems for better water management in agriculture and for safe food production. The good maintenance of irrigation networks and investment in irrigation infrastructure ensures the reduction of poverty in rural fields and can help direct the world-wide need for food in agriculture. Therefore, the need to improve water management in agriculture is a very current issue, both for agriculture and for other productive sectors. Finally, for issues related to environmental sustainability that provide for a wise use of water resources in agriculture.

1.3 IRRIGATION ADVISORY SERVICES IN ITALY

In Italy, the agricultural development in different areas has been strongly linked to the water accessibility and the irrigated cropping systems have been a strength in terms of income and employment. Many of the major challenges that the Italian agriculture will face in the coming years will be related to the intensification of environmental performance, as established by the Common Agricultural Policy. In this context, water resources will become increasingly important and the irrigation will have to respond to the needs of the agricultural sector with agricultural practices more efficient in terms of water savings and benefits for the environment. In our country, water is a key resource for Italian agriculture. In fact, the irrigable area accounts for more than 40% in the territories of the plain, to 10% in the hills, and 5% in the mountains. Moreover, such availability is even more

important when you consider that over 83% of the value of Italian agricultural production comes from irrigated lands.
Unfortunately, in the future due to climate change, pollution, competition with other uses and related phenomena such as the impact of urban land use, water availability in agriculture will be more precarious. Therefore, in recent years at the national level, there is a widespread concern that insufficient water management could be a major obstacle to sustainable development for the future. In Italy, the greatest interest in irrigation management as well as for environmental reasons was also determined by a legal framework introduced by the European Directive 2000/60 (Water Framework Directive, WFD) and other initiatives such as Blueprint plan.
The WFD adopted a comprehensive approach to the risks faced by the waters of the European Union, and clearly stated as water management must take into consideration above all, i) the qualitative and quantitative aspects of water, ii) coordination with spatial planning accepted by the Member States and iii) integration in funding priorities. Although, the temporal horizon of the WFQ was 2015, recent Communications of the European Commission and the European Environment Agency underlined that this goal will probably be achieved for just over half (53%) of EU waters.
Departing from this result, the European Commission deemed to specify an additional policy tool, the Blueprint. The report outlines i) actions that focus on better enforcement of current legislation of water resources, ii) the integration of the objectives of water policy into other policies, and III) aims to fill the openings, in special as regards quantity and water efficiency.
The Blueprint temporal horizon is closely linked to the EU 2020. However, the long-term goal is to ensure the sustainability of all activities that have an impact on the water, so as to ensure the availability of quality water for sustainable and equitable water use.
During the recent years in Italy, in addition to the policy proposals related to irrigation management, have become popular technical tools to support the management of irrigation. The purpose of these Irrigation Advisory System (IAS) is to provide an efficient management of irrigation water with high economic performance and management. The spread of the IAS was facilitated by the use of the internet and the possibility of real-time access to agrometeorological databases.
Irrigation Advisory system in the near future will have a critical role in the challenges imposed by environmental threats, climate change, and competition in the utilization of water resources in other economic sector.
In Italy, the agricultural world is reacting with increasing interest in the introduction of IAS for irrigation and their high technical capacity. In particular, in the context of irrigation has been reached the awareness that innovation is a central constituent in the growth of profitability in farming. For

instance, reducing environmental impact and improving the character of agricultural production for consumer security.

1.4 OBJECTIVES AND OUTLINE

The present research by the use of discrete choice models (CM) has analysed the willingness to pay for satellite based irrigation advisory services in an area of Italy effects of intensive use of water for irrigation.

This thesis is organized assembling manuscripts that have been published or are awaiting either published in international peer - reviewed journals and in conference proceeding.

Chapter II provides an overview of various water use accounting devices and systems, of diverse scales, from farm to broader local and sub national scales, that requires the appropriate measurement of water use, of its adequacy to needs and adequate tools to compare the efficiency of different farms and farming systems as well as availability of data at the appropriate scales. It considers means to share knowledge and information between farmers as easily as with other actors in order to improve water management for sustainable food organizations. In particular, in this section has been seeking to answer on i) importance of accounting water use in agriculture for sustainable food system, ii) how measuring water use at different scale iii) key points to be taken into consideration to assess efficiency of water in agriculture and food production? iv) how is could share knowledge and information between farmers as well as with other actors in order to improve water management for sustainable food systems.

Chapter III reports, analysis of irrigated agricultural systems in Italy with a detailed analysis of demand and supply of water management instruments. In fact, in the agricultural sector, the demand for water can be affected by reductions in the availability of water for crops, forcing farmers to revise their addresses in some cases cultivation. In fact, adaptation measures to climate change may involve the utilization of less water demanding crops. Recently, a combination of the above mentioned factors has contributed to the development of irrigation advisory services (IASs) at farm level, often of high technological value, for the rational use of water for irrigation. Instruments such as high-tech irrigation systems will play a central role in the hereafter for the challenges that climate change will inflict. The objective of this chapter has been defined, irrigated agricultural systems in Italy throughout of analysis of demand and supply of water management instruments. The analysis has been conducted of IASs.

Chapter IV presents the application of the discrete choice model to analyse the willingness to pay for satellite based irrigation advisory services. One original aspect of this study concerns the case study area, where our work has been implemented. In fact, several studies that used CM have been implemented in agricultural areas and considered water resources management, but we do not fund studies concerning the IASs, specially characterized by a i) highly innovative and technological value offering by the use of Earth Observation (EO) techniques for water saving. The study was carried out in the Campania region in area of Italy covered by IAS IRRISAT. In 2013, the service has provided support for three Irrigation and Land Reclamation Consortia (ILRC), with 669 farmers and extension of 55.03,57 hectares. Based on these considerations, the specific aims of this work has been i) to analyse the importance of technological innovation in theagricultura water management ii) to define throughout the use of choice experiments (CE) the preferences of the farmers regarding the main characteristic, attributes, of the IRRISAT, iii) to analyse marginal willingness to pay for this service. Chapter V produces a summary and conclusion of the work, emphasising the attention on the results obtained and the possible developments.

CHAPTER II
ACCOUNTING FOR WATER IN AGRICULTURE IN THE CONTEXT OF SUSTAINABLE FOOD PRODUCTION UNDER GROWING WATER SCARCITY

ABSTRACT

In many areas, irrigation plays a key role to increase and stabilize food production. Its importance is increasing with growing food demand and climate change. It is also essential to increase and stabilize farmers' income, particularly where water and/or land are scarce. At the same time, agriculture is already a major water user and confronted with many areas of water scarcity and increasing competition from other users. This calls for a more efficient and sustainable management of irrigation, grounded on accurate knowledge and information. It requires appropriate measurement of water use, of its adequacy to needs and adequate tools to compare the efficiency of different farms and farming systems as well as availability of data at the appropriate scales. Such information has then to be made available to relevant actors, first of all to the farmers themselves. This contribution provides an overview of various water use accounting devices and systems, of diverse scales, from farm to broader local and sub national scales. It finally considers means to share knowledge and information between farmers as well as with other actors in order to improve water management for sustainable food systems. In particular, this work seeks to answer on i) importance of accounting water use in agriculture for sustainable food system, ii) how measuring water use at different scale iii) key points to be taken into consideration to assess efficiency of water in agriculture and food production? iv) How we could share knowledge and information between farmers as well as with other actors in order to improve water management for sustainable food systems.

2.1 ACCOUNTING WATER USE IN AGRICULTURE

Water is an essential input in agriculture and natural resource of primary importance for ensuring food safety. The production of biomass is inextricably linked to the need of water, as well as livestock. The use of water for food production has always been the dominant share among all other uses and its demand is increasing continuously with the increase in population. Agriculture is the largest consumer of fresh water on the planet with about 70% of all freshwater withdrawals[1].

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[1] http://data.worldbank.org/indicator/ER.H2O.FWAG.ZS/countries?display=graph

In the global context which provides increased food demand and climate change, to ensure the maintenance of agricultural production is a very important goal. This target can be achieved through a proper and efficient availability of agricultural inputs, including water.
The need for water for agriculture collides today with a water deficit pressing. The problems related to water supply are covering different areas of the world. The water supply is a critical issue and conflicts in order to take advantage of the water are increasing in many regions, because on the one hand are witnessing a decrease of the resource, in terms of both quantitative and qualitative, on the other hand increased requests for the various competing uses(Bruinsma 2009; FAO 2011).
In fact, the water is not only a factor of production for agriculture, which implies a certain amount of competition with other uses, and it is only one factor of production, as the basis of social development and civil society is resource natural and public to be protected. It is, therefore, an entirely out of the scheme compared to other agricultural inputs. As a result, the sector policies are closely linked not only to other policies of the primary sector, such as the common agricultural policy and rural development policies, but also to environmental, energy and land development. There is the need, therefore, to adopt the strategies of adaptation and water management rather scrupulous.
The water saving measures already put in place in many countries of the world are varied. They include rainwater harvesting, crop rotation that makes best use of the available water, an adjustment of sowing dates according to temperature and precipitation, the use of crop varieties better adapted to new climatic conditions (for example, varieties with shorter cycles, more resistant to water stress), the adoption of conservation practices that promote water infiltration and water storage in the soil, water reuse, improving energy irrigation systems, plant on land arable hedges or small wooded areas that reduce water run-off and act as windbreaks and modernization of irrigation infrastructure (FAO 2011).

2.2 ACCOUNTING WATER IN AGRICULTURAL SECTOR: MAIN CHALLENGES

In the first part of this work has been pointed out that the use of water in agriculture can be attributed mainly to irrigation practices. It was also highlighted that the pressure on water resources from water withdrawals for irrigation is in continuous growth and helps create serious environmental problems, especially in those areas where water availability is limited by environmental and economic conditions.
The increased pressure and scarcity of resources at the global level and in particular in some regions require a better use of water resources at all levels and in particular in the agricultural sector that uses more than other water in its production processes. One of the possible solutions to improve the use

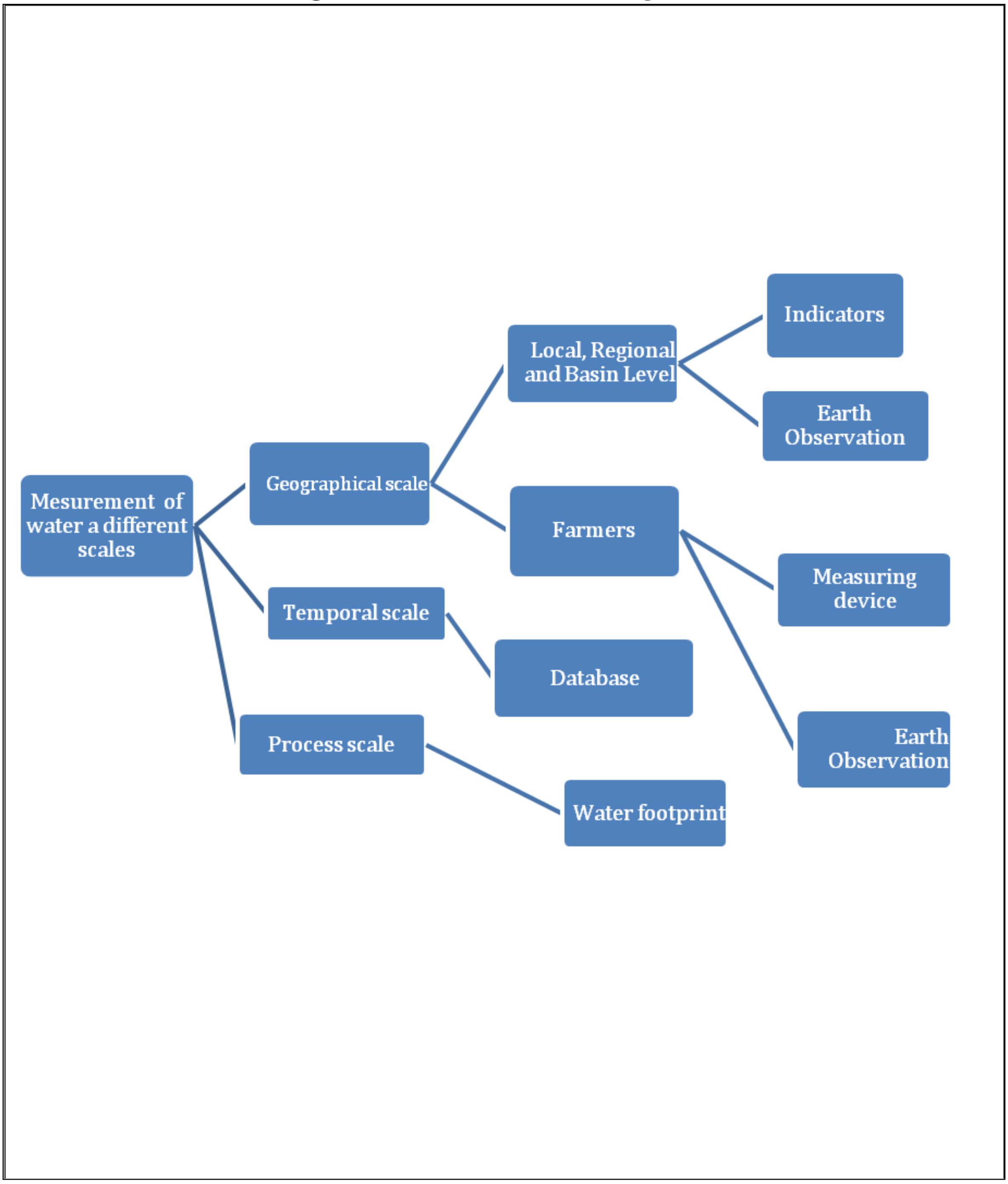
of water resources in agriculture is to give policy-makers, at all levels, from the farm to the governments and consumers tools and resources to act.

Firstly, through awareness of the availability of water resources, both now and in the future. Arises, therefore, the need for tools and metrics to compare the efficiency of the irrigation practices and irrigation systems, identifying potential improvements and monitor their impact. The knowledge of the availability of water and the degree of their use helps to improve their management.

In fact, in a world where the use of water is intended not only to the agricultural sector, but also other areas of production, such as the industrial sector and the tourists, the views and objectives of water use may be very different. In this context the need to work on a long-term perspective has become a priority, while most of them have to consider first a short-term result.

In the agricultural sector the accounting of water for irrigation is a problem that emerges in recent years more and more with larger strength. The reasons are different, firstly economic factor. In fact, in areas of the world where the water resource has been very available both to the surface, mainly rivers and lakes, is the one coming from the subsoil has not been for a long time a limited resource and put to other use or service of production. Therefore an unlimited natural resource. The second environmental reasons. The continuous changes in climate have helped to reduce water availability and therefore compromise the availability of water for irrigation purposes.

Figure 2.1 - Levels of accounting water



Source: INEA, 2014

The matter of accounting of the water tends to analyse the bigger picture of supply and demand of water resources, intends to systematically analyse the hydrological cycle, the current state and its trend. Beyond the simple accounting of the volumes and flows, also focuses on issues related to accessibility, uncertainty and governance (Steduto et al. 2012). The increasing use of groundwater for irrigation in recent decades also poses problems for water accounting, since both the stock of this resource and the rate at which it is depleted and replenished are difficult to measure with any accuracy. The dynamic nature of the physical processes and the needs of society vary continuously in space, resulting in a continuous difficulties and of great importance for all colours who have the need to quantify and monitor natural resources and especially water. The water accounting should not adopt a general methodology and applies to all situations where it is required (see figure 2. 1). The choice of the type required accounting of water in agriculture depends on the geographical scale at which it refers, and for which data are required. Also the temporal horizon is very important because it influences, in fact, the choice of some data rather than others for the level of analysis (Berger et al. 2011).

In some cases, for example, it is necessary to make a measurement of the water at the farm level, in other cases it may be necessary to carry out a collection of data at the basin level. In some cases it is necessary to take into considerations data that have a very different time horizon, within the same year or an average of several years. In other cases it is necessary to estimate the amount of water needed to produce a product, in other cases that required to perform a process. Therefore, we can say that there are several approaches to the definition of water use in agriculture(Gitz, V. Meybeck, A. Huang 2012).

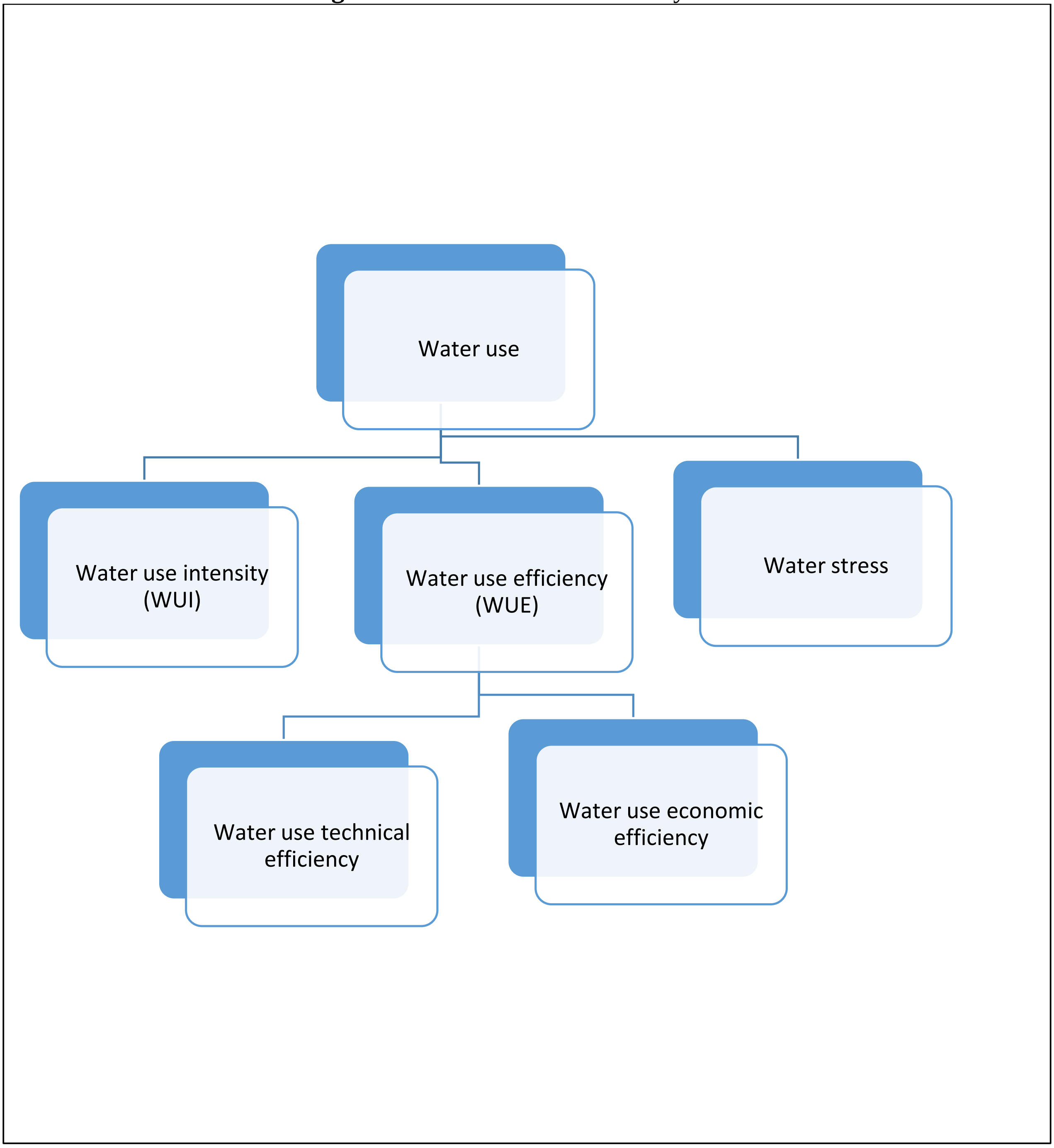
In the following paragraphs we will try currently displaying some of which are used for different uses and different purposes, but also allow a reliable level of the result.

2.3 AGRICULTURAL WATER USE INDICATORS: THE OECD APPROACH

The following overview of indicators of agricultural water use in OCDE countries highlight the different aspects of these tools, for better assessing the impact of this resource on environmental aspects.

The environmental impact of water use in agriculture is increasing issues in OCDE Agriculture. For instance, in different area of Australia, Korea, Japan, USA and Mediterranean countries the scarcity of water is a limiting factor in development. In this context, agricultural water use indicators can help useful tools for policy makers to monitoring the pressure on water use on environmental(Merrett & Parris 2003; Gould 1972).

Figure 2.2 - Water use indicator by OCDE



Source: OCDE, 2004

The importance of the indicators for the measurement of water in agriculture is due to the possibility to know indirectly and without the use of accurate measurement tools, the impact of the use of the water resource. They represent important tools for reporting on how the agricultural sector impacts in terms of environmental pressure on water resources.

The OCDE is developing three indicators related to agriculture's use of surface and ground water (Kevin Parris 2004).

i) The water use intensity is the share of agricultural water use in national total water utilization.
ii) The water use efficiency cover irrigated agriculture land and are defined are i) Water Use Technical Efficiency, WUTE, measured the mass of agricultural production (tones) per unit volume of irrigation water utilized; ii) water Use Economic Efficiency, WUEE, measurement the monetary value of agricultural production per unit volume of irrigation water utilized. Water use efficiency indicators are a measure of the utilization of irrigation water by crops relative to the farming system. These indicators measure the set of water leaks that are not used by crops including evaporation. Information on the technical or economic efficiency of irrigation water use is limited. These indicators are strongly linked with various aspects of farm management, in particular irrigation and water management indicators.
iii) The water stress is defined as the proportion of rivers subject to diversion or regulation for irrigation without defining minimum reference flows. The indicator is calculated as the percentage of river lengths that do not have recommended minimum flow rate reference levels, that is, where there are no regulations to ensure the maintenance of downstream flows. The indicator is based on information on regulatory measures that provide for minimum flow rates in rivers (see figure 2.2).

The different aspects of agricultural water use can to express by several lists of indicators (USDA 2003). Irrigation and water management (figure 2.3). Define as a share of irrigation water applied by different forms of irrigation technology. This indicator is calculated as the share of irrigation water used under different irrigation technologies and systems (such as, flooding, high-pressure rain guns, low-pressure sprinklers, and drip-emitters) divided by the total quantity of water used for irrigation. Scientific and well managed irrigation methods (drip-emitters, booms and pivots) have facilitated a reduction in water use to the minimum levels required by the crop in some countries. However, this reduction in water use is often accompanied by an increase in irrigated area, so that the overall quantity of water utilization remains the same. Irrigated area showing trends and geographical differences in irrigated area are used (figure 2.3). In many examples maps or diagrams are used to illustrate regional differences in percents in the percentage of agricultural land that are irrigated. Irrigation by crop types. As different crops are subject to irrigation at different levels of intensity indicators providing the irrigated area by crop type or application rates by crop types are often included. The following paragraph will describe the emerging measurement tools water use in agriculture water use efficiency indicators. Define as water use per economic value of irrigated crops

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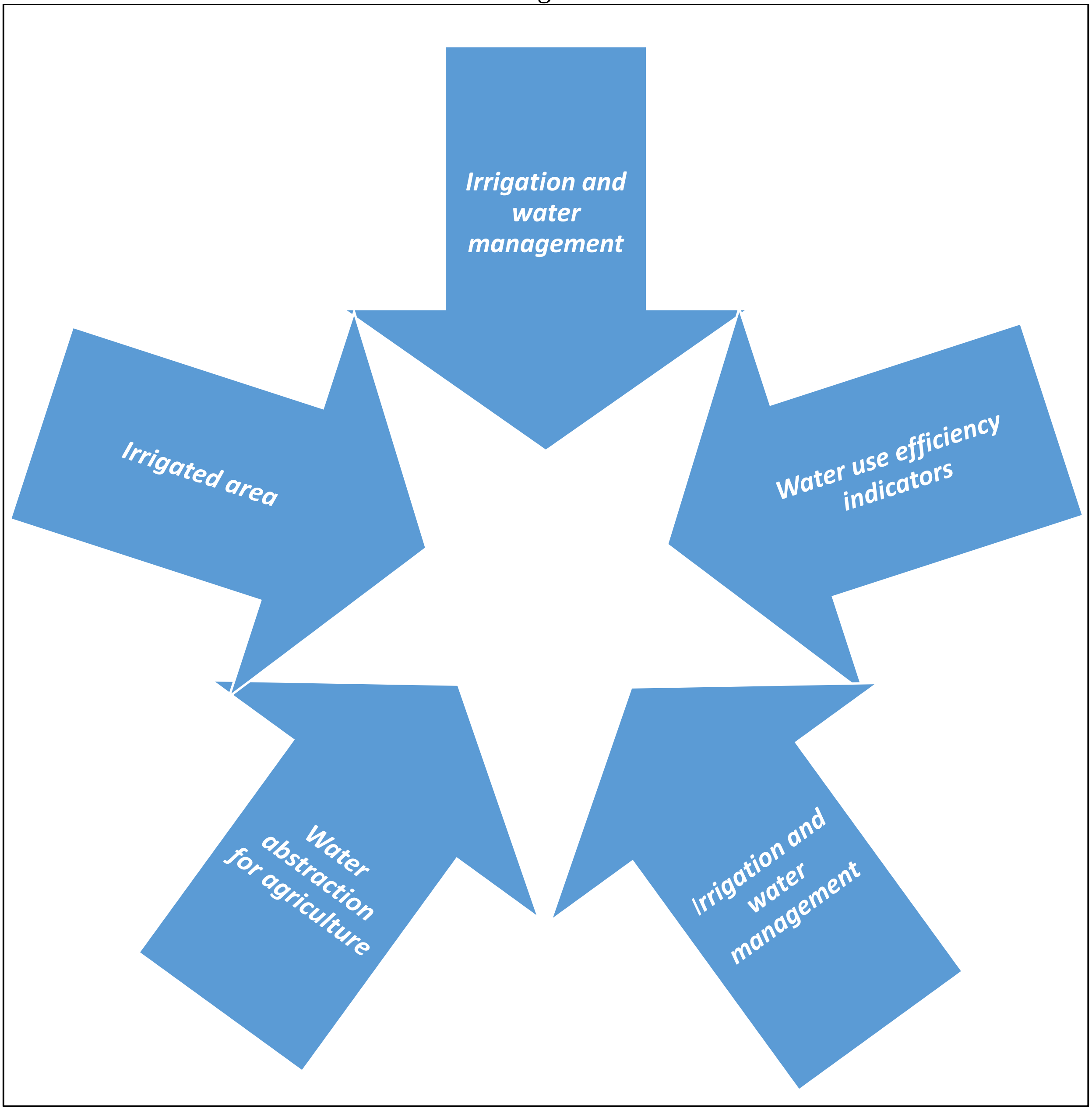
Figure 2.3 - Examples of indicators used to describe the different aspect of agricultural water management



Source: USDA 2003

2.4 MEASUREMENT BASED ON EARTH OBSERVATION SYSTEM AND MODELING

Integration of models to estimate the water balance of the earth and observation techniques for the measurement for the estimation of irrigation requirements have become popular for a long time, these same tools can be very useful to measure the use of water in agriculture. This technique helps also stakeholders involvement in the optimize crop productivity and cost-effectiveness by providing them with irrigation scheduling information based on the actual crop development. Procedures for estimating irrigation requirements are based largely on the use of Earth Observation (EO) techniques and applied modelling. These methodologies processing a high intensity of data returns very reliable info about the intensity of water applied.

The integration of the whole of computer technology in the production and distribution of information has made this information easily available to farmers associated with these initiatives in a personalized way (Molden & Sakthivadivel 1999).New technologies based on the analysis of data from EO and description of hydrological processes to assess the demand for water for irrigation purposes in relation to the availability of water resources (water accounting). This system also can offer scale monitoring of the district and the area and evaluation of the space-time efficiency irrigation network. This technique helps also stakeholders involvement in the optimize crop productivity and cost-effectiveness by providing them with irrigation scheduling information based on the actual crop development (Vuolo et al. 2014).

Box. 1 - SIRIUS-Sustainable Irrigation water management and River-basin governance: Implementing User-driven Services

SIRIUS-Sustainable Irrigation water management and River-basin governance: Implementing User-driven Services

Italy is considered a country with a good availability of water resources. Effective water management has gotten a well known topic recently due to water scarcity phenomena, especially for the southern Italian regions and, more in general, for the raising awareness of the masses to the environmental issues related to climate change. A great contribution to the increased people awareness of the topics related to the efficient water management in agriculture is to be acknowledged to numerous national and international research projects financed during the last decade.

The SIRIUS projected, funded by EC FP7, is developing efficient water resource management services in support of food production in water-scarce environments. It addresses water governance and management in accordance with the vision of bridging and integrating sustainable development and economic competitiveness. The project is developing new services for water managers and food producers, and a range of additional information products in support of sustainable irrigation water use and management under conditions of water scarcity and drought. More in details Sirius has developed new services for water managers and food producers, including maps detailing irrigation water requirements in different areas, crop water consumption estimates, and a range of additional information products in support of sustainable irrigation water use and management under conditions of water scarcity and drought. The results of the project at the end of the second year of operation showed a 20% decrease in the use of water for irrigation during the irrigation season in 2012 (Altobelli et al. 2012).

2.5 MEASURING OF WATER AT FARM LEVEL: HEIGHT, PRESSURE AND FLOW RATE

The measurement of water levels, pressures and flow rates is mainly a factor of considerable importance in the operation of an irrigation system to scale farm. This level of accuracy allows to evaluate the efficiency of water management. The choice of the type of measure and the measurement technique to be adopted should be carried out as a function of both the characteristics of the site and of the irrigation systems.

Criteria for the selection good tool for water accounting should be taken into account many aspects. Regarding the operational characteristics of the used tool they should be very simple and easy to use and also have a good recording frequency of the data collected. But also should be chose on respecting the local traditions. Moreover, it is very important to respect the local traditions in the choice of measuring instruments more familiar to farmers in relation to the areas where they need to be applied. Another important aspect is the adaptability of measuring instruments to to the hydraulic characteristics of the site that are under investigation. In this context the gauge chosen must not be intrusive. For example a flow meter should not modify technical prescriptions hydraulic operation of a water course. Also the durability in relation to environmental, technical prescriptions has a very important role. In fact, the measuring instrument will be expected to ensure adequate stability of its caratteristihc edi operation. Especially in light of the risks linked to the environment in which it will be installed. Finally, economic and environmental aspects should be taken into account. Regarding economic issues the sustainability of the cost of the instrument should be well evaluated, it doesn't exceed the actual requirement. In order to use tool with a good level of the environmental sustainability, is very important considering the some measurement systems may have harmful effects on the environment.

There are different tools that can be useful to get measured at the farm level (see tab. 2.1). Some of these, i) measuring the level reached in the tanks, canals and water courses (Hydrometers); others like ii) level sensor and flow deeps in tanks, canals, with the aim of measuring the level reached by the water in them, in some case are iii) ultrasonic level sensor that are based on the response time of the echo reflected. There are tools that can indirectly measure the pressure of the fluid. In this case, each variation causes a variation in the level. These measures of level can have strength and weakness. Hydrometers for example, show difficulty in reading the height in the case of courses or wild rivers, other and survey of the data can also be done by untrained personnel and in the cheap way too. In some cases can alter the courses of water, giving rise to erosion and sedimentation

Table 2.1 Measuring of water at farm level: height, pressure and flow rate

Level measuring	Description	Areas of use in the irrigation sector	Strength	Weakness
Hydrometer	Measuring the level reached in the tanks, canals and water courses.	All	The survey of the data can also be done by untrained personnel. Economy. Allows the indirect estimation of flow rates.	Difficulty in reading the height due to access problems hydrometer, in the case of courses or wild rivers.
Level sensor and flow	Rigid rod immersed in tanks, canals, with the aim of measuring the level reached by the water in them.	All	Easy to use. Economy. Allows the indirect estimation of flow.	Cannot be used at heights above the meter. Electronic instrument, to ensure the power supply.
Ultrasonic level sensor	The tool is based on the response time of the echo reflected.	All	Continuous recording of the signal. Reliable. Economy. Affidabile. Allows the indirect estimation of flow rates.	The reading level may be difficult in case of changes in the water level of the signal.
Measuring device pressure level (pressure gauge, piezometer, pressure cell, etc.)	The measurement of the water level is carried out in tanks and canals. The measure can be determined indirectly by measuring the pressure of the fluid. Each pressure variation causes a variation in the level.	The limitations to the use are due to the type of channel or tank to which it is applied. The meter.	The tool can be used only if the channel walls or the tub, are easily accessible and the application of the instrument is easily installable.	It has a difficult to use in open-ceiling canals with an upright course .

Source: INEA, 2010

2.6 MEASUREMENT BASED ON VIRTUAL WATER AND WATER FOOTPRINT

The highly technological instruments are not the only useful tools to quantify the water used in agriculture. It should be noted that even the models of social development help to have a big impact on water resources and the environment. Therefore, instruments for the benefit of appropriate water management that contribute to quantify these phenomena become strategic.

Other concepts, such as virtual water (VW) and water footprint (WF) are extensively used in a successful scientific production to define the amount of water incorporated in marketing product, useful into the food chain, or need to produce one unit of given product or service.

The VW is the water needed to produce agricultural commodities (Allan 2003), and links water and food. Allan in his studies underline that 90 percent of water need for food and other agricultural production can come from freshwater, from soil, water or it can be accessed in effect via food imports. In this context virtual water and water used for manufactured are very useful tools for contrasting their water deficits.

The virtual water concept has led formulation of the WF by the contribution of the Hoekstra and Hung (Hoekstra & Hung 2002), where they make an association of the virtual water idea and the concept of theWF.

The WF defines the consumption of water in analogy with ecological footprint. WF is an indicator that is used to calculate water use, taking into account both the direct and indirect use of water, the consumer or the producer. The WF of an individual, a community, a company is defined as the total volume of freshwater used to produce the goods and services consumed by that individual, community or business. The WF appears as an empirical indicator of water consumption, allows us to measure how and why the water is consumed and what direction it takes in the form of goods which incorporate water through the volumetric analysis (A. Y. Hoekstra & Chapagain, 2007).

The interest in the idea of the WF is rooted in the recognition that the impact on freshwater resources on the planet can be traced to human consumption, and that issues such as water scarcity and pollution of water resources can be better understood and addressed by considering the manufacturing process and the supply chain as a unique thing. Moreover, the WF and VW approaches in the last few years have seen increasing attention due to their ease of understanding and sharing of meaning, both for users and for water managers.

Nevertheless, the use of inaccurate statistical databases, produced values VW/WF very uncertain. In some cases, the values unreliable scientifically, were attributed to the use of data from information sources with a broad scale.

This level of analysis, was inaccurate, and not allowed to take into account many aspects relating to agricultural crops, such as, for example, the seasonal consumption, the annual variations of water consumption(European Commission 2011).
Too often, the results of WF elaboration returned by inaccurate estimates and modelling. However, these problems related to the accuracy of the information and the methodological approach to be used for the calculation of the WF should not be considered an obstacle to the use of the indicator, but rather a stimulus to undertake studies at a local scale. This approach will allow an accurate analysis of the statistical bases and local data and therefore a value of actual water use compared to the agricultural products of a given area.
In fact, has been the undeniable role thatWF has played to raise public awareness on the need for sustainable water consumption. The measure of the flow of water through the estimation of the virtual water trade between one country and another, has been very important to quantify the flows of agricultural products from places with water scarcity other high availability of water resources. In this respect, these concepts should be offered as a means to sustain the agricultural and food labeling.
A recent study of the European Commission, about the assessment of the efficiency of the approach of the agricultural products and reiterates the need to pursue policies, also by the same European Commission, to promote the use of theWF for its important role reducing risk for unsustainable water, with important benefits for the environment, businesses and national economies (European Commission 2011).
The WF could be a good candidate to measure water used by irrigation (blue water) and water pollution (grey water). The latter could also constitute an aggregated proxy indicator of pollution caused more generally by inputs use (fertilizers and pesticides) in agriculture and food chains, and thus indirectly also of some of its impacts on biodiversity, aquatic, but not only (Mekonnen & Hoekstra 2014). To better fulfil these functions for all actors, three points need to be improved in the way the WF is calculated and used. First, it should enable to calculate the “water footprint of the outputs of main interest”, knowing that the nature of this main interest can be different for each type of actors; food for consumers, but for instance also income or jobs for farmers and public authorities. Second, it should focus on the most critical points, blue and grey water, including the need to distinguish non renewable sources of water, such as through the identification of “red water” as suggested by some authors (Greco F; Antonelli M 2013). Finally, it should enable to calculate WFs at the level of detail corresponding to the range of choices of the various actors. This will require adequate collection of data, linked to specific practices and systems, calculation of benchmarks and appropriate tools to make this information available.

2.7 ASSESSING WATER USE EFFICIENCY IN AGRICULTURE AND FOOD PRODUCTION

The efficiency of water in agricultural product and food production needs to take into account several aspects in its use. The efficiency of the use of a water resource, for instance, can be linked to the availability of other inputs, or enhance the efficiency of the use of another resource. Very important aspect concern the need to take into account different outputs, agriculture produces food and also livelihoods, jobs, income; which from a food security perspective are equally important. Not less important aspect is the level and range at which it is calculated, is central to its usefulness to inform action and choices. This aspects calls for a diversified, multidimensional approach to account for resource. Such an approach requires appropriate tools to measure each type of resource use and impact, (Gitz, Meybeck and Huang, 2012).

Choice criteria depend on the specific needs of actors. When producing food, the objective is not only to produce food but also incomes and jobs. For instance a farmer will make choices in the management of his/her farm according to the incidence it will have on production, but as it determines income. For a public authority the objective could be to create more jobs in a rural area. They need indicators which are linked to their target. For both types of actors, the degree of choice is determined by local conditions, including water availability. They need to compare production systems using data with enough precision to show the difference between them.

2.8 DISCUSSION AND CONCLUSIONS

The topics discussed in this paper, show that water for irrigation in agriculture is particularly timely. The water is a fundamental good for humans and for life in general. In agriculture the water is, without doubt, the most decisive factor of production

A large number of poor areas of are concentrated, more frequently in geographical areas where natural resources availability to population are scarce, especially water. Is therefore evident that correct irrigation management can also result in good levels of food production and therefore food safety.

These preliminary considerations require the irrigation sector extensive use of tools and methodologies for monitoring the water used for agricultural products.

However, water measurement systems are not widely used. Despite the technology in recent decades has provided a good range of solutions.

The need to increase the level of penetration and diffusion of measuring instruments in agriculture should be implemented primarily through, dissemination of knowledge between all stakeholders involved in the water management agriculture. How to guarantee access to knowledge for all actors involved in the agricultural sector (farmers, small and large processing companies) to improve their business processes and compare their performance with that of others?

In this context, one opportunity could be offered by more accurate use, where is possible of introducing or rebuilding of Irrigation Advisor Systems (IASs) and their application. A more accurate use of this instrument 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 spread IASs for the proper management of water resources could lead to a strong decrease of the energy costs associated with irrigation. The effects of careful irrigation management can be successful in terms of increasing the income of farmers and to decrease the energy costs incurred by the managing bodies of water resource in the area.

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CHAPTER III

IRRIGATED AGRICULTURAL SYSTEMS IN ITALY: DEMAND AND SUPPLY OF WATER MANAGEMENT INSTRUMENTS

ABSTRACT

In the recent years the availability of water for irrigation, has been strongly influenced by climate change (CC) in agriculture. The availability of water can be directly linked to amount and distribution of rainfall and indirectly through changes in water reservoirs, underground, stored in glaciers and snow that can be used for withdrawals of water for irrigation purposes. The demand for water instead, can be affected by reductions in the availability of water for crops, forcing farmers to revise their addresses in some cases cultivation. In fact, adaptation measures to climate change, for example due to the raising of the temperature and the increase of the phenomena of wind may require the use of less water demanding crops in Italy. A combination of the above mentioned factors have contributed in recent years to the increase and development of irrigation advisory services (IASs) at farm level, often of high technological value, for the rational use of water for irrigation. This development has been further facilitated by the spread of the Internet and the possibility of real-time access to agro meteorological databases. Tools such as high-tech irrigation systems will play a key role in the future especially for the challenges that climate change will impose. Therefore, in the management of water resources in agriculture. The objective of this paper has been define, strengths, weakness, opportunities, treats of the IASs in Italy. The SWOT analysis has been conducted of IASs and their applications within irrigation systems. Furthermore, interesting aspects investigate has been, i) what is the interest for IASs? ii) Who offer irrigation advisor services in Italy? iii) How many farmers and government agenesis use IASs for manage irrigation practices? Which are the areas of country where the IASs are common used as tools for better management water for irrigation? Which are needed and opportunity of for their utilization ? Main results of the conducted analysis has shown that many areas of the country do not adopt this services. Therefore, the opportunity for their widespread is very large. This could be reached by improving ICT at farm level.

3.1 INTRODUCTION

The demand for water can be affected by reductions in the availability of water for crops, forcing farmers to revise their crop systems. In fact, adaptation to climate change rising temperatures and increased wind phenomena may require the use of more water demanding crops (Gain & Giupponi 2015).

However, other factors not strictly dependent on environmental events affect the availability of water for irrigation, like the multipurpose utilization of water resources. In some cases this competition for use of water, especially during the irrigation season, has caused in Italy, problems of availability of water for irrigation during the dry season. This preliminary considerations, ii) climate change and their effects on water resources in agricultural sector(Olesen & Bindi 2002), ii) the use of diversified water resources that actually reduce the availability of water for the irrigation sector, are accelerating the need for good management of water resources in agriculture. In addition, national and international level, in recent years, has become increasingly more and more widespread the concern that inadequate management of water resources could represent one of the biggest obstacles to sustainable development in the coming decades.

A combination of the above mentioned factors have contributed in recent years, to the diffusion and solutions to agricultural water management problems (Bastiaanssen et al. 2007) and development of Irrigation Advisor Services (IASs) at farm level, often with high technological value, for the use and management of water in the economies of management. FAO has provide a large number studies and tools on water management solution for irrigation, some of these today are integrated in IASs and used. One of the most cited and useful tool is FAO#56 (Allen et al. 1998).

The agricultural world answers with increasing interest in the introduction of irrigation systems consulting and innovative technologies. These system in Italy, are proving very interest both at farm level and for decision-makers. In fact, in the context of irrigation has been increased the awareness that innovation as well as being an indispensable element to improve profitability in agriculture provides the opportunity and means to adapt quickly to directions, continually evolving, policy agricultural community; such as reducing environmental impact and improving the quality of agricultural production in order to protect the interests of protecting consumers.

Techniques for estimating irrigation requirements are based largely on the use of Earth Observation (EO) techniques and applied modeling. These methodologies processing a high volume of data returns very reliable information about the volume of water used. The integration of the whole of computer technology in the production and distribution of information has made this information easily available to farmers associated with these initiatives in a personalized manner.

EO data and geo-spatial tools, in recent years have been widely used. . The main reasons for this diffusion have been due to changing in pricing policy also allowed a cost – effective use of high spatial resolution imagery are overcome. In fact, in the past spatial, temporal resolutions are the main problem to the large application of this tools (Moran et al. 1997). In future the availability of free data for several use form commercial to scientific will be secured trought the European EO programme Copernicus. This initiatives will stimulate the development of various operational, services at European level. Thanks to this initiatives, the use of the data come from EO techniques will be more common and will be integrated in agriculture services, and within IASs, for monitoring and controlling activities from farm to regional scale (Lee et al. 2010).

The very interesting application in this field of studies, of satellite – based irrigation advisory services was considered for the first in the DEMETER UE – RDT project (D'Urso, G., Calera Belmonte, A. 2006). This technologies was, successively improvement for better satisfy needs of farmers trough a personalized weekly irrigation advices to the users at field scale and regional level (F. Vuolo & Lazzaro 2006). In the recent years IASs based on web GIS plattaforms has been first of all within the PLEIADeS UE- project and in more recent SIRIUS (www.sirius-gmes.es; www.pleiades.es).

The work that is presented in this paper is inspired by a workshop organized in Italy in January 2013 by Italian Irrigation Study Group (GRUSI) and the National Institute of Agricultural Economics on Irrigation Advisor Services in Italy. The workshop aimed to present the main experiences in this field of study, comparing the potential of irrigation services operating in the area with the needs of end users and managers of water resources in agriculture, and with the criteria adopted by the European Directive on water n.60/2000. The results of the workshop have highlighted the large demand of the IASs in Italy.

The objective of this paper is to make Strengths - Weakness - Opportunities - Treats (SWOT) analysis of IASs and their applications in the irrigation systems.

3.2 THE DEMAND OF IRRIGATION WATER MANAGEMENT

The continuous extreme climatic events, which have led in some cases flooding in other cases long drought, bring a serious rethink on adaptation strategies are needed to counteract these environmental phenomena. In particular, in recent years have been recorded prolonged periods of reduced precipitation; this environmental condition has resulted in a scarce water supply. The most serious water crisis in recent years has occurred in the summer of 2002 (especially in the south and central part of the country) and in the summer of 2003, 2006 (especially in the northern regions).The limited water resources have coincided with periods of high demand for irrigation. Causing a water crisis that has had effects on the agricultural sector.

Environmental risks are not primarily responsible for poor water availability. In some cases, other factors related to inadequate water facilities in some areas of the country helped to limit the availability of water for irrigation in some areas of southern Italy, which have relatively high aridity indices, losses of water along the water pipelines by about 27%, with peaks of 40%.

Conventional irrigation practices more widespread in Italy and many parts of the world are directed to overcome the stress of crops in order to facilitate the maximization of production (English 2002). However, the expansion of irrigation in recent years motivated by a growing need to produce more food, has led, in some cases, a higher risk for the environment. This increase of the negative effects of water withdrawals for irrigation resulting in augmented environmental risk is leading to a greater awareness of the risk and a change in this approach. As illustrated from the several studies the approach that you are doing forward is based on the maximization of the economic benefits rather than associated to the production. The scientific community, irrigation professionals and farmer as the basic approach for irrigation management more and more share this new course that refers to optimization economic benefit. Other authors agree that the interest in irrigation management is shifting from simply supplying water to crops, to address their water needs, towards a more complex approach, where to the economic benefit must to be obtained from the source of water used (Molden & Sakthivadivel 1999). In agriculture increasingly is spreading the idea that farmers should use a lesser amount of water to produce more food, increasing the Crop Water Productivity (CWP)(Molden et al. 2001a). Higher CWP results in either the same productions from less water resources, or higher production from the same water resources, so this is of direct benefit for other water users. In fact, is well known such as irrigated agriculture is the sector that uses the most water and which competes directly with other production sectors such as industry and domestic (Zwart & Bastiaanssen 2004). The needs for better water resources management is usually accepted as a means to achieve sustainable increases in productive use of water resources (Molden et al. 2001b).The scope of the modern agriculture is to achieve water savings in irrigated agriculture, but in the meantime to improve the productivity of water in irrigate agriculture.

The new Water Framework Directive (WFD) (60/2000), is another of the key issues in a future strategy addressed to a careful use of water a European Level. The introduction of the Water Framework Directive has led a big changes for irrigated agriculture in the European Union, in particular as a result of the principles of full cost recovery, the polluter pays principle (PPP) and the use of water pricing as tool to reduce water use and water pollution (Bartolini et al. 2007). The Water

Framework Directive has set a goal of achieving good water status by 2015. Nevertheless, the recent report on the state of the waters of the EEA and the Commission's assessment of river basin management plans developed in the Member States under the water Framework Directive are in agreement that this goal will likely be reached for slightly more than half (53 %) of EU waters. For these reasons, the European Commission has proposed a new plan for the preservation of water resources. The "Blueprint " outlines actions that focus on better enforcement of the current legislation of water resources, the integration of the objectives of water policy into other policies, and aims to fill the gaps in particular as regards the quantity and the water efficiency. The aim is to ensure that sufficient quantities of good quality water is available for the needs of the people, the economy and the environment throughout the EU. The Blueprint is closely linked to the EU 2020 strategy. Nevertheless, the analysis underlying the Blueprint covers a longer time, up to 2050, and plans to guide the EU water policy in the long term. The long-term goal is to ensure the sustainability of all activities that have an impact on the water, in order to ensure the availability of quality water for sustainable and equitable water use (European Commission 2012).

In this framework, the concept of optimization of water use in agriculture is essential. Today it is widely taken over in the scientific community at the political level between farmers the need for a more rational means of rational irrigation management. In recent years large parts of the stakeholders (farmers, land reclamation and irrigation, research centers etc.), have begun to seriously consider the need to take action and tools to optimize the water for irrigation. Unfortunately, in many cases, even though the science has produced notable studies for the rational use of irrigation, the transfer of results to the agricultural world has been insufficient. However, in recent years a new way to undertake more research-oriented application results ensured a greater dissemination of the results of the agricultural world. In particular, in Italy has been observed a rapid growth of consulting services to help irrigation farmers

The contribution of irrigation to the new challenge posed by water productivity and greater knowledge of irrigation efficiency is difficult to determine without a detailed knowledge of the water requirements of crops. Such information today, thanks to the greater diffusion of technological systems and facilitates the collection of field data can be provided, the information collected and compiled in IASs. Currently in agricultural systems evolved as much in Italy, there is a clear need for use of highly innovative and technologically advanced for the estimation of irrigation requirements in agriculture, able to give answers on the quantities of water used in agriculture. Such systems are increasingly required as well as by farmers and managers of water in agriculture such as land reclamation and irrigation consortia in addition by decision-makers (D’Urso, 2001).

3.3 THE SUPPLY OF IRRIGATION WATER MANAGEMENT SERVICE

Irrigation Advisory Services (IASs) are suitable management instruments to achieve a better efficiency in the use of water for irrigation. IASs help farmers to optimize crop productivity and cost-effectiveness by providing them with irrigation scheduling information based on the actual crop development (Belmonte 2003) .

The current methodology used by IASs for this purpose is generally based on the standards recommended by FAO (Allen et al. 1998). This method, also known as the crop coefficient approach, consists of two parts. Firstly, reference evapotranspiration (ET0) is obtained from measurements of the agro meteorological station. Secondly, the crop coefficient (Kc) is determined from calibrated look-up tables and phonological observations across the IAS area.

Then, crop evapotranspiration (ETc) is obtained by multiplying these two quantities. In the final step, the crop water requirement is calculated as the difference between observed precipitation and ETc (Allen et al. 1998). The irrigation scheduling information obtained is then transferred to the end-user, the farmer, in various ways (Calera Belmonte et al. 1999; de Santa Olalla Mañas et al. 1999). IASs are key instruments for a sustainable agriculture water management in the Mediterranean countries, especially under current and expected climate change and variability.

There are several actors involved in the management and protection of water resources, supply the irrigation service in Italy (see tab. 3.1).

The main structures involved in the service supply at the administrative level are Regional Agencies for Environmental Protection, ARPAs. These agencies are involved in monitoring and control aimed at protecting the environment and water resources. The ARPA conduct monitoring to the continuous updating of knowledge on the state of the quality and quantity of water bodies at the regional level. In addition, the ARPA provides technical support to the Region and other government bodies. In the field of irrigation offer support to farmers and land reclamation for the estimation of crop irrigation requirements.

Table 3.1 - Examples irrigation advisor services provides in Italy

Regional level	**Water balance models**	**Service provider of IAS**	**Methods of access to service**	**Source**
Lombardia	IRRIFRAME	ANBI	Internet	Mannini et al. (2013); Rossi e Mannini (2012)
Veneto	IRRIFRAME	ARPA Veneto	Internet	Mannini et al. (2013)
Friuli Venezia Giulia	BIdriCo, IRRIFRAME	ARPA FVG,ANBI	Internet	Mannini et al. (2013); Gani et al. 2014
Emilia Romagna	ICOLT, CRITERIA, IRRINET;IRRIFRAME	ARPA SIM, CER	Internet	Marletto et al. (2005); Spins (2008);Mannini et al. (2013)
Marche	IRRIFRAME	ANBI	Internet,sms	Mannini et al. (2013), Munaretto et al (2013); Rossi (2012)
Umbria	IRRIFRAME	ANBI	Internet,sms	
Toscana	IRRIFRAME	ANBI	Internet,sms	
Lazio	IRRIFRAME	ANBI	Internet,sms	
Molise	IRRIFRAME	ANBI	Internet,sms	
Abruzzo	IRRIFRAME, Irrigua	ANBI, ARSAA	Internet,sms	
Basilicata	IRRIFRAME	ALSIA, ANBI	Internet,sms	
Puglia	IRRIFRAME	ANBI	Internet,sms	
Campania	IRRISAT	Campania Region	Internet,sms,mail	Vuolo et . al (2014);Antenucci et al. 2010; Vuolo et al. (2014)
Calabria	Agrometeo Irrigation; IRRIFRAME	ARSSA, ANBI	Internet,sms	Mannini et al. (2013), Munaretto et al (2013); Rossi (2012);
Sicilia	IRRISIAS	Sicilia Region	Internet,sms	Drago et al. (2003)
Sardegna	IRRINET Sardegna	ARPA Sardegna	Internet,sms	Fiori 2005; Fiori M., Micale M. 1998)

Source: own elaboration

In other cases, the technical departments directly provide the irrigation advisory services private organization for agriculture, within the administrative region (see tab. 3.1, Campania and Sicilia Regions).

An important organization that provides consulting services for irrigation is the National Association of Drainage and Irrigation, ANBI. The most important role of ANBI is to protect the interests of the reclamation and irrigation, are also responsible for the implementation and management of defence works and hydraulic control, supply and use of water for irrigation.

Water management services for irrigation are spread by access to web page on the agencies.

The access to the free and each stakeholder, farms and actors who manage irrigation, be able to have information on irrigation advise. Transfer of irrigation information to farmers and other stakeholders are done in different ways as SMS or mail (Munaretto 2013; Mannini et al. 2013; Rossi, F. e Mannini 2012).

The advisory system for irrigation of Campania Region, to reduce water wastage and cost of production of crops is called IRRISAT (Antenucci et al. 2010; Vuolo et al. 2014). The service is addressed to different levels of user, level i) the consortium administrations, which are associations of water users, and level ii) individual farmers. In year 2013, 669 farmers and total extensions of 5509 ha (Table 3.2) participated at the IAS, involving 4 regional consortia mainly cultivated with corn, tomatoes, alfalfa, fruit trees and vineyard (see fig. 3.2-3.3). The methodology used to estimate the crop irrigation requirements is the expected result of the data provided by processing satellite images. The main output of the project is related to the production of i) maps of crop development, in each of the areas for request the information; ii) maps of the irrigation requirements; weekly values of maximum irrigation volumes to be administered to crops in open fields and in plots protected. The IRRISAT system's result the most innovative and technologically advanced system of IAS in Italy.

The advantages of this service are made up of i) the high level of reliability of the information, ii) the large amount of data that can be analysed, and iii) the ease of information acquired by farmers. The "irrigation advice" or information on the amount of water used for irrigation is distributed to farms via SMS, MMS and email, as well as on the Internet. In this last case, the service is delivered through the arrangement of dedicated pages for each farm and the Consortium of Reclamation and Irrigation afferent to the advisory services.

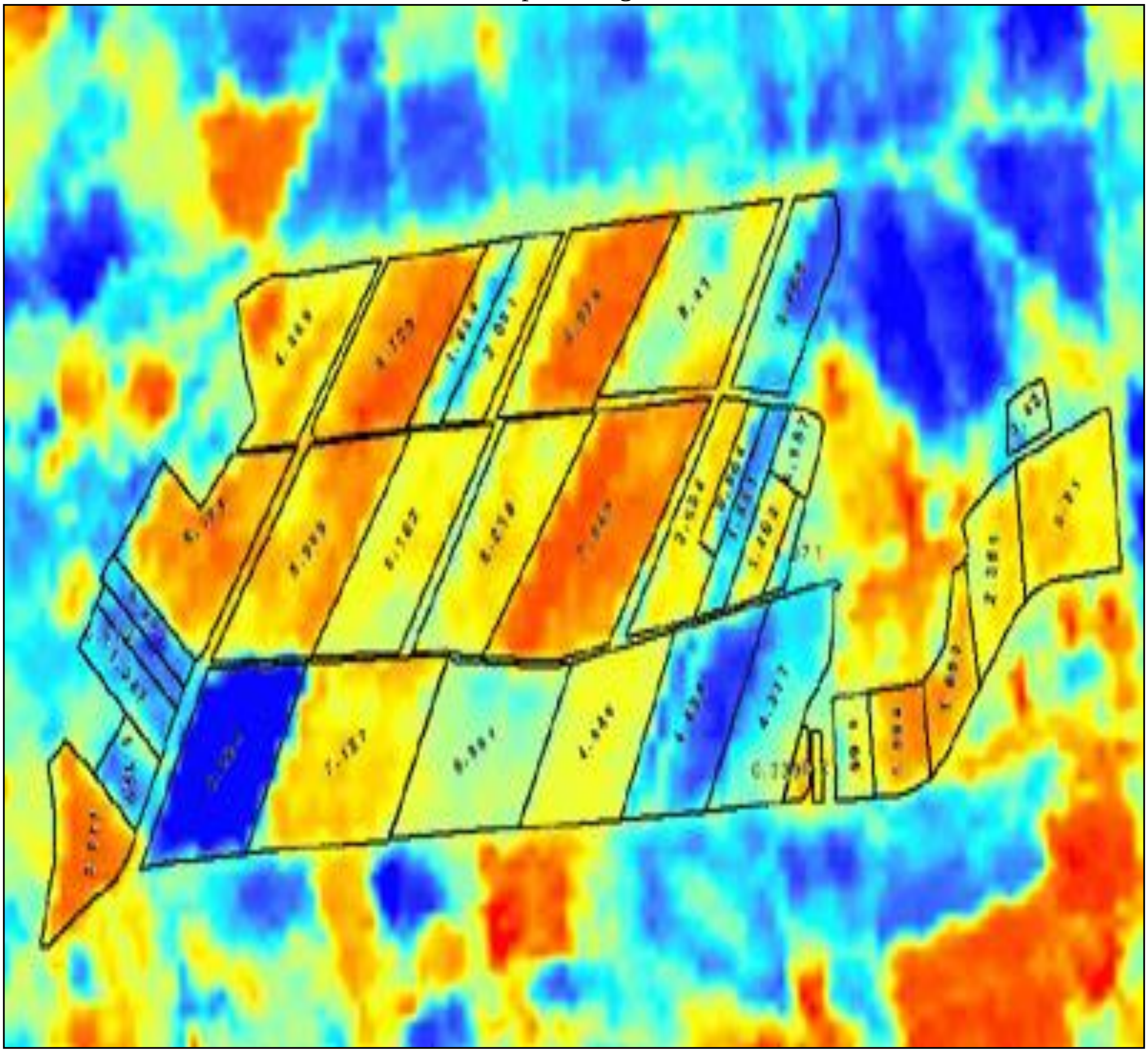
Table 3.2 - IRRISAT service in Campania region, Italy, irrigation season 2012

Irrigation district	Farmers	Plots	Extension ha
Destra Sele	353	704	1935.60
Paestum	209	416	1166.48
Sannio- Alifano	29	208	782.57
Volturno	78	465	1618.92
Total	669	1793	5503.57

Source: (Vuolo et al. 2014)

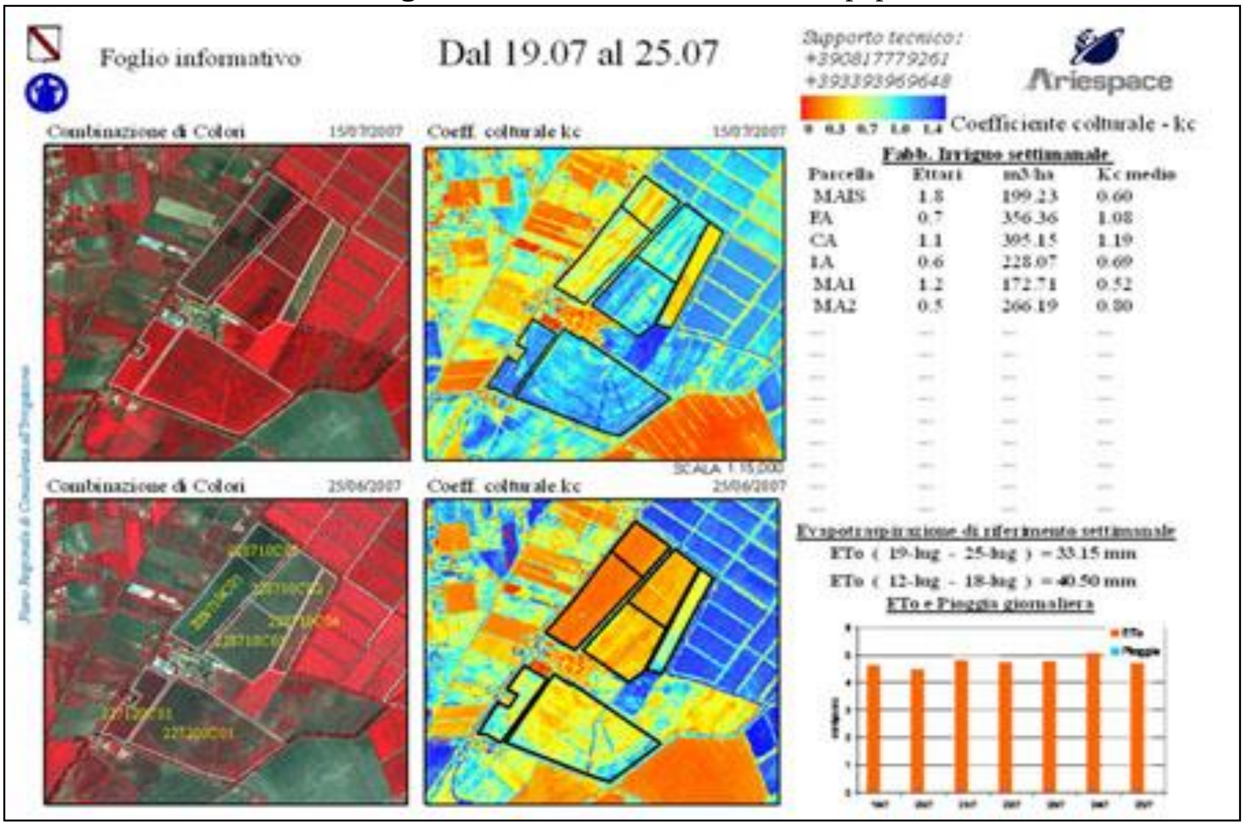
Some critical aspects of this type of system are relative high cost of the images, which in some cases, especially in small areas, can affect the cost of the service. However, the use of satellite technology in irrigation management will be in Italy in the coming years, more and more widespread. Proliferating satellites in orbit that will provide satellite images at low cost an with high resolution will ensure this popularity.

Figure 3.1 IRRISAT, Crop Coeficient (Kc) estimation at farm level in areas where the IAS is providing



Source: www.irrisat.it

Figure 3.2 – IRRISAT- information paper

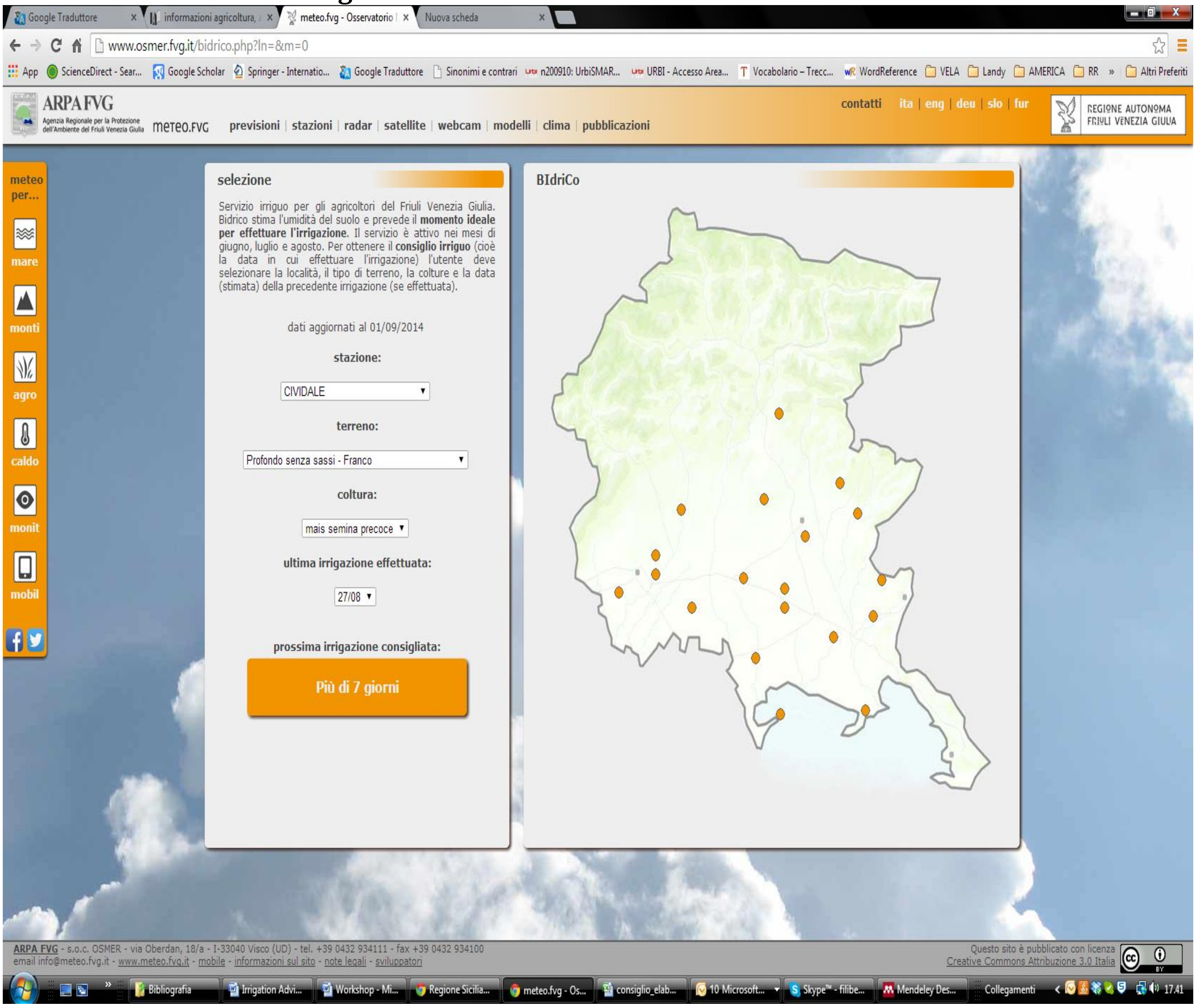


Source:www.irrisat.it

IRRINET is Irrigation Advisory Services provide by the CER (Emiliano-Romagnolo Canal Irrigation Consortium). The IRRINET project was supported by the Emilia-Romagna Region with the aim to progressively reduce water use for irrigation all over the region. The service started in 1984 is spreading in some regions of Italy, with IRRIFRAME project. The IRRINET service is freely available on Internet and provides an ‘irrigation advice’ for the main water demanding crops. The system provides a real-time irrigation scheduling: day-by-day information on how much and when to irrigate farm crops (Mannini et al. 2013). The model has a structure that is concerned with the soil-plant-atmosphere continuum. It includes the soil, with its water balance; the plant, with its development, growth; and the atmosphere, with its thermal regime, rainfall and evaporative demand. This advisory service for irrigation has

BIdriCo is service irrigation for farmers of Friuli Venezia Giulia. This IAS estimate soil moisture and foresees the right time to do irrigation. The service is available in the months of June, July and August. To obtain the irrigation advice the user must select the location, type of soil, the crops and the date of the previous irrigation (Marco Gani 2000).

Figure 3.3 – BidriCo - IAS of Friuli Venezia Giulia



Source: www.osmer.fvg.it

The project iCOLT (Classification of crops in place using Remote Sensing) is an instrument for identifying and quantifying the spatial and evaluation of crop water consumption expected (Spisn 2008)(see table 3.1 and fig. 3.4). The modelling system for the simulation of the water balance of the soil of the plains is known as CRITERIA (Territorial Control of Water Resources for the Reduction of Environmental Impact) (Marletto et al. 2005). The objective of the project is the evaluation and the definition of an operational tool applicable at the regional level to able to monitor the use of real agricultural soil on an annual scale for the management of irrigation water. The outcome of classification is provided by the end of June in order to monitor the evolution of water consumption during the summer season to greater demand for water. The main beneficiaries of the project are the Land Reclamation Consortia of Emilia-Romagna. The area of study covers the Emilia-Romagna plain for a total of about 1.180,000 ha. The classification of agricultural crops in macro-groups is through the analysis of multi-temporal series of optical images acquired by satellite planned and ad-hoc during the period between November and June.

Figure 3.4 - I COLT

Source: www.arpa.emr.it

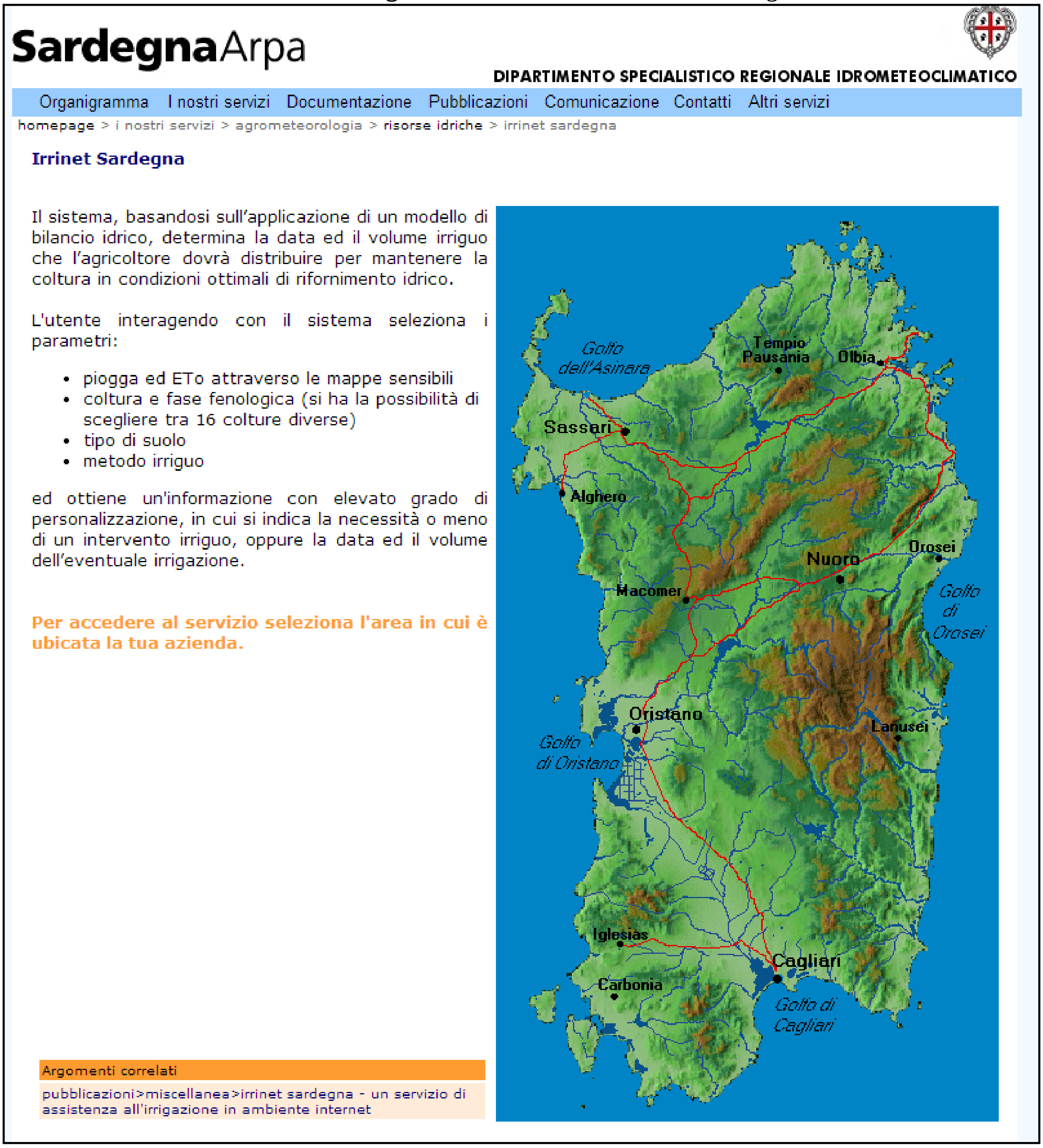
The IAS providing by Sicily region is called IRRISIAS (Drago 2003), that through inserting some data on the agronomic features and cultivation of plots of the farm give the possibility to obtain information on the time of irrigating, the water volume. The system allowed to achieve the water balance for the plot of the farm of their own interest, in each case, the user is encouraged to insert, in addition to the data, an indication of the main data for the plots of the farm for the which they want to calculate the water balance. The indication of the date of irrigating is graphically represented by a graduation of colours, ranging from light green to levels of deep red.

Another example of model of irrigation service given at the regional level is proposed by the Regional Agency for Agricultural Development Services of the Abruzzo Region, ARSAA. The model used known as IRRIGUA, is provides to the user with a customized irrigation advice in different agricultural and environmental situations. The model used involves the simulation of the water balance for 20 crops, grasses and fruit trees. The service is available through a program installable on personal computers (Lena et al. 2010; Antenucci et al. 2010).

IRRINET Sardinia is IAS providing by environmental regional agency of Sardinia Region that works for the promotion of sustainable development and the protection and improvement of the quality of natural ecosystems, ARPAS (Fiori 2005; Fiori M., Micale M. 1998). The system, based on the application of a water balance model, determines the date and the water volume that the farmer must distribute to maintain the culture in optimal conditions of water supply (see fig. 3.5). The user interacts with the system, the map on the web page, select the parameters of precipitation and ETo, the culture and its phonological state. Other parameters are the type of soil and irrigation method.

In Italy the use of IASs provide from the major agencies of the country and regional associations, is greatly facilitated by the presence and availability of services on web platforms. This facility use and easy access of open source tools, it is not recompensed by the active participation of end-users, the farmers. In fact, this type of systems requires the active participation of farmers. Very often it takes time and a large amount of data processing. These factors combine to discourage farmers to the use. Therefore, although the coverage of the service may be potentially very large, actually, the technological obstacle strongly limits its use.

Figure 3.5 – IRRINET – IAS of Sardegna



Source:www.sar.sardegna.it

3.4 STRENGTHS, WEAKNESSES, OPPORTUNITIES AND THREATS (SWOT) ANALYSIS

3.4.1 Strength

Benefits of research knowledge. In Italy the level of scientific research system for IASs, has reached very good level and is well known at national level. In the last decades in Italy it has been observed a proliferation of scientific research projects related to the management of water resources in agriculture. In particular, in many cases, these studies have been directed to the estimation of irrigation requirements for crops. The need for such a careful dissemination of alert systems in irrigated farming has coincided with both national and European agricultural policies for preservation of natural resources and in this context the water (see tab. 3.3).

Benefits of utilization IASs. Many experimental studies have provided very interesting result, for IASs that using remote sensing technologies and mathematical models for estimating crop water requirement. In fact, the use of these systems can reduce at least 20% water consumption for irrigation in agriculture, a sector that accounts for 90% of the national resource.

Capacity and competence. During the last year the public actors (regions, environmental and agricultural agencies) in some areas of the country have achieved high levels of knowledge in the use of IASs, and this deep competence could be now, transfer to all stakeholders that want to improving their use of water in agriculture (see tab. 3.3).

Good network of land reclamation and irrigation. There is a consolidated system of associations represented by land reclamation and irrigation directly involved in the management of irrigation. The ongoing activities of these organizations in disseminating information have encouraged the reduction of asymmetric knowledge and the improvement of irrigation management in the agricultural areas of the country (see tab. 3.3).

Food security and climate risk. The presence of widespread practices of collective management of irrigation guaranteed until today a better rationalization of the use of water resources and an effective response to climate – environment risk. Therefore, the support of IASs in this context is particularly useful (see tab. 3.2).

The benefits of ICT knowledge. The growing diffusion of ICT among the Italian population, and therefore also in the rural areas of the country, is an advantage, for the promotion of IASs a systems that mainly use ICT technologies to disseminate their information to the rural areas (see tab. 3.3).

Policy support systems for innovation. In the planning cycle of European policies (2014-2020), the scope of innovation and knowledge plays a central role, highlighting the need for a national strategy for innovation in agriculture, food and forestry sectors through joint actions and competitors, with the appropriate instruments of government to a sound and effective management to avoid duplication or gaps (Puliga 2014). The strategic objectives of the program under the new Common Agricultural Policy (CAP) 2014-2020 emphasize the importance of the transfer of innovation from research to the world of agriculture through farm advisory systems. In this framework will play a leading role also advisory systems for irrigation. The CAP encourages the adoption by the farm systems of advice and assistance in agricultural practices, in order to increase their level of sustainability and gain access to a share of direct payments (greening) (see tab. 3.3).

3.4.2 Weaknesses

Lack of irrigation water measurements. The IASs can contribute to the lack of irrigation water measurements by providing a model-based assessment of the irrigation water use at farm level. Although several areas are installed a wide variety of flow measurement devices, most irrigation system water measurements are not performed routinely. In addition, water measurement may be expensive or unfeasible. Even if measuring devices are installed, there are numerous reasons (from technical to socioeconomic) that prevent systematic measurements. Few information about irrigation water use are actually available for Italy, the fragmentation and the complex organization of public agencies combined with the private water abstraction prevent a complete accounting (Lupia, 2012).

Lack of accurate accounting for water in agriculture. In the water management sectors there is a lack of tools that can help farmers to value the level of their sustainability of production. In fact, farmers don't know how their water management techniques impact on environmental sector and on economic management. The water accounting should not adopt a general methodology and applies to all situations where it is required. The choice of the type required accounting of water in agriculture depends on the geographical scale at which it refers, and for which data are required. Also the temporal horizon is very important because it influences, in fact, the choice of some data rather than others for the level of analysis. In some cases, for example, it is necessary to make a measurement of the water at the farm level, in other cases it may be necessary to carry out a collection of data at the basin level. In some cases it is necessary to take into considerations data that have a very different horizon time, within the same year or an average of several years. In other cases it is necessary to estimate the amount of water needed to produce a product, in other cases that required to perform a process. Therefore, we can say that there are several approaches to the definition of water use in agriculture.

Table 3.3 – Strengths, weaknesses, opportunities and threats (SWOT) analysis

Strengths	**Weaknesses**
Benefits of research knowledge Benefits of utilization IASs Capacity and competence Food security and climate risk The benefits of ICT knowledge Good network of land reclamation and irrigation. Policy Support Systems for innovation	Lack of irrigation water measurements Lack of accurate accounting for water in agriculture Poor agricultural information on water
Opportunities	**Threats**
Improving agricultural production Increase the water management troughs the ICT Institutional mechanisms to link rural communities Improving the accuracy of fresh water indicators Advantage in water quality management through the use of IASs Large space developing opportunity for IASs applications	Low degree of education and high age of farmers High risk of leaving rural areas Low access to the information Scarcity of public finance Climate change Water shortages and drought

Poor agricultural information on water management. In Italy information addressed to farmers, to support and increase agricultural production are widely studied and deepened in organizations of different types (universities, regions, regional agency for environmental protection, etc.). In any case, all this information and knowledge are often poorly documented or difficult to access for small farmers. This results in a significant loss of opportunities for development and improvement of the agricultural context.

3.4.3 Opportunities

Improving agricultural production. 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.

Increase the water management troughs the ICT. Information Communication Technologies (ICT) play an important role in addressing these challenges and uplifting the livelihoods of the rural poor. 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. The technological development in place can ensure greater capillarity in the dissemination of information on good irrigation management to a broad group of stakeholders.

Institutional mechanisms to link rural communities. There is a deep gap between information residing in agricultural knowledge canters and rural communities. At the local level, multi stakeholder mechanisms are important to make relevant information accessible to end users. 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)

Advantage in water quality management through the use of IASs. The impact of water management in irrigation systems can have effects on water quality, are also complex and highly uncertain. 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).

Table 3.4 - Farms and Surface used in Italy, 2010

REGIONS	FARMS	SURFACE USED
Abruzzo	66.837	453.629
Basilicata	51.756	519.127
Calabria	137.790	549.254
Campania	136.872	549.532
Emilia-Romagna	73.466	1.064.214
Friuli-Venezia Giulia	22.316	218.443
Lazio	98.216	638.602
Liguria	20.208	43.784
Lombardia	54.333	986.826
Marche	44.866	471.828
Molise	26.272	197.517
Piemonte	67.148	1.010.780
Puglia	271.754	1.285.290
Sardegna	60.812	1.153.691
Sicilia	219.677	1.387.521
Toscana	72.686	754.345
Trentino-Alto Adige	36.693	377.755
Umbria	36.244	326.877
VALLE D'aosta	3.554	55.596
Veneto	119.384	811.440
Italia	1.620.884	12.856.051

Source: ISTAT, 2010

Large space developing opportunity for IASs applications. As shown by the data collected during the general agricultural census of 2010, which provides a basis of complete information on the structure of the agricultural system at the national, regional and local level (ISTAT 2010), the opportunities for spread of the IASs are very high. In this context the analysis of census data regarding to the farms that use irrigation advisory systems in Italy helped to well identify the state of the diffusion of these systems.

The most farmers that use the largest irrigation services are primarily focused in the northerly regions (Lombardia, Emilia Romania, Trentino Alto Adige and Veneto). These four regions, with a total area of irrigated 926,762 hectares, representing one third of the total area of irrigated land (2 418 920,7 ha). While three of the four regions that employ a lesser extent services for irrigation are concentrated in the center and south of the country (Molise, Marche, Abruzzo and Basilicata), which is higher than the risk of drought.

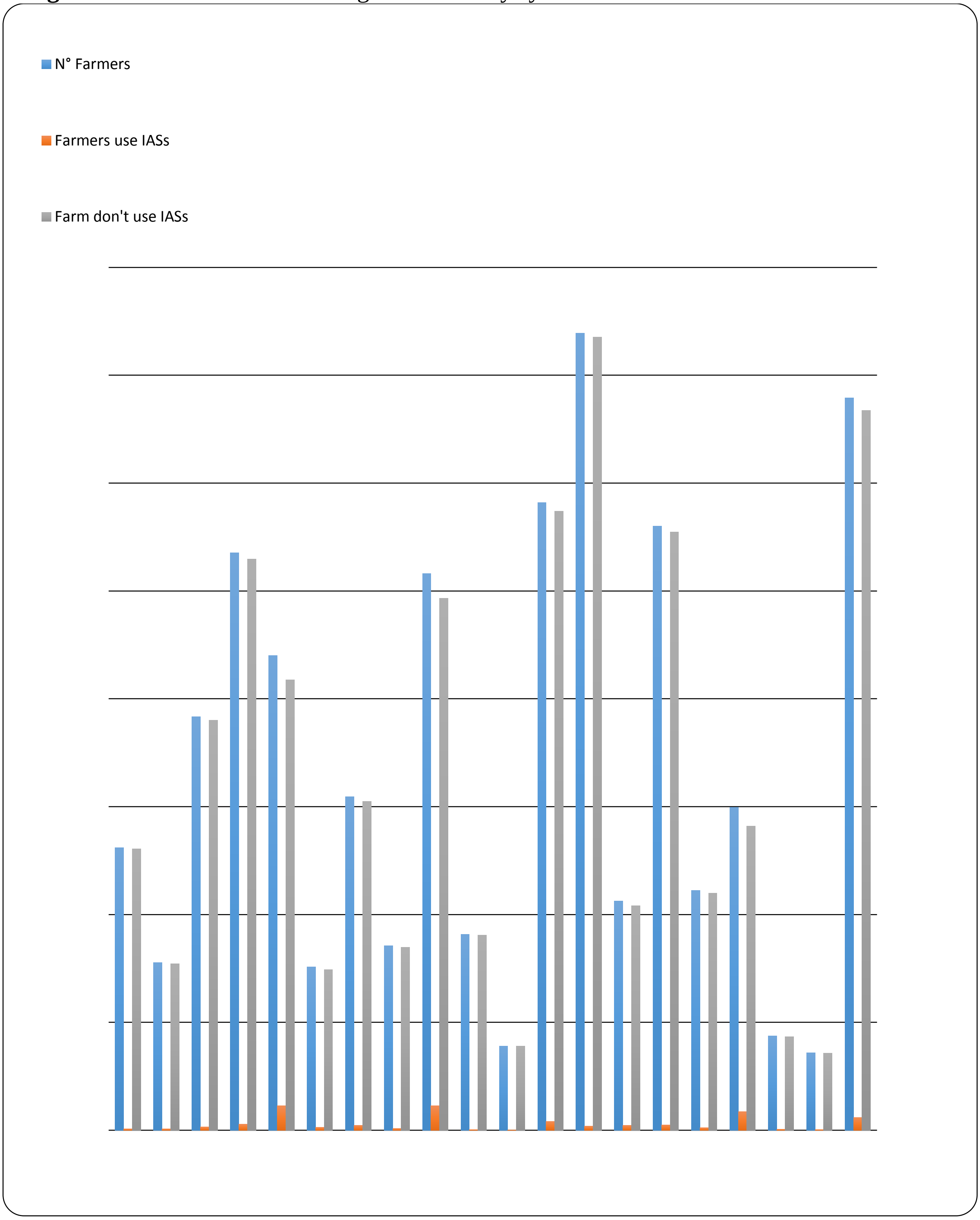
In addition, incidence of use of the IASs than the number of total farms shows a general and very limited use of these services at the national level, 98% of farms with irrigation systems in Italy does not use Services Consulting irrigation in their production systems. The limited numbers of farmers that make use of IASs bring out great opportunities for development and promotion of this type of assistance within the agricultural sector in Italy.

Table 3.5 - Irrigated total surface in Italy, 2010

Regiones	Irrigated total surface
Valle d'Aosta	15 247.55
Liguria	5 183.61
Lombardia	581 713.88
Nord-ovest	**968 404.23**
Trentino Alto Adige / Südtirol	61 150.41
Provincia Autonoma Bolzano / Bozen	41 323.55
Provincia Autonoma Trento	19 826.86
Veneto	242 053.12
Friuli-Venezia Giulia	62 838.18
Emilia-Romagna	257 300.12
Nord-est	**623 341.83**
Toscana	32 521.76
Umbria	20 011.11
Marche	16 247.11
Lazio	76 322.51
Centro	**145 102.49**
Abruzzo	29 145.11
Molise	10 708.71
Campania	84 942.74
Puglia	238 545.72
Basilicata	33 791.27
Calabria	74 756.52
SUD	**471 890.07**
Sicilia	147 162.91
Sardegna	63 019.17
Isole	210 182.08
ITALIA	**2 418 920.7**

Source: ISTAT, 2010

Figure 3.6 - Farmers that use irrigation advisory systems on the total number of Italian farmers



Source:ISTAT, 2010

Table 3.6 - Utilization of irrigation advisory systems by farmers on total of Italian farmers

Regions	N° farms	Farms use IASs	Incidence %
Abruzzo	52.404	226	0,4
Basilicata	31.092	234	0,8
Calabria	76.651	599	0,8
Campania	107.039	1.104	1
Emilia - Romagna	88.029	4.507	5,1
Friuli Venezia Giulia	30.301	530	1,7
Lazio	61.878	926	1,5
Liguria	34.220	303	0,9
Lombardia	103.221	4.550	4,4
Marche	36.332	119	0,3
Molise	15.609	27	0,2
Piemonte	116.412	1.631	1,4
Puglia	147.821	719	0,5
Sardegna	42.544	893	2,1
Sicilia	112.001	1.013	0,9
Toscana	44.452	456	1
Trentino Alto Adige	59.843	3.486	5,8
Umbria	17.507	168	1
Valle D'Aosta	14.375	79	0,5
Veneto	135.843	2.344	1,7

Source: ISTAT, 2010

3.4.4 Threats

The threats that can be identified are mainly attributed to both aspects social and technological. Regarding the social aspects, the development threats to the spread of the IASs it should be noted by low level of education and high level of age of farmers. In recent years, this aspect is responsible for determining the leave of the rural areas.

All above mentioned aspects are in contrast with the information about correct water management that often are delivered by use of ICT tools. The low education level and the high age of farmer are often an obstacle to ICT tools use. This inclination, in many cases, has represented a large problem of improving the IASs at local level.

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

3.5 DISCUSSION AND CONCLUSIONS

During the last years the environmental risks link to the water in agriculture are increasing. Droughts are common in Italy during the cropping seasons, floods are common in different areas of the central and north Italy especially during spring and autumn seasons. Currently, tourism industries, environmental groups, electrical company 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 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 for well understands that bigger proportions of the national territory and a large number of farms do not utilize IASs. The low adoption of this service represents a very great opportunity to increase the use of IASs in this country.

However, the concentration of population over 65 years is very high in rural areas, and increases in time (Trapasso R. 2009). The aging population is a national trend. In Italy in 2006 the ratio of the population over age 65 and those under 15 years was 141/100, the highest value in the OECD, after Germany and Japan. 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 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.

Finally, 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 companies that do not fall within the areas covered by land reclamation and irrigation.

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CHAPTER IV
USE DISCRETE CHOICE MODEL TO ANALYSE THE WILLINGNESS TO PAY FOR SATELLITE BASED ON IRRIGATION ADVISORY SERVICES

ABSTRACT

The present research by the use of discrete choice model (CM) has analysed the willingness to pay for satellite based irrigation advisory services in an area of Italy effects of intensive use of water for irrigation. One original aspect of our study concerns the case study area where our work has been implemented. In fact, several studies that used CM have been implemented in agricultural areas and considered water resources management, but we do not fund studies concerning the irrigation advisory service (IAS), specially characterized by a i) highly innovative and technological value offering by the use of Earth Observation (EO) techniquesfor water saving. The study was carried out in the Campania region in area of Italy covered by IAS called IRRISAT. In 2013, the service has provided support for three Irrigation and Land Reclamation Consortia (ILRC), with 669 farmers and extension of 55.03,57 hectares. Based on these considerations, the specific aims of this work has been i) to analyse the importance of technological innovation in theagricultura water management ii) to define throughout the use of choice experiment (CE) the preferences of the farmers regarding the main characteristic, attributes, of the IRRISAT, iii) to analyse marginal willingness to pay for this service. The results have shown the general appreciation for IRRISAT, needs receive simple and complete information about the whole farm. In fact, farmers do not consider one field less important than others. Concerning water saving this study has shown a lack of attention to this aspect. In fact, this attribute was not considered decisive for the choice of the service of irrigation. They agree with the needs of IAS, but have shown more attraction for other aspects like duration of the contract; the study has highlighted the propensity of farmers to longer choice, the three-year contract. Probably the contractual aspect that is frequently considered one obstacle in the supply of services, in that case it does not seem to have this effect, but more interest in the farms gone to the easy access to the service that they feel good and useful. Finally, regarding the price of the service the range of price proposed is seems acceptable for the farmers, especially when the price has been lower.

4.1 INTRODUCTION

Today is widely accepted in the scientific community at the political level between farmers the need for a more rational direction of rational irrigation management. Emerging necessity regarding better allocation of water and its efficiency in the agricultural sector are the primary drivers to face the need of improving demand and supply of water for irrigation. In recent years large parts of the stakeholders (farmers, land reclamation and irrigation, research centers, etc.), have begun to seriously consider the need to exact action and tools to optimize the water for irrigation. Unfortunately, in many cases, even though the science has produced notable studies for the rational use of irrigation, the transfer of results to the agricultural world has been insufficient. However, in recent years a new way to undertake more research-oriented application results ensured a greater dissemination of the outcomes of the agricultural world. In particular, in Italy has been observed a rapid growth of irrigation advisor services (IASs) to help farmers to manage the irrigation. In this framework the IASs represents today very good instruments for improving the water efficiency and water productivity for several users.

In this regards, very interesting examples of IASs have been produced in Italy during the recent years. One good instance is provided by Friuli Venezia Giulia Region is called BIdriCo, the service that works during the summer season (Marco Gani 2000), implement the soil moisture and foresees the right time to do irrigation. The Emilia Romania Region provides several IASs i) I COLT, classification of crops in place using remote sensing, that carry out classification of crops in place using remote sensing provide the water requirement estimation of an area (Spisn 2008). Another very interesting service widely used in this region is ii) CRITERIA, territorial control of water resources for the reduction of environmental impact, (Marletto et al. 2005). iii) IRRINET an expert system for irrigation scheduling developed by the CER, Canale Emiliano Romagnolo (Mannini et al. 2013), the system provides a real-time irrigation scheduling, day-by-day information on how much and when to irrigate farm crops. The service started in 1984, on the videotext network, and currently, IRRINET is spreading in other 6 Regions of Italy, with IRRIFRAME project, (Rossi, F. e Mannini 2012). The use of IASs in Italy, Campania Region, has achieved a high grade of specialization. IRRISAT is IAS based on the use of EO techniques, operative since 2007. The service has provided its help to 669 farmers, during irrigation season 2012, covering about 5503,57 ha (Vuolo et al. 2015).

Based on these considerations, the aims of this work are i) to analyse the importance of technological innovation in the agricultural water management ii) to define throughout the use of Choice Experiment (CE) the preferences of the farmers regarding the main characters, attributes, of the IRRISAT. iii) To analyse marginal willingness to pay for IRRISAT.

In what follows, section 2 describes the importance of water demand management instruments in the context of innovation. Section 3 describes the methodology, case study description (3.1), in this section IRRISAT, IAS analyzed (3.2). Section 3.3 describes the CE methodological background, statistical model (3.3.1), choice experiment for IRRISAT in the section 3.4 and survey operation and data collection (3.4.1). Finally, section 4 presents results, whilst section 5 concludes.

4.2 WATER DEMAND MANAGEMENT INSTRUMENTS: IMPORTANCE OF INNOVATION

In the context of the European Union has policies to promote innovation as a method to improve labor productivity and the competitive position in a rapidly changing world. This also involves the agricultural sector and food production (AKIS SCAR 2012).

The innovation in the agricultural framework is defined as progress of the actual situation, development of the product and process with particular regards to the method. In the future policy strategy " Europa 2020", the European policy for the rural development 2014-2020, innovation will be one of the main milestones. In these political context the main aims are improving the competitiveness, the efficient management of the natural resources and the environmental performance of the food chain and economic aspects of the rural systems. More specifically in the context of agricultural water management the introduction of the farming system can contribute to improving the water allocation at farm level. In this regards with high step of economic benefit for the farmers that thank to the right allocation of the water resources can use less water, and face the water scarcity problem that is common in the Mediterranean area, but, also, convenience in economic terms due to less energy for pumping water for irrigation.

In the framework of innovation, the aspects relative to the transfer of innovation are very important for well know what are the primary drivers for its widespread. The most shared systems for the dissemination of the innovation is imitation. The farmers chose to adopt one specific solution improving their system when they can appreciate the success of its introduction in the productive system. The first incentive to the innovation comes from the benefit of the income. In this regards both in terms of improving of the production and/or in terms of reduction of the cost. Therefore, the introduction of the innovation representing an economic investment, for facilitating its diffusion the

risks linked to the failure should minimized. To do so the innovation transfer should fail more quickly.
The EU's rural development policy helps the rural areas of the EU to fill the entire scope of challenges and opportunities that confront them in the 21st century – economic, environmental and societal. Recognized as the "second pillar" of the Common Agricultural Policy (CAP), it has been improved in the period 2014-2020 through the process of wider CAP reform, via a number of legislative enactments. The implementation of the "Europe 2020" strategy, European policy for rural development from 2014 to 2020, contributes to the growth of a knowledge-based economy by promoting the transfer and agricultural knowledge. These policy directions are materialized at the stratum of the member states of the european community, through initiatives fund aimed at sustaining the utilization of new technologies and dissemination of new products developed. More and more farms have the demand for innovation in their production operations. Therefore, it is very important to start of production processes, innovation, encouraging the development of innovative products and services for agriculture sector. In this conceptual framework, the publication of environmental sustainability and the appropriate and efficient use of natural resources in agriculture is a top priority, first of all water for irrigation (Paul Courtney, Stephen Gardner, Derek McGlynn, Edina Ocsko & Alex Papakonstantinou, Mark Redman, Angelo Strano, Justin Toland, Peter Toth 2013).

4.3 METHODOLOGY

4.3.1 Italy, case study description

The Campania Region, located in the south west of Italy is the case study region. It has heterogeneous physical characteristics: about half of the total area (50.8%) are hills, 34.6% are mountainous and only 14.6% are plains. In 2012, the population living in Campania was equal to 5,769,750 million units, this region has the highest density of population not only in the South, but throughout Italy, it is in fact the second most populated region after Lombardy. There are also imbalances in the distribution of population on its territory as densely populated urban areas are contrasted with other sparsely populated or even uninhabited. The Utilized Agricultural Area (UAA) represents 40.2% of the regional total area. This value is slightly lower than the national average (42.6%) but significantly lower than that of the district of the South (49.3%).
The Sixth Italian Census of Agriculture (October 2010) indicates 136,872 farms, livestock and forestry in Campania, with a total area of 722,687 hectares, of which 549,532 of the UAA.The distribution of farms and relative surface shows a particularly accentuated presence of micro-farms,

in fact, there are 51,665 farms (37.7% of the total) that have less than one hectare of UAA, with a coverage of 5.1% UAA. Furthermore, all the farms with less than 5 hectares account 82.8% of the total, which corresponds to a share of 30.1% of the UAA. On the other hand the farms over 100 hectares of UAA, while representing only 0.21% of the total, account for 14.4 of the UAA. 97.2% of the farms are directly conducted by farmers and in terms of UAA farms owned directly account for 85% of the total agricultural area, while farm employees are 2.4% of the total and cover about 7% of the regional UAA (ISTAT 2010).

Farms with rented land are only 7.2% of the total, covering 11.8% of the UAA, while most of the farms (71.4%) are in property, and cover about 50% of the UAA. The most important form of land use is the arable land which covers 48.8% of the UAA. Followed by permanent crops (vines, olive trees, fruit trees) that cover 28.7% of the UAA. Finally, horticulture covers 0.6% of the agricultural area while the permanent pastures and meadows cover about 22% of the UAA. The farms engaged in the breeding of cattle are 22,182 (16.2% of the total) and most popular are cattle farms (42% of farms, with about 183,000 heads), sheep (14.3% of the farms and about 181,500 heads), pigs (8.3% of breeding farms and about 86,000 heads). The buffalo farms account 6.4% of the total with 261,500 animals.

The study area covers three Irrigation and Land Reclamation Consortia (ILRC), Destra Sele, Paestum, Sannio Alifano of Campania Region (Italy) (Table 4.1) . The “Consorzio di Bonifica Sannio Alifano” sites in southern Italy, north of the Campania Region. The administrative area measures 194.937 hectares. The irrigated surface measures 18 970 hectares. The irrigation perimeter is organized into two irrigation districts, i) dx Volturno and ii) sx Volturno. Both districts are divided into irrigation sub-districts. Main water resources are selected from the Volturno and Lete rivers this allows water to be supplied to the entire irrigation perimeters, also using several pump stations along the network. The different types of irrigated surface (under pressure and gravity) allow different irrigation types at farm level, with different degrees of efficiency. The most effective system is represented by sprinkler irrigation, in recent times, drip irrigation, more efficient, is being applied to tree crops too, and the lowest by the border and furrow system. The range of efficiency is especially for sprinkler irrigation and border and furrow system, associated with the different local conditions and soil properties. The most common crops in Sannio Alifano are field crops cycle spring - summer, tobacco and maize, which constitute 36% of the UUA. The other irrigated crops widespread within the district of the consortium are the vegetables. The vineyards and olive oil are very common, but are not irrigated regularly.

ILRC of Paestum is located in Salerno Province of Campania Region. The administrative area comprises 100.605 hectares. Irrigation infrastructures are present in an area of 12.000 hectares. The main irrigation water supply is from the Sele river. Destra Sele is located Salerno Provice of Campania Region. The total area covers 70.963 hecaters Irrigation infrastructures are present in an area of 16.375 hectares. The main irrigation water supply is from the Sele river. 31% of the UAA are irrigated, mainly cultivated with field crops in the crop cycle spring and summer vegetables. This irrigation district lies in an area of the richest part of the water due to the presence of the river Sele. The great flood plain within the ILRC is very fertile, so agriculture is very productive.

Table 4.1 – Irrigation and Land Reclamation Consortia (ILRC)

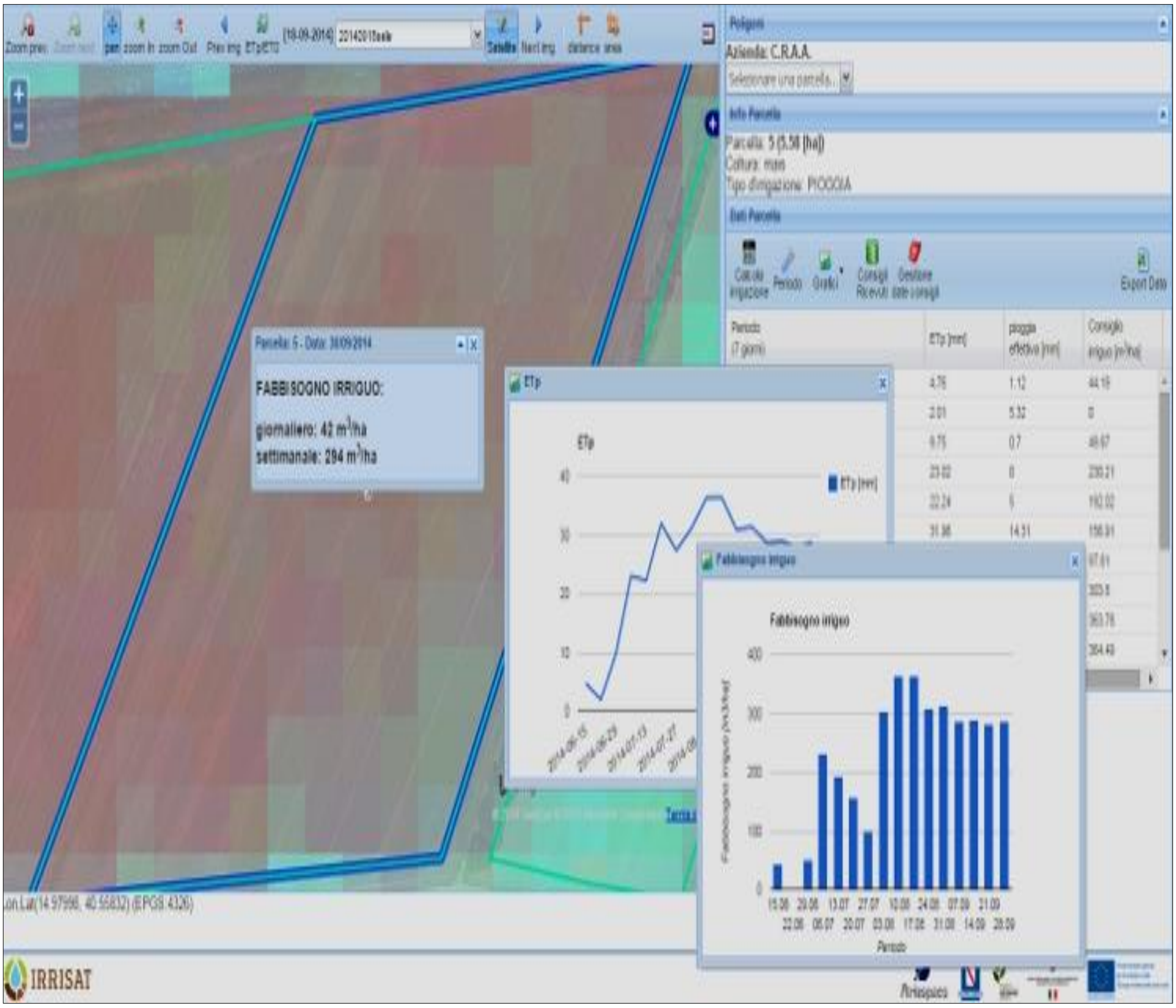
ILRC	Irrigation infrastructures (ha)	Administrative area (ha)	N° of farmers under irrigation service (ha)	Province
Sannio Alifano	18.976	194.937	35.000	Avellino, Benevento, Caserta
Paestum-Sinistra del Sele	12.000	100.605	7.000	Salerno
Destra Sele	16.375	70.963	6.331	Salerno

Source: Irrigation and land reclamation Consortia

4.3.2 Irrigation advisory service of Campania Region

IRRISAT (www.irrista.it) is IAS supported by Rural Development funds of the Campania. The service is based on near-real time distribution of EO products (Vuolo et al. 2015) and has been active since 2007. During its application has been evidenced to be a valuable tool to support the decisions the main users of water for irrigation. In some events, the water savings obtained by a careful irrigation were considerable, 20-30 %. The main product of this service is mapped of crop water requirements, irrigated areas, that are aggregated at different temporal scales as weekly or monthly and at different land management units like field, farm, district (Figure 4.1).

Figure 4.1 - IRRISAT



Source: Ariespace s.r.l.

In 2013, the service has provided support for ILRC, with 669 farmers and extension of 55.03,57 hectares (Table 4.1).The information on the amount of water used for irrigation is given out to farms via SMS, MMS and email, as well as on the Internet. In this last case, the service is delivered through the arrangement of dedicated pages for each farm and ILRC afferent to the advisory service. This decision support system (DSS) has been considered in Italy, both at the national and regional level a valuable tool support decisions for farmers. During its works main beneficiaries were farmers, small and large scale factory farm and water managers at irrigation scheme or catchment level, authorities in charge of water management (such as river basin authority, government), national irrigation plan monitoring office.

Table 4.2 - Summary of IRRISAT service in Campania region, Italy, irrigation season 2012

ILRC	**Farmers**	**Plots**	**Extension ha**
Sannio Alifano	29	208	782.57
Paestum	209	416	1166.48
Destra Sele	353	704	1935.60

Source: Ariespace s.r.l.

4.3.3 Methodological background and choice modelling techniques

The benefits derived from the application of IASs, as an entire component of the DSS, have been developed to increase the decision-making process and reduce the information gap between the players involved. Moreover, thanks to understand how the development of acceptable policies for the management of water resources should first of all start by stakeholders and by the perception of utility that they can benefit from the introduction of DSS for irrigation. These tools today are an appreciated resource on improving the management of water resources and increase economic benefits obtainable from agriculture (de Santa Olalla Mañas et al. 1999). In recent years, the economic component relating to the role of DSS. In particular, the cost - economic benefits derivable from both farmers and water managers has become to be more relevant. Underlying this growing attention is need to understand what is the marginal utility that the user can have in adopting this type of systems that necessitate a very high commitment in terms of knowledge of the user.

In general, in this study we seek to know how we could improve the use of IASs a national level, analysing one of the most efficient IAS in Italy, IRRISAT. We have carried out this study throughout use of economic tools as choice modelling (CM). To do so we were evaluating the farmer's preference and the marginal willingness to pay (WPA). The methodology used in the CM was adopted to evaluate preferences of stakeholders with respect of numbers of aspects related to the providing of irrigation. In particular, the appearance of the cost of the service and the economic benefit obtainable with respect to certain choices.

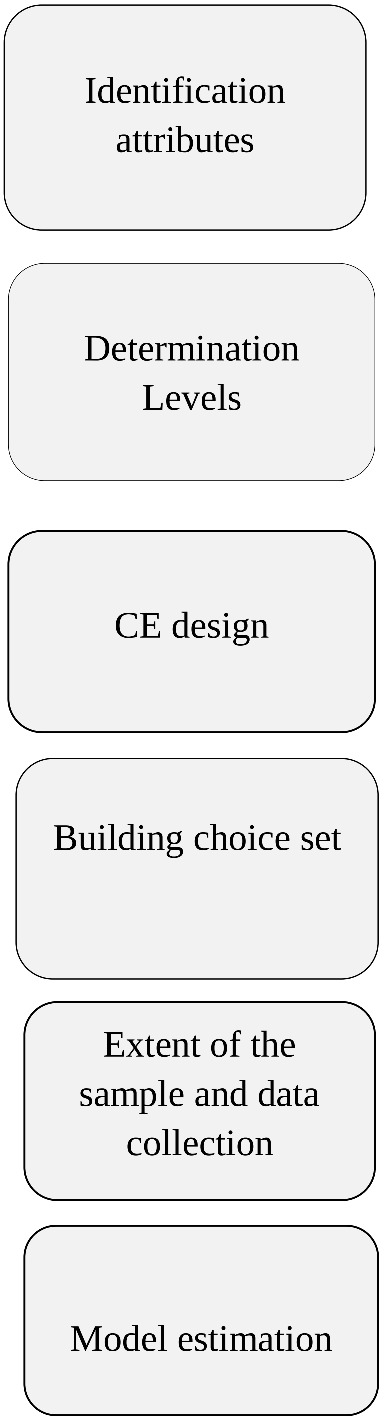
The use of the techniques of CM are the way forward for environmental valuation (Hanley et al. 2001) and are very appropriate for the analysis of water resources in the context of environmental economics.

CM is widely used in the social sciences and transportation studies to analyse decisions made by individuals (Imai & Van Dyk, 2005). Regarding the specifics of these approaches, CM is family of survey based methodologies for modelling preferences for goods, where goods are described in terms of their attributes and the levels of that these attributes take. Respondents are presented with their attributes and for modelling preferences for goods, where goods are described in terms of their attributed and of the levels that these attributes take. The response is presented with different alternative descriptions of good, differentiated by their attributes and levels, and are asked to rank the various alternatives, to rate them or to choose their most preferred. By including price or cost of one of the attributes of the good, WTP.

Choice Experiment (CE) is a Stated Preferences Method (SPM) widely used for monetary environmental evaluation (Birol, Ekin, and Phoebe Koundouri 2008). CE is part of the CM family that includes contingent ranking, contingent rating, paired comparisons. This method is based on the notion that any environmental good can be described in terms of its characteristics, or attributes, and the levels that these attributes take (Lancaster 1966). Using the CE is a flexible and pragmatic approach to defining trade-off between more complex attributes. A CE is composed by a set of determinate stages . Once attributes and their levels are identified, experimental design theory is used to generate different profiles of the environmental good in terms of its attributes and levels these attributes take. These profiles are then assembled in choice sets, which are presented to the respondents, who are asked for their preferences were in multiple occasions.

A CE is composed of 6 stages (Figure 4.2). The first step is identify the relevant attribute of the good to be of value. Generally at this stage literature review and focus groups are used to select attributes. One of the attributes which is typically included in a choice experiment study is a monetary cost/benefit attribute. The monetary attribute and the random utility framework on which the CE method allows for the estimation of welfare estimates, IE, WTP or willingness to accept (WTA) compensation, for changes in the levels of environmental attributes (Hanemann 1984). Second step consists in assignment of levels. The CE design, is the third step. Statistical design theory is used to combine the levels of the attributes into a number of alternatives to be seniors or profiles presented to respondents. Four step, consit in to the construction of choice sets the profiles identified by the experimental design are then grouped into choice sets to be presented to respondents. Stage five is the measurement of the preferences, here the choice of a survey

Figure 4.2 - Flow chart choice experiment



Procedures to measure individual preferences: ratings, rankings or choices. Finally, stage consists to estimate procedures. Variables that vary across alternatives do not have to be interacted with choice - specific attributes. (Pearce et al. 2006). The CE relies on the basis tecnhnique idea that an individual can chose, maximizing utility, choice between sets including different attribute levels. Utility is derived from characteristics which possesses a good rather than from the goods per se (Karimi et al. 2013) . Specifically, the CE can provide four types of information about the values of environmental goods: (i) Which attributes are significant determinants of the values that stakeholders (local or national public, farmers, recreational visitors to a site) place on environmental goods; (ii) the implied ranking of these attributes amongst the relevant stakeholders; (iii) The value of changing blackberries than one of the attributes at once; and (iv) the total economic value of an environmental good (Bateman, I. J. 2003).

4.3.4 Statistical model

In 1974, (McFadden 1974) has developed the Conditional Logit Model (CLM), the most common method for CLM. With which we determine the probability of selection of a given individual, in respect a choice rather than another. Adoption of CLM has provide to predict the influence of the choice of the individual. In particular, for both the attributes of the alternatives provided for both the characteristics of the subject, levels.

The model assumes that the individual chooses between them alternatives obtaining utility

J – th, chosen equal to:

$$U_{j,n} = v_{j,n} + u_{j,n} = \sum_{h}^{H} \beta_h x_{j,h,n} + u_{j,n} = \mathbf{x\beta}_{j,h,n} + u_{j,n} \qquad (1)$$

Where

- $U_{j,n}$ Utility deriving from the consumption of the good 'j' individual 'n'.
- $v_{j,n}$ Observable component of the utility deriving from the consumption of the good 'j' individual 'n'.
- $\upsilon_{j,n}$ Stochastic component and not observable deriving from the consumption of the good 'j' individual 'n'.
- $x_{j,h,n}$ attribute observable ‘h’ to the arternative ‘j’ for consumer ‘n’.
- β_h Estimable parameter indicating the effect of the attribute 'h' on the utility of the consumer.

- β A column vector (h x 1) of parameters estimated.
- X A row vector (1 x H) of the parameters relating to the attributes of the product.

To maximize the utility, it is assumed that the consumer will choose the alternative with the attributes most preferred. Consequently, the probability that the individual chooses alternative j is defined by the probability the utility associated with that choice is greater than or equal to the usefulness of any alternative different

from j :

$$\Pr(U_{j,n}) = \Pr(U_{j,n} \geq U_{\neq j,n}) \qquad (2)$$

Moreover, if the residue i $\upsilon_{j,n}$ are IID (independently and identically distributed) with an extreme value distribution of type I (Type the Extreme Value), then the probability of choice is:

$$P(Ujn) = P(Yjn = 1) = \frac{\exp^{\beta' X_{ij} + \alpha_j Z_t}}{\Sigma_{k=1}^{m} \exp^{\beta' X_{tk} + \alpha_k Z_t}} \qquad (3)$$

Where

Zt - are specific variables related to individuals

XTJ - vector of values for the attributes of the i-th choice as perceived by the t-th individual.

A similar argument can be made, in case the individual will not be asked to choose the preferred alternative in a set of choice but to order the products available from most preferred to least preferred. Even in this context of choice, under the assumption that errors are IID and distributed as variables, extreme value type I. The CLM shown above can be extended to the case of a complete or partial ranking (Bunch, D. S., Bradley, M., Golob, T. F., Kitamura, R., & Occhiuzzo 1993). In fact, the complete ranking of alternatives p can be interpreted as a sequence of p-1 favourite choices independently. In other words, the consumer selects his favourite product in a set of my alternatives, he chooses the product which maximizes its utility, in a set of alternatives m-1 and so on.

In this case the probability of the ranking becomes:

$$\Pr(U_{j^1,n} \geq U_{j^2,n} \geq \ldots \geq U_{j^p,n}) = Pir = \prod_{j=1}^{p} \frac{\exp^{\beta' X_{ij} + \alpha_j Z_t}}{\sum_{k=1}^{m} \exp^{\beta' X_{tk} + \alpha_k Z_t}} \quad (4)$$

Where

j = position into

r = sort

With this formulation, the logit estimate for p choices ordered simply becomes the joint event of p separate CLM. The major advantage shown by (4) and, especially, by (5) is represented by the ease of the estimate due to the shape calculation closed for Pij and Pir.

This facility, however, hides a highly restrictive assumption that is represented by the properties of independence of irrelevant alternatives. This implies that the odds ratios (ratios probability) for selecting the i-th and j-th, are equal to exp (Ui) / exp (Uj), and therefore do not depend on the number of alternatives present. Consequently, also an expansion of the set of considered choice, provide the same value of that joint probability. This evidence implies, as highlighted by (Gerard DEBREU 1984) for the model originally proposed by (Luce 1959) predicts that this conditional probabilities high for products that are perceived as substitutes rather than as alternatives.

Some efforts to overcome the limitations described were represented by the logit model and the multinomial probit. (Hausman & Wise 1978)In the first developed by (Hausman & Ruud 1987) it is expected that each rank has a different heteroskedasticity. This allows you to model the uncertainty of the value of the expected utility of the alternatives, thus exceeding the ownership independence of irrelevant alternatives (Bhat 1995). Very similar to as in (4), the probability of choice in this case is calculated in the following

$$Pir = \prod_{j=1}^{p} \frac{\exp^{\omega_j \beta' X_{ij}}}{\sum_{k=1}^{m} \exp^{\omega_j \beta' X_{tk}}} \quad (5)$$

Where ω_j = scala parameter $j = 1,....,p$

Given this, normalizing the scale parameter ω_j for the product in the most preferred (rank=1), is right except that the other parameters are greater than 1 (Layton 2000). Finally, have been developed different techniques to perform these estimates through simulation procedures (McFadden 1986), the resolution of the model is still problematic when the number of choices is greater than 4 (Bergland O. 2001).

Regarding WTP, if it is assumed as the function (1), which expresses a preference linear utility of the consumer for the good in question, the trade off between a generic attribute and the monetary expresses the marginal willingness to pay for the specific attribute according the relationship WTP = - β_{nm} / β_{m},, where β_{nm} and β_{m} are respectively the coefficient of the attribute non-monetary and moneta

4.3.5 Choice experiment for IRRISAT

In our case study CE was applied to set the marginal willingness to pay (WTP) for IRRISAT service. The method was applied whit use of conditional logit model.

The CE was conducted for farmer reply to investigate how the different service supply of IRRISAT. The first attribute is correlated to perfect and examine how farmers answer to IAS different options and price, we have to propose four attributes (Table 4.3). The first attribute is related to land management unit for IRRISAT. Actually the service is supplied for tree at different levels, farm area, plot area, and land parcel to meet the needs of different users.The second attribute proposed three levels of percentage water saving (5,10,30%) that could be obtained at different price of service selected.The third attribute proposed offers three prices, euro for year, for IRRISAT service (Table 4.4). The price of the IAS (cost attribute) set as the price that the farmers have to pay for to achieve a required level of service by irrigation advisor IRRISAT. The price of IAS is between 6 and 10 euro/hectare for year. The price range offered in the set choice is based on options shared with the core group of the users during the building of choice set, and the experience matured during previous research project implemented in this area of Italy. In particular on the PLEIADEeS EU project (www.pleiades.es) and SIRIUS (www.sirius-gmes.es). Finally, not less significant has been the opinions of IRRISAT partners' in determining the right range of monetary values. During the survey in the study area were carried out a qualitative review by some opinion leaders between (farmers, agronomist etc.), In order to identify the attributes that principally characterize the appreciation of IAS, and undertaken to check the validity of the experimental design. In this regards, some changes were made before conducting the actual choice experiment.

Last attribute was related to the duration of the IAS, the duration of service was proposed for one, two or three years. The three levels of services to the farmers give the possibility to choose the best time for service providing.

4.3.6 Survey operation and data collection

The survey implementation was collected from farmers that are in areas covered by ILRC of Sannio Alifano, Destra Sele and Paestum, between April - Agust 2014 using face-to-face interviews . The survey was administered to a sample of 115 farmers by questionary. 15 farmers did not fully complete the interview and were later rejected from the analysis of results.

The questionary consist in four main sections. The first section contains questions on general aspects of farming. In particular regarding age of owner of the farms, total surface of farms, UAA. Furthermore, an additional question was placed on the form of ownership of the land used as UAA (landholder, leaseholder).Regarding the water supply methods it was asked to choose between more common irrigation methods (sprinkler, drip irrigation etc.).

The second section of the questionnaire concerned the attitude to change and to 'innovation with special regard to the type of investments made in the past five years (purchase of machinery, land acquisition, building etc.).

Table 4.3 - List of attribute levels of the choice set

Attribute	Levels
Land management unit service	Farm area
	Plot
	Land parcel
Water saving	5%
	10%
	30%
Prize (euro/ha for year)	6
	8
	10
Time of service	One year
	Two years
	Three years

The third part of the questionnaire was instead based on the choices of the farmer than consulting services to irrigation. In this regard have been proposed a range of options for the provision of consultancy service to irrigation. Finally, in the fourth part of the questionnaire it has been included willingness adoption of innovation, with particular attention for sustainable innovation. In particular, it was asked to put in evidence the level of satisfaction obtained from adoption of innovation systems, such as the economic benefit.

During the interviews with farmers, detailed information was provided them for each section of the questionary. This aspect of the survey, it was very important in fact, the risk associated with wrong comprehension of attributes an their level’s contents in the questionary could distort the results of the survey.

Table 4.4 – IRRISAT choice set

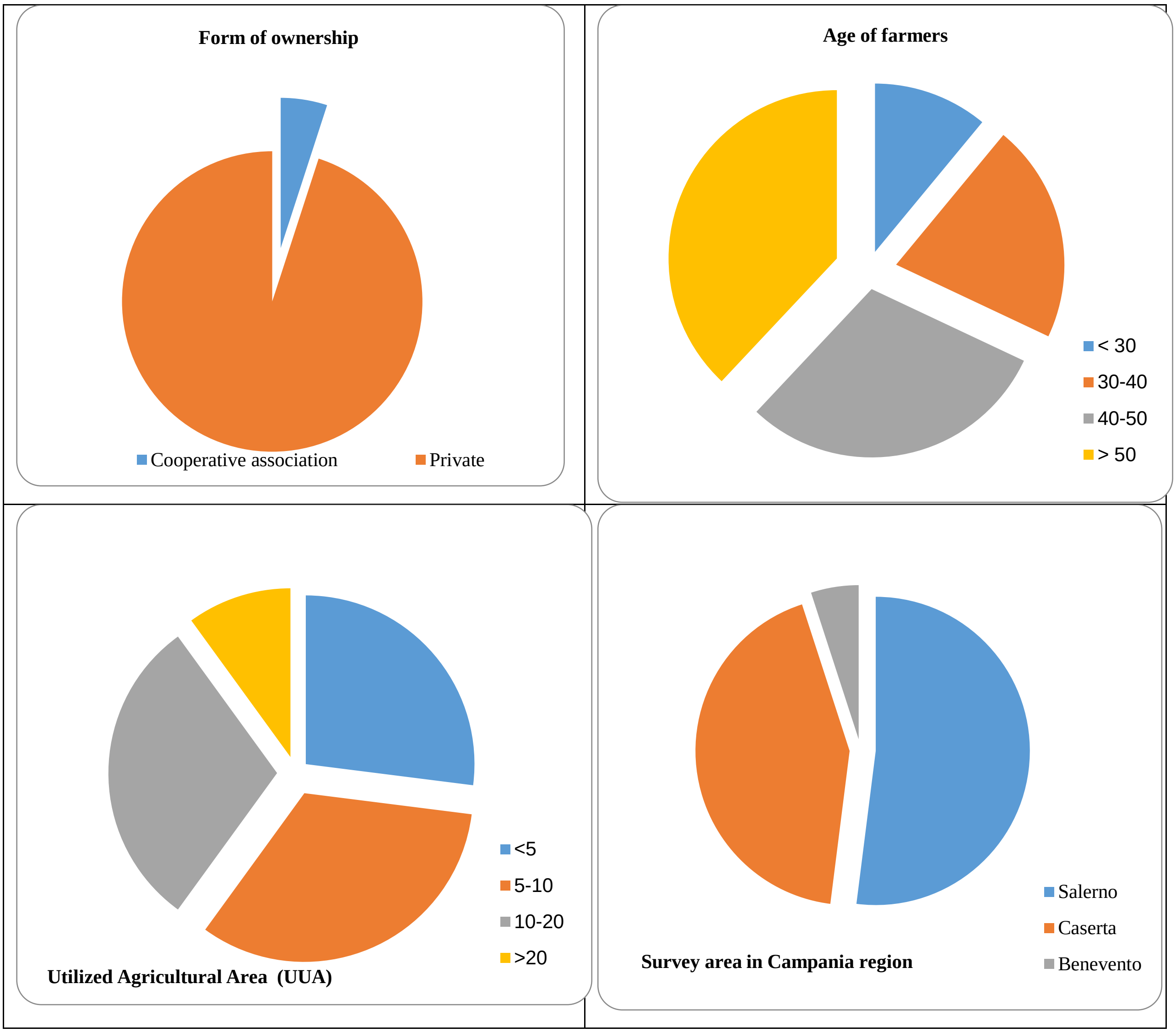
The following are proposed ten options of choice of irrigation advisory service, Irrisat. Which option suit on your needs and which one do you prefer between those suggested?

Option 1	**Option 2**	**Option 3**	**Option 4**	**Option 5**	**Option 6**	**Option 7**	**Option 8**	**Option 9**	**Option 10**
Farm area	Plot	Land parcel	Farm area	Plot	Farm area	Plot	Land parcel	Land parcel	Neither
Price of the service, 6 €/ha per year	Price of the service, 6 €/ha per year	Price of the service, 10 €/ha per year	Price of the service, 8 €/ha per year	Price of the service, 10 €/ha per year	Price of the service, 10 €/ha per year	Price of the service, 8 €/ha per year	Price of the service, 6 €/ha per year	Price of the service, 8 €/ha per year	
Water saving 10%	Water saving 30%	Water saving 10 %	Water saving 5 %	Water saving 5 %	Water saving 30%	Water saving 10%	Water saving 5 %	Water saving 30%	
Supply contract of two-year service	Supply contract of three-year service	Supply contract of three-year service	Supply contract of three-year service	Supply contract of two-year service	Supply contract of one-year service	Supply contract of one-year service	Supply contract of one -year service	Supply contract of two-year service	

4.4 RESULTS

The CE has considered the responses of 100 farmers. Farmers interviewed are mainly represented by men (96%), while women a small part (4%). The age of respondents varied between 21 and 83 years, with an average of 50 years. Specifically, under 30 years is 11% of the sample, between 30 and 40 years, 21%, between 40 and 50 years 30%. Finally, 38% are over 50 years old.

Figure 4.3 - Some characteristic of the interviewees



The farms are mainly individual ownership (95%), and only rarely is made up of an agricultural cooperative (5%). The farms are mainly specialized in the production of fodder and vegetables (68%), the rest mainly livestock (32%). Most farms produce milk and dairy products (cheese and mozzarella). The farms have a utilized agricultural area 12.8%. The UAA is between 1.10 and 43 hectares. 27% of companies have a UAA of less than 5 hectares, 33% between 5 and 10 hectares, 30% between 10 and 20 hectares, and 10% greater than 20 hectares. The survey area covered the provinces of Salerno (52%), Benevento (5%) and Caserta (43%). The sample showed a strong dynamism regard to economic investments. In recent years, 50% of farmers have made investments in innovation to his farm. Regard to the effects that this type of investment produced on product innovation, technological innovation and the organization, 44% of respondents stated, a 33% increase in production capacity business. Investments in innovation have not resulted in increases in exports, in market share and overall employment.

The results of the survey on the preferences of choosing the attributes, proposed in the CE, have had a different result than forecast in the experimental design (Table 4.5). The most attribute considered by farmers to service IRRISAT was in the entire area of the holding (AZIE). This level has been preferred to others proposed, aimed at the individual crops and cadastral units. The other attribute that has experienced significant preference is related to the contract (CONT). The preference for IRRISAT, among the three options proposed, (two-year supply contract, the three-year or annual), has gone to the three-year service. Finally, it was noted i) lack of interest in the attributes water savings and a significant preference of choice for services with the price of 6 euro, compared to other solutions for the price of 8 and 10 euro.

Table 4.5 - Conditional logit model estimation

	Coef.	Std. Err.	P-value	[95% Conf.	Interval]
AZIEN	2,117261	0,9355944	0,024	0,28353	3,950992
RIAC	0,0783864	0,0375294	0,037	0,00483	0,1519427
CONT	1,165991	0,431154	0,007	0,320945	2,011037

The importance or weight of an attribute was assessed by estimating the willingness to pay (WTP), which measures consumer preferences in monetary terms (Table 4.6). The estimate of WTP was calculated as the ratio, changed sign, between coefficient of each attribute and that attribute monetary. WTP can be defined with a direct approach because it is the trade-off between each attribute non-monetary and monetary. The estimate of WTP for ten scenarios presented in table 4.6, it has been possible thanks to the application of the CLM which allowed to compare the WTP farmers for IRRISAT .

The results obtained through the econometric model, and the positive signs of the coefficients for the attribute AZIE have confirmed preference of farmers to service irrigation business addressed to the entire surface rather than to a portion of the farm. Equally significant was the level of appreciation with regard to the three-year contract offer, rather than biennial and annual basis.The interest in the attribute saving water was very low too. This confirmed that the attribute of saving water is not preferred by farmers.

Table 4.6 - Willingness to pay estimations for IRRISAT according whit the model specification

Attribute	(euro)
AZIEN	2,41
RIAC	0,09
CONT	1,32

4.5 DISCUSSION AND CONCLUSIONS

The methodology of economic evaluation using CE is an extremely innovative context for economic analysis. Particularly, to investigate the individual preferences of the services offered by public goods and mixed, defined through a multi dimensional and multi attribute. It is important to note that the CE, such as contingent valuation, are not a theory of behavior, but an analysis tool to generate behavioral data to consumers and users. The use of models of choice has been widely adopted in many research fields, including transport and marketing. With regard to applications for advisory services to irrigation we have not found any application and this study is the first application of a CE to IASs.

Following this approach, in our work, we were interested to see i) which of the attributes of choice for system IRRISAT was most important for farmers, and ii) the willingness to pay farmers for the attributes proposed.

As regards price attribute, farmers have shown a preference of choice for the services offered at a lower cost. This confirms expected forecast during the process of experimental design. Particularly, the cost in this case is also considered a strategic element for use the service. In many cases the cost of the IAS, varies between 6-10 euro per hectare, and depends greatly by extension of farms. The farms that are larger farm pay a lower price, about 6 euro per hectare. The smaller farmers pay higher prices up to 10 euro per hectare. However, the attribute relating to the cost of the service represented less attractive attribute for farmers.

As regards the contract attribute, the study has highlighted the propensity of farmers to the three-year contract. Probably the contractual aspect that is frequently considered one obstacle in the supply of services, in that case it does not seem to have this effect. This would confirm as observed in the former stages of investigation a high appreciation of the service IRRISAT between farmers who have used it.

As regards plot attribute, the results showed a preference of selectionated attribute of IRRISAT, extended to the whole farm. No statistical preference for other attributes i) plots per crop and ii) plots divided by a cadastral parcel was significant. We consider this choice very relevant because it emphasizes the need of the farmer to receive simple and complete information about the whole farm. In fact, farmers do not consider one field less important than others. This choice shows that the good economic farm is reached when the whole farm to be considered and not a part of this.

As regards water saving attribute, RIAC, the CE has shown a lack of attention to this attribute. In fact, this attribute was not considered decisive for the choice of the service of irrigation. Although, in the future, will be defined sure systems of water accounting and assignment of price for water resources with increased costs for the farmers.

One original aspect of our study concerns the case study area where our study was implemented. In fact, several studies have been implemented in agricultural areas, but only some of these are concerns of advisory services addressed to irrigation, and characterized by a high technological value.

The methods of administration of the questionnaires in the choice experiments are usually carried out either by phone or face to face.

In this case was decided to subject questionnaires, face to face. This specific methodology was needed to establish direct contact with farmers, facilitating interviews. The major obstacle during the interviews was the availability of farmers, reluctant interview and therefore not easily accessible. Moreover, the choice of making face to face interviews proved correct. In fact, this procedure allowed to explain, with accuracy, the reasons and the contents of the survey. The time spent on each interview was, in some cases, very long. Most of the difficulties can be attributed to the cultural aspects. In fact, farmers, although often motivated by good intentions, could not understand the meaning of the questions, a problem that is to be pursued, perhaps, in the lowest literacy farmers present in the areas observed.

In our work the role of ILRCs ware decisive for the success of the research project. The activism of Reclamation has allowed to bring together farmers and facilitated the administration of the questionnaires. In all stages of the survey inside the area covered by questionaries technicians of the ILRCs have collaborated with researchers explaining the utility of the research and the reasons behind this activity. Technicians have explained to farmers as this investigation could have a positive effect on the supply of the service IRRISAT. It was described that the improvement of the service in terms of economic offer, the cost of service, could have been improved through the evaluation of the data obtained through interviews. Finally, ILRC land reclamation consortia have represented the meeting point, physically, between the world of research and farmers.

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CHAPTER V
DISCUSSIONS AND CONCLUSIONS

5.1 SUMMARY OF ACHIEVEMENTS

The main results of the research have confirmed that water is a primary asset for Italian farms and the most important factor for agricultural production. Therefore, there is a clear need for greater use of tools and methodologies to account for water use in irrigation practice. The results of this study have shown that the measurement systems in agriculture are not particularly common in Italy and are rather inaccurate. Despite the technology in recent decades has provided a good range of innovative solutions, as well as statistical data about its estimate. In particular, the analysis of the context of supply and demand of the Irrigation Advisory Service, has provided an interesting picture of the use of these systems in Italy. However, the results of the study showed a spread of Irrigation Advisory Service still very limited, to ensure effective support in terms of environmental and economic sustainability in irrigation. The econometric analysis, carried out by the advisory systems for irrigation, allowed to carefully evaluate the economic benefit of their use. The results showed that farmers find it very useful these tools to improve farm management.

5.2 DISCUSSIONS, CONCLUSION AND OUTLOOK

5.2.1 Discussion

The methodology of economic assessment by the Choice Experiment (CE) is an extremely innovative framework for the economic analysis of individual preferences, with respect to services offered by public goods and mixed, defined in a multi-dimensional and multi attribute.
This methodology is not a theory, but an analysis tool to generate behavioural data of consumers and users and can be used as a logical structure and theory to understand and predict the choices and tradeoffs of choice. But, can not be considered a theory about the behaviour of choice. The choice mechanism implicit in the CE determines and generates a set of information, derived from repeated choices among alternatives offer greater, and therefore a more comprehensive understanding of the preferences, benefits, and costs of the alternative scenarios offer. The use of the methodology CE, through a direct questionnaires, can detect the stated preference. One of the merits of the use of CE is linked to the monetary factor, in fact, the price of the service is "shadow", implicitly, by reducing

distortions due to strategic compartment. One of the advantages of the use of CE is provided by the results that may be useful in more complex procedures for cost-benefit analysis and cost effectiveness. It asks respondents directly their willingness to pay. Their degree of complexity of the choices is variable from case to case, the decomposition of the well in the attributes and levels can be more or less the analysis and the number of choices made for individual may vary. The survey econometrics may use techniques and alternatives of varying complexity. Moreover, it can extend as required. In this regard, the analysis generally begins from multinomial conditional logit models (standard) and then spread to models Conditiona Logit and Nested Logit models. The weak points of this methodology are due to the higher costs that the analysis shows, both in the preparation phase both in the phase of administration and completion of the questionnaire. Finally, in the organization and in the data analysis.

In feature this work has tried to make the most of the flexibility and broad analysis capabilities offered by these analysis tools using these systems for farmers, which in our case are the consumers of the IAS. The innovative approach of this work was to understand and learn about the different expectations of farmers than consulting services for irrigation in an area of Italy where such services have achieved levels of excellence.

5.2.2 Conclusion and outlook

In Italy, a large number of marginal agricultural areas are concentrated in geographical areas where natural resources have a very limited availability of these water. Proper irrigation management can determine good levels of food production, with significant results in terms of food security and economic sustainability. The need of tools of water accounting in irrigation practice is certain. And very important increase the level of penetration and diffusion of measuring instruments in agriculture through the dissemination of knowledge among all those involved in agriculture and water management. In this context, an opportunity could be a greater adoption and spread of IAS. In fact, their increasing use could provide clear benefits in terms of sustainable use of water resources in agriculture, both in economic terms, could contribute to an increase in profitability for farms, and primarily to a significant reduction of energy costs associated with irrigation.

The limited spread of IAS within the agricultural areas of our country highlights the need to increase their use. This could be achieved with a greater spread of the technical assistance for irrigation in rural areas. A greater presence of technicians in the area could help increase the understanding of farmers, the real economic benefit provided by this type of agricultural assistance.

The economic analysis, conducted among the most productive agricultural areas of the Campania Region, has brought to light as most (38%) of farmers conductors of companies have an age of 50 years and a very low level of education, which could be due to the low efficiency of the adoption of IAS. Therefore, it is necessary to provide for the development of efficient marketing tools and communication that are able to transfer the information produced by farmers in an effective and incisive that take into account the social context in which they operate. The economic assessment methodology used in this study was innovative for the Italian context irrigation. Were not detected in other studies both in the national bibliography is the one in which foreign been applied economic evaluation, econometrics, for the definition of the choices of farmers than the IAS. Although, the use of models of choice has been widely adopted in many research fields, including transport and marketing. This innovative application has allowed us to deepen and to know the preferences of farmers compared to this particular type of service.The study was carried out in the Campania region in area of Italy covered by IAS called IRRISAT. In 2013, the service has provided support for three Irrigation and Land Reclamation Consortia (ILRC), with 669 farmers and extension of 55.03,57 hectares. Based on these considerations, the specific aims of this work has been i) to analyse the importance of technological innovation in theagricultura water management ii) to define throughout the use of choice experiments (CE) the preferences of the farmers regarding the main characteristic, attributes, of the IRRISAT, iii) to analyse marginal willingness to pay for this service. The results have shown the general appreciation for IRRISAT, needs receive simple and complete information about the whole farm. In fact, farmers do not consider one field less important than others. Concerning water saving this study has shown a lack of attention to this aspect. In fact, this attribute was not considered decisive for the choice of the service of irrigation. They agree with the needs of IAS, but have shown more attraction for other aspects like duration of the contract; the study has highlighted the propensity of farmers to longer choice, the three-year contract. Probably the contractual aspect that is frequently considered one obstacle in the supply of services, in that case it does not seem to have this effect, but more interest in the farms gone to the easy access to the service that they feel good and useful. Finally, regarding the price of the service the range of price proposed is seems acceptable for the farmers, especially when the price has been lower.

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ANNEX 1 : CHOICE MODEL QUESTIONNAIRE

INDAGINE CONOSCITIVA SUI

SERVIZI DI CONSULENZA ALL'IRRIGAZIONE

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Nell'ambito delle attività di ricerca svolte sul tema dell'irrigazione dall'Istituto Nazionale di Economia Agraria, INEA e dal Dipartimento di Agraria dell'Università Federico II di Napoli, UNINA, viene di seguito proposto un questionario rivolto a tutti gli operatori del comparto agricolo.

In particolare, il questionario è indirizzato a tutti quegli operatori che hanno avuto esperienze con i sistemi di consulenza all'irrigazione nel corso delle campagne irrigue degli ultimi anni e a tutti gli operatori che saranno, in futuro, interessati alla ricezione dei sistemi di consulenza all'irrigazione sia nelle aree servite dai Consorzi di Bonifica ed Irrigazione sia al di fuori delle stesse.

L'obiettivo del questionario è quello di rilevare i benefici economici ed ambientali derivati e derivabili dall'erogazione del servizio di consulenza all'irrigazione. Con il fine di rendere sempre maggiore il risparmio in termini economici che può essere ottenuto da un miglioramento nell'impiego dell'acqua ad uso irriguo all'interno dell'azienda agricola.

Pertanto, l’invito che le rivolgiamo è di compilare il questionario in allegato.

Il questionario è anonimo. Serve solo l’indicazione di alcuni dati da parte di chi lo compila: ad esempio età e sesso.

Ringraziando per la collaborazione, porgiamo cordiali saluti.

SEZIONE I. DATI GENERALI SULL’AZIENDA

Le ricordo che tutte le risposte sono completamente anonime e confidenziali.

1.1 Sesso ☐ M__ ☐ F__

1.2 Età________

1.3 Coltivatore diretto ☐ Si ☐ No

1.4 Comune in cui è localizzata l’azienda________________________________

1.5 Forma giuridica

Azienda individuale ☐

Società cooperativa ☐

Altro tipo di società ________________________

1.6 Superficie aziendale

Superficie Agricola Totale (SAT) ha_______

Superficie Agricola Utilizzata (SAU) ha_____

1.7 Forma di possesso dei terreni della Superficie Agricola Utilizzata (SAU)

Proprietà superficie in ettari ___________

Affitto superficie in ettari ___________

Altro (specificare) _________________superficie in ettari ____

1.8 Indirizzo produttivo prevalente _____________

1.9 In caso di indirizzo prevalente zootecnico:

quale _____________________ numero di capi ___________

1.10 Sistemi irrigui prevalenti. (barrare con una x la casella corrispondente)

1. metodo per sommersione	
2. metodo per scorrimento	
3. metodo per aspersione o a pioggia	
4. metodo per microportate o a goccia;	
5. metodo per subirrigazione	

1.11 Potrebbe indicare quali sono i canali di distribuzione prevalenti dei prodotti agricoli della sua azienda?

Grande Distribuzione Organizzata_GDO	
Ingrosso	
Dettaglio	
Ristorazione	
Vendita diretta	
E-Commerce	

Altro(specificare)	

1.12 La sua azienda ha ottenuto qualche sistema di certificazione?

Si	No

Se, si potrebbe specificare quale?

SEZIONE II - ATTITUDINE AL CAMBIAMENTO

2.1 Negli ultimi 5 anni ha fatto investimenti in azienda?

Si	No

Se si, quali?

2.1.2 Acquisto di macchinari	Si	No
2.1.3 Costruzione di fabbricati e/o capannoni		
2.1.4 Impianti di trasformazione e confezionamento		
2.1.5 Attività di promozione		
2.1.6 Acquisto terreni		
2.1.7 Altro		

2.1.8 Se Si, indicare gli effetti che gli investimenti sull'innovazione di prodotto, tecnologica o di organizzazione, realizzati dall'impresa hanno avuto nei seguenti fattori (max una risposta per riga)

	Aumento	Nessun effetto	Diminuzione
Capacità produttiva			
Capacità organizzativa			
Capacità gestionale			
Esportazioni			
Quote di mercato			
Occupazione complessiva			

Sostenibilità ambientale			

2.2 Negli ultimi 5 anni ha effettuato:

2.2.1 Cambiamento di ordinamento colturale	Si	No
2.2.2 Cambiamento tecniche colturali		
2.2.3 Innovazioni organizzative		

2.3 Secondo Lei, in una scala di priorità di interventi da effettuare nella sua azienda quale tra questi assume maggiore/minore importanza al fine di risultare più competitivi nel mercato?

1= Molto importante   2=Parzialmente importante e 3= Nessuna Importanza

(Inserire il numero nella casella vuota corrispondente)

1 Interventi di rinnovamento dei processi produttivi esistenti	
2 Interventi di introduzione di processi innovativi	
3 Interventi di innovazione di prodotto	
4 Interventi tesi al miglioramento del prodotto	
5 Interventi tesi all'aumento della professionalità del management	
6 Interventi tesi al superamento delle dimensioni aziendali attraverso processi di accorpamento (affitto o acquisto)	
7 Interventi tesi a introdurre processi di innovazione organizzativa	
8 Interventi tesi al miglioramento della strategia di commercializzazione del prodotto	
9 Interventi mirati ad una maggiore sostenibilità del processo produttivo	
10 Interventi di automazione di processo	

SEZIONE 3 - SCELTE DELL'IMPRENDITORE RISPETTO AI SERVIZI DI CONSULENZA ALL'IRRIGAZIONE

Nella Regione Campania nell'ambito del Piano Regionale di Consulenza Irrigua e poi attraverso altri programmi di sviluppo agricolo è attivo il sistema di consulenza all'irrigazione che si propone di rendere più efficiente l'uso dell'acqua a scopo irriguo per le aziende agricole. L'adozione di tale sistema si propone di ridurre i maggiori costi dovuti alle spese energetiche e all'impiego di acqua in agricoltura, fornendo corrette indicazioni sulla quantità di acqua da somministrare, per ciascuna coltura, nel corso della stagione irrigua.

Al fine di perfezionare il servizio di consulenza all'irrigazione e poter offrire agli agricoltori un servizio che gli consenta di aumentare il risparmio idrico e diminuire i relativi costi energetici le chiediamo la cortesia di rispondere ai seguenti quesiti.

3.1 Quale tra queste opzioni di fornitura del servizio di consulenza all'irrigazione sceglierebbe? (barrare con una x il numero della casella corrispondente)

1	2	3
Intera superficie aziendale	Appezzamenti suddivisi per coltura	Appezzamenti suddivisi per parcella catastale
Costo del servizio Euro 6 ha per l'intera stagione irrigua	Costo del servizio Euro 6 ha per l'intera stagione irrigua	Costo del servizio Euro 10 ha per l'intera stagione irrigua
Risparmio idrico 10%	Risparmio idrico 30%	Risparmio idrico 10 %
Contratto di fornitura del servizio biennale	Contratto di fornitura del servizio triennale	Contratto di fornitura del servizio triennale

4	5	6
Intera superficie aziendale	Appezzamenti suddivisi per coltura	Intera superficie aziendale
Costo del servizio Euro 8 ha per l'intera stagione irrigua	Costo del servizio Euro 10 ha per l'intera stagione irrigua	Costo del servizio Euro 10 ha per l'intera stagione irrigua
Risparmio idrico 5%	Risparmio idrico 5 %	Risparmio idrico 30%

Contratto di fornitura del servizio triennale	Contratto di fornitura del servizio biennale	Contratto di fornitura del servizio annuale

7	8	9	10
Appezzamenti suddivisi per coltura	Appezzamenti suddivisi per parcella catastale	Appezzamenti suddivisi per parcella catastale	Nessuna Scelta
Costo del servizio Euro 8ha per l'intera stagione irrigua	Costo del servizio Euro 6 ha per l'intera stagione irrigua	Costo del servizio Euro 8 ha per l'intera stagione irrigua	
Risparmio idrico 10%	Risparmio idrico 5%	Risparmio idrico 30%	
Contratto di fornitura del servizio annuale	Contratto di fornitura del servizio annuale	Contratto di fornitura del servizio biennale	

3.2 Con che frequenza consulta i dati meteo che le consentono di stabilire quando irrigare?

(barrare con una x la casella corrispondente)

Ogni giorno	2-3 Volte alla settimana	1 Volta alla settimana	1 Volta al mese	Mai

3.3 Quali informazioni ritiene molto utili ed interessanti per il suo lavoro?

(barrare con una x la casella corrispondente)

Volume irriguo	Immagini satellitari	Sviluppo della coltura	Dati meteo	Evapotraspirazione potenziale	Altro

3.4 Confrontando il beneficio con le aspettative che aveva all'inizio dell'erogazione del servizio di consulenza all'irrigazione . Si ritiene?

(barrare con una x la casella corrispondente)

Completamente soddisfatto	Parzialmente soddisfatto	Non completamente soddisfatto

3.5 Ritiene che i servizi all'irrigazione debbano migliorare se si come?

3.6 Quale metodo, oltre al sistema di consulenza all'irrigazione impiega per determinare i tempi ottimali irrigazione? (barrare con una x la casella corrispondente)

Sensori di umidità del suolo	Dati meteo	Esperienza pratica	Altro

3.7 Quali sono stati i costi di investimento sostenuti per l'irrigazione nel corso 2013/2014?

Euro………

3.8 Prevede investimenti per gli impianti di irrigazione nei prossimi 5 anni?

Euro……..

3.9 Costi operativi per l’irrigazione in termini di energia per il pompaggio dell’acqua, lavoro, acqua?

Acqua	Energia	Lavoro
Euro…………..	Euro……	Euro……..

SEZIONE 4 - ANALISI DELLA PROPENSIONE ALL'ADOZIONE DI UN'INNOVAZIONE, IN PARTICOLARE UN'INNOVAZIONE SOSTENIBILE

Nella pagina seguente troverà una lista di affermazioni. Il suo compito è quello di indicare, nel modo più preciso possibile, il suo grado di accordo con esse.

Per fare questo, dovrà apporre una croce sul numero che meglio rappresenta il tuo grado di accordo, utilizzando una scala che va da 1 (PER NIENTE D'ACCORDO) a 7 (TOTALMENTE D'ACCORDO).

Le diverse posizioni (da 1 a 7) sono intese proprio come una scala numerica: ad esempio 2 è il doppio di 1, 4 è il doppio di 2, 6 è il triplo di 2, e così via. Allo stesso modo, la distanza tra 2 e 3 è equivalente a quella tra 4 e 5 oppure tra 6 e 7. Questa scala, quindi, le consentirà di indicare il suo grado di accordo con le affermazioni sotto elencate in maniera quantitativa e nel modo più preciso possibile.

È molto importante che lei risponda a tutte le domande.

Le ricordiamo che tutte le tue risposte saranno completamente anonime.

Se crede di aver compreso bene le istruzioni, vada pure alla pagina seguente. In caso contrario, potrà leggere nuovamente le istruzioni, oppure chiedere chiarimenti a un membro del gruppo di ricerca, che sarà felice di fornirle tutte le delucidazioni di cui lei ha bisogno.

4.1 Quali sono gli effetti attesi dell'adozione dell'innovazione per la sua azienda?

Si può rispondere con un numero da 1 a 7, dove 1 significa "fortemente in disaccordo" e 7 significa "fortemente d'accordo". Si può anche rispondere con i numeri intermedi tra 1 e 7.

Domanda	Risposta						
1 Miglioramento dell'immagine	1	2	3	4	5	6	7
2 Benefici economici	1	2	3	4	5	6	7

3 Un aumento del valore del prodotto o del servizio	1	2	3	4	5	6	7
4 Creazione di un nuovo mercato o l'espansione del mercato	1	2	3	4	5	6	7
5 Un compatibilità con le attuali attrezzature / tecnologie adottate in azienda	1	2	3	4	5	6	7
6 Sintonia con la cultura aziendale	1	2	3	4	5	6	7
7 Facilità nell'intraprendere misure sostenibili di sviluppo	1	2	3	4	5	6	7
8 Facilità nella comprensione misure di sviluppo sostenibile	1	2	3	4	5	6	7
9 Difficile realizzare innovazioni maggiormente rispettose dell' ambiente	1	2	3	4	5	6	7
10 Riduzione dei rifiuti	1	2	3	4	5	6	7
11 Riduzione dell'impiego di materie prime	1	2	3	4	5	6	7
12 Aumento della produttività	1	2	3	4	5	6	7
13 Riduzione dell'impiego di energia o di altre risorse naturali(acqua per l'irrigazione)	1	2	3	4	5	6	7
14 Nessuna necessità di cambiare la struttura organizzativa	1	2	3	4	5	6	7

4.2 A suo giudizio, a chi ed in quale misura andrebbero comunicate le pratiche sostenibili che lei intende adottare nella sua azienda?

Si può rispondere con un numero da 1 a 7, dove 1 significa "fortemente in disaccordo" e 7 significa "fortemente d'accordo". Si può anche rispondere con i numeri intermedi tra 1 e 7

Domanda	Risposta						
1 Autorità governative	1	2	3	4	5	6	7
2 Consumatori	1	2	3	4	5	6	7
3 Associazioni di consumatori	1	2	3	4	5	6	7
4 Comunità locali	1	2	3	4	5	6	7
5 Dai miei dipendenti	1	2	3	4	5	6	7
6 Azionisti, investitori privati	1	2	3	4	5	6	7
7 Controparti nel settore dell'agricoltura	1	2	3	4	5	6	7

8 Fornitori di materie prime a valle e a monte dei processi produttivi aziendali	1	2	3	4	5	6	7

4.3 Dopo l'eventuale adozione delle pratiche sostenibili, gli obiettivi successivi della sua azienda dovrebbero essere….

Si può rispondere con un numero da 1 a 7, dove 1 significa "fortemente in disaccordo" e 7 significa "fortemente d'accordo". Si può anche rispondere con i numeri intermedi tra 1 e 7

Domanda	Risposta						
1 Avere un controllo effettivo sulle nuove misure	1	2	3	4	5	6	7
2 Avere maggiori responsabilità manageriale nelle pratiche ambientali	1	2	3	4	5	6	7
3 Avere un budget sufficiente per attuare le misure ambientali	1	2	3	4	5	6	7
4 Avere un adeguato supporto tecnologico per la loro adozione	1	2	3	4	5	6	7
5 Avere l'opportunità di provare nuove misure ambientali	1	2	3	4	5	6	7
6 I miei dipendenti avranno le nuove conoscenze su questo tema	1	2	3	4	5	6	7
7 La società accetterà le nuove iniziative sul tema ecologico con più favore	1	2	3	4	5	6	7
8 Il Governo possa sosterrà politiche o regolamenti in materia ambientale	1	2	3	4	5	6	7
9 La "catena" di produzione o dei fornitori cooperino alla adozione di misure ambientali	1	2	3	4	5	6	7
10 Si possa collaborare, su questo tema, con gli Istituti di ricerca	1	2	3	4	5	6	7

4.4 Trovo che l'adozione di pratiche ambientali :

Si può rispondere con un numero da 1 a 7, dove 1 significa "fortemente in disaccordo" e 7 significa "fortemente d'accordo". Si può anche rispondere con i numeri intermedi tra 1 e 7

Domanda	Risposta						
1 Sia si scarso significato	1	2	3	4	5	6	7
2 Sia inutile	1	2	3	4	5	6	7
3 Sia saggio	1	2	3	4	5	6	7

4.5 Quali sono i suoi programmi in merito all'eventuale adozione delle pratiche sostenibili ?

Si può rispondere con un numero da 1 a 7, dove 1 significa "fortemente in disaccordo" e 7 significa "fortemente d'accordo". Si può anche rispondere con i numeri intermedi tra 1 e 7

Domanda	Risposta						
1 Entro un anno, l'azienda intende adottare pratiche sostenibili	1	2	3	4	5	6	7
2 Entro un anno, c'è la probabilità che vengano adottate pratiche ecologiche	1	2	3	4	5	6	7
3 Nessuna necessità di cambiare la struttura organizzativa	1	2	3	4	5	6	7