Identifying sector needs to increase resource use efficiency

Authors Francisco José Blanco-Velázquez & María Anaya-Romero

Affiliation Evenor-Tech "Technology-Based Company focus on Solutions for Soil Use and protection". Centro de Empresas Pabellón de Italia Business Center, 5th floor. C/ Isaac Newton, 4. Science and Technology Park Cartuja, 41092, Seville, Spain.

Project	OPERA
Project title Operationalizing the increase of water use efficiency and resilience in irrigation	
Work package	1. Identifying sector needs to increase resource use efficiency
Deliverable D1.2 Outcome of the two stakeholder workshops	
Period covered	May 2017 - December 2019
Publication date	October 2019



Acknowledgement

"The authors would like to thank the EU and The Ministry of Economic Affairs (The Netherlands), CDTI (Spain), MINECO (Spain), ANR (France), MIUR (Italy), NCBR (Poland) and WRC (South Africa) for funding, in the frame of the collaborative international consortium OPERA financed under the ERA-NET Cofund WaterWorks2015 Call. This ERA-NET is an integral part of the 2016 Joint Activities developed by the Water Challenges for a Changing World Joint Programme Initiative (Water JPI)."







OPERA consortium members

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





















Contents

S	ummary	/	1
1	Introd	duction	3
2	The w	vorkshops	5
	2.1	Case Study 1: Poland	5
	2.2	Case Study 2: France	6
	2.3	Case Study 3: Italy	6
	2.4	Case Study 4: South Africa	7
	2.5	Case Study 5: Spain	8
	2.6	Case Study 6: the Netherlands	9
3	Resul	ts per case study	11
	3.1	Case Study 1: Poland	11
	3.2	Case Study 2: France	16
	3.3	Case Study 3: Italy	19
	3.4	Case Study 4: South Africa	22
	3.5	Case Study 5: Spain	28
	3.6	Case Study 6: the Netherlands	32
4	Evalu	ation of the workshops and interviews	37
5	Other	r information	41
6	Refer	ences	43
Ą	nnex 1 (Guide cover and surveys template	45
Δ	nnev 2 [Dictures	47



Summary

The EU project OPERA is based on a transdisciplinary approach to ensure the joint learning and codevelopment with all relevant stakeholders throughout the project, by identifying the needs and demands of the users, as well as the preferred combinations of information technologies and service models. Each case study partner selected particular stakeholders based on the document "guidelines for analysis and selection of stakeholders". The approach followed a snowball sampling design, where identified and contacted stakeholders were asked to identify further stakeholders, starting with the case study partners. A total of 233 stakeholders from different sectors were identified and selected to participate in the questionnaires elaborated by identifying the needs and demands. Increasing the competitiveness of farms, different actions were selected for the cases studies. Improving the marketing strategy for the products was selected in France and South Africa and increasing the size of farms was selected in South Africa and Poland. On the other hand, different preferences between improvements provided were selected according to the local needs. In addition, the barriers identified to improve the water efficiency and adopting alternative crops were analysed for every country. Economic barriers such as high prices of sensors or high investment costs were selected in most of the cases. Some countries identified administration barriers as lack of agility by de administration to obtain water intake permit. According to adopting alternative crops the answers collected were more general. The main limitation is the uncertainty of prediction market demands and the cost to implement a new crop (infrastructure cost). So, it is necessary to develop local strategies to improve the efficiency of the farmers regarding to the local needs. There seems to be not a single solution because the needs of farmers differ from region to region. However, the information obtained from the stakeholders will allow to develop common strategies between countries and sharing experiences and efforts.



1 Introduction

During the first decade of the 21st century in Europe, the extreme climatic events negatively affected to crop productivity and this is expected to further increase yield variability under climate change (EEA, 2016). According to the growing of population density (FAO, 2017), a high production of resources is required for the increase of the human supplies (Domingo, 2008). When the yield rises, the overexploitation of crop field begins (Orta-Ortiz, 2018; Roberts, 2018) so, the aquifers are overexploited and water irrigation becomes insufficient. For that, sustainable agricultural could be helpful but sustainable agricultural water management requires the best fitting of water supply to the actual demand in a more flexible way.

"Operationalizing the increase of water use efficiency and resilience in irrigation" (OPERA) is a European Project co-financed by the Joint Action Activities ERA-NET Cofund WaterWorks 2015. The main objective of OPERA is the application of the best combination of advances and technologies from remote sensing, soil moisture monitoring, plant responses and forecasting to bring them rapidly towards implementation and commercialization in the form of innovative service models.

OPERA is based on a transdisciplinary approach to ensure the joint learning and co-development with all relevant stakeholders throughout the project, by identifying the needs and demands of the users (farmers, farmer associations, extension services, water management organizations and policy makers, among others), as well as the preferred combinations of information technologies (sensors, models, remote sensing) and service models. The application of this kind of approach enables notable social and scientific outcomes and benefits with interest to both scientists and practitioners (Scholz and Steiner, 2015; FAO, 2017).

Regarding to the transdisciplinary approach of the project, OPERA needs an appropriate and accurate identification of stakeholders from the outset of the project, including a good understanding of them, their roles and the interactions among them, since the overall legitimacy of the participative process and the extent to which outcomes are broadly accepted depends on how participants are selected, and how well they represent the broad stakeholder environment (Dougill et al., 2006; Prell et al., 2009).

Stakeholders are defined as anyone who can affect, or is affected by, a decision (after Freeman, 1984); they might be individuals or formal organisations and may span a range of interests and sectors (Leventon et al., 2014). Because that two guidelines were developed following the results of Dougill et. al, 2006; FAO, 2017; Leventon et. al,2014; Miah et. al, 2015; Njoroge et.al, 2015; Prell et. al, 2009 and Scholz et. al, 2015. The guidelines allowed identifying key stakeholders for every case study and could be invited to the workshops.

Since each case study in the OPERA project is developed in a different geographical location, under different language, cultural and socioeconomic particular traits, a deeper understanding of the water use efficiency and its context is held by each case study partner, so each of the partners will undertake the particular stakeholder selection for its own case study. To this aim, the guidelines provide a flexible protocol to be implemented by the case study partners according to their own needs and capabilities, also providing certain degree of harmonisation between case study sites by providing key principles to follow in each site.

The guidelines were based on previous experiences and results as well as the report developed by Leventon et al. (2014), which was designed and tested to provide input to a range of transdisciplinary research projects (see also Deliverable D1.1 of the OPERA project by Blanco-Velázquez and Anaya-Romero, 2018; Annex 1). The process is designed to be implemented by partners with little previous experience in social research, and in a range of case study contexts.

The stakeholder analysis and selection will help for the case studies going forwards in completing the workshops and deliverables under WP1 and requirements for the development of WP4 (stakeholders as service users). It should also feed into WP2 (evaluation of method functionalities) and WP3 (Field operational works: monitoring and demonstration activities).



2 The workshops

In this section, we present the outcomes of the stakeholder and institutional analysis process. For each case study, we present a brief description of the crops, and of the general administrative levels present in the area. We then present the identified stakeholders, highlighting how they fit to the administrative structures and key sectors. Each case study overview includes a table of the identified stakeholders, and of policies that were identified during the analysis process. Recommendations were made for each site as to further stakeholders that they may wish to consider in order to fully represent administrative levels and key sectors. Recommendations were also made (where relevant) as to how partners may choose to select which stakeholders (or which representatives of a stakeholder) to invite to on-going stakeholder platforms under the OPERA project. Partners were also encouraged to look at the summaries of other case studies in order to consider a broader range of stakeholders and policies.

2.1 Case Study 1: Poland

The case study in Poland is situated in the Kujawy region in Kujawsko-Pomorskie (Eng. kuyavian-pomeranian) province, in the north-centre of the country.. The first demonstration area is located in Zglowiaczka river catchment on the small productive field and the second one (added to the project in 2018) is located in the Upper Notec river catchment on the big productive field. Vegetables are cultivated as well as irrigated on both fields. The pilot areas are situated in the southern part of the province. This is the region of intensive agricultural crop production but even in the average year it suffers significant rainfall water deficits. The main problems: water scarcity in the growing season, use of clean long-renewable deep groundwater resources for irrigation, low efficiency of water use for irrigation, lack of irrigation decision support system for farmers based on current crop water needs and weather forecasts.

Both workshops in Poland were organized and conducted in Kujawsko-Pomorski Agricultural Advisory Centre, in Minikowo. In total 38 stakeholders participated in the first workshop (27 November 2017) and 17 in the second one (28 March 2018). The stakeholders are: individual farmers, agriculture producer groups, water companies, agricultural advisors, scientific institutions, representatives of local and government administration as well as other groups in the Kuyavian-Pomeranian province interested in the Opera project. Table 1 shows the list of workshops participants. During the first workshop, the objectives and expected results of the Opera project were presented, as well as the needs and condition of irrigation in the Kuyavian-Pomeranian province, as well as the costs of water services and water protection against pollution in the agricultural sector in the light of the new Water Law Act. Additionally, surveys were also discussed and carried out regarding identification of the project stakeholders, recognition of irrigation needs of arable crops and recognition of barriers (restrictions), needs and requirements of the irrigation system user. Analysis of the information from the above-mentioned surveys allowed for detailed identification of project stakeholders, their needs as end users of the optimal irrigation planning system. The aim of the second workshop was to present the CROPIRR irrigation control system, operational planning of irrigation on a county scale, and analysis of the stakeholders' attitude to irrigation advisory services. In addition, 27 surveys were collected in the first workshop and other 34 surveys were collected in other way (phone or face two face interview). After the second workshop, a total of 124 surveys were collected to the end of the project.

Table 1. List of institutions participated in the workshops in Poland

Institution	Sector	Institution	Sector
Province Board in Bydgoszcz, Faculty of Infrastructure and Agriculture	Provincial government administration	Experimental Station of Plants Varieties Assessment	State entity
County Board in Torun	Regional government administration	Individual farmers	Private sector, agricultural producers,



National Water	Central administrative body responsible for water conservation, water management and water use	Fruit Farms and Group	Private sector, fruit
Management Authority		of Fruit Producers	farmers
Water companies	Farmer associations	Institute of Technology and Life Sciences at Falenty, Kuyavian- Pomeranian Research Centre in Bydgoszcz	Research
Kujawsko-Pomorski	Governmental	University of	Research
Agricultural Advisory	sector, agricultural	Technology and Life	
Centre, Minikowo	advisory service	Sciences, Bydgoszcz	
County Agricultural Advisory Teams	Advisory service	University of Warmia and Mazury in Olsztyn	Research

2.2 Case Study 2: France

The Crau region is located in the vicinity of Marseilles, at the intersection of Rhone River valley, and the Mediterranean seashore. The entire area is a natural steppe as soils are very thin and consist mainly of pebbles that prevent soil tillage, while climate is very dry with no natural hydrographical network and a violent wind (Mistral). As a consequence of these natural handicaps, intensive agriculture (e.g., cereals, vine, orchards) is not possible, and it has long remained a "desert" between rich intensively cultivated regions such as Rhône River valley and the Aix-en-Provence sedimentary basin. It has thus been used for extensive cattle (sheep) breeding since the Neolithic and Antiquity. The region is one of the very few steppe areas in Europe, with many endemic species of patrimonial and ecological significance protected by different European and national regulations under various statuses

Part of this steppe area was converted to grasslands by irrigation with water brought from the Durance River since the 16th century, so that soils were thickened by silt input and became more fertile. High quality productions (the "Foin de Crau", the only hay with an AOP label¹, sheep breeding of "Mérinos d'Arles" and "Agneau de Sisteron" lamb IGP²) rely on these grasslands irrigated by water from the Durance's river. By bringing water in a plain with no surface hydrographical system, man has shaped the landscape since the 16th century. The Durance hydrographic regime has always been irregular, and the supply of irrigation water suffered from many shortages, which generated many conflicts until the Serre-Ponçon dam was built, in the 1960s. Nowadays, Durance waters, through the gravity irrigation system of the Crau grasslands, are the major source of water percolating towards the aquifer. They contribute to over 75% the Crau's groundwater recharge and thus supply drinking water to approximately 290 000 people as well as to the large industries established at the south of the area.

A meeting gathering different stakeholders was organized on February 2nd 2018. 9 participants were present covering different sectors (aquifer management, irrigation association, irrigation water provider, nature protection, farmers (hay producer only)). The goal of the meeting was to identify expectations in terms of decision tools based on the different developments made in the project:

- Use of remote sensing (Sentinel);
- Use of crop models as STICS, Aquacrop.

2.3 Case Study 3: Italy

In view of changing weather patterns and water scarcity, irrigated agriculture must be supported by offering a higher flexibility to switch to other water saving crops and/or a better operational forecasting of actual water demands and water availability. The case study is located in Campania, Italy (around Naples), were the main cultivated crops are silage maize, wheat, tomato and other vegetables (i.e. pepper, beans). Here water use optimization implies a decision-making process under significant hydroclimatic uncertainty.

² IGP (Indication géographique protégée) Protected geographic indication



6

¹ AOP (appellation d'origine protégée) Protected origin destination

Key investigation during the project includes adaptation potential and end-user needs, optimal approaches for dynamic forecasting of crop water requirements based on sequential assimilation of remote sensing observations and numerical weather predictions in a crop growth model. The main contribution to OPERA of Italian case study is to emphasize the role of reclamation consortia for raising awareness and develop tools for optimum water management under climate variability and uncertainties in the Mediterranean.

Key stakeholders involved are farmers, regional government, land and water reclamation authorities, farmer associations, local policy makers and legislators. Workshop venue: the workshop was held at the Consorzio Generale di Bonfica del Bacino Inferiore del Volturno, which is the main authority for land reclamation and irrigation of the study area (see Annex 2). Total participants were 14 and the institutions are listed in Table 2.

Table 2. List of institutions assisted to the workshop in Italy.

Institution	Sector	Institution	Sector
UNIFI	Research	CONSBIV	Irrigation/land reclamation
Individual	Farmer	COLDIRETTI	Farmer association
CONFAGRICOLTURA	Farmer association	ARIESPACE	Private sector SME
University of Napoli	Research and High Education		

2.4 Case Study 4: South Africa

Farmers in the Western Cape of South Africa, particularly the Breede River valley, are up to 7 times more water efficient than growers of the same crops in other parts of the world (WWF, 2015). The increasingly dry summers over the past few decades, particularly the last decade, have forced farmers in the Province to adapt in order to remain profitable or grow their businesses. They've had to test and adopt a variety of irrigation techniques and farm management tools to boost their water efficiency.

In an effort to support farmers to become as efficient as possible, the Western Cape Government partnered with Dutch firm eLEAF, Hortgro and the Integrated Application Promotion Programme for the European Space Agency to develop an open access online platform, using satellite and weather information, to monitor vineyards and orchards in terms of crop growth, crop water-use and leaf nitrogen content. The platform, called FruitLook, has been online since January 2012 and covers approximately 200 000 hectares (105 000 ha of wine grapes, 12 500 ha of table grapes, 30 500 ha of deciduous fruit, 12 000 ha of citrus and 21 000 ha of stone fruit).

This case study focuses on the irrigation practices and uptake of technology (field-based measurements as well as information technology such as Fruitlook) by farmers in Breede River Valley, particularly the area around Robertson. Although traditionally known for vineyards, peaches and apricots, farmers are diversifying and planting increasing amounts of citrus. Through in-depth interviews, this case study gathered important information regarding:

- Main types of irrigation used.
- What factors and technology farmers and advisors consider and use in their irrigation scheduling.
- Whether farmers and advisors use satellite and/or weather information services already available to them; as well as their eagerness to adopt new technologies.
- What they are willing to pay for satellite services and what they would like to see in such products.
- What they changed in their irrigation practices and scheduling in order to get through the drought of the past season, during which they only received 50% of their water allocations.

In-depth interviews structured around these questions allowed the researchers in South Africa to gather information on extreme water efficient farming and the use of on-farm and satellite information systems to support decision-making. This information will be relevant to all other OPERA countries where farmers have only in recent years been forced to think about water-efficient irrigation techniques.



Further to this, technical analyses were done to determine whether the existing Fruitlook programme could have added value to their decision-making. This was done by comparing evapotranspiration values from weather data, with that of the programme and soil probe data. With all this data, the researchers were able to determine the water use of the entire valley (for one particular crop), providing meaningful information to government regarding the farmers' water requirements.

A decision was made to hold individual interviews with stakeholders, rather than a workshop, for the South African case study. The reasons for this decision include:

- 1. From previous experience the researchers know that workshops are generally poorly attended by farmers. They have too many other commitments and do not like this type of environment. Getting them all in one room at the same time is also difficult, given different harvesting times of their crops.
- 2. Similarly, we have found that in such workshops, one or two people would dominate discussions (even in small groups), while the opinions of the majority of attendees are not documented.
- 3. The researchers wanted to use the interviews for both completion of the questionnaires, as well as information gathering for the other work packages for which much more detail is required. It made sense to gather all the necessary information from each farmer during one meeting, rather than to meet them at a workshop and see them again later to collect more information.
- 4. The approach followed allowed the researchers to build good, personal relationships with each of the stakeholders interviewed, which is useful should we require further information from them in the future.

Interviews were held between 15 May 2018 and 1 August 2018. Out of 44 persons contacted, 4 agricultural advisors (viticulturists/soil scientists) and 29 farmers agreed to be interviewed (total of 33 interviews conducted). **Interviews were conducted anonymously, therefore farm names cannot be provided here.** All interviewees work in the Breede River Valley around the town of Robertson, stretching towards Worcester, Ashton, Bonnievale and McGregor.

2.5 Case Study 5: Spain

Agriculture in the Mediterranean regions is facing serious problems related with present drought and the general scarcity of water resources, resulting to an increasing water demand. Such difficulties are to be aggravated due to the future predicted severe water scarcity in the Mediterranean area. Olive crop has been selected as a case study since it is a strategic economic sector representing 24% of the value of the agricultural production in the Andalusia area, covering a surface of around 1.5 million ha (about 17% of the region total surface, covering the 60% of the national surface dedicated to olive crops and 30% of the European surface), providing around 40% of the global olive oil production and around 20% of the global table olive production. It is, in addition, an important source of wealth and employment (it supports more than 22 million wages annually), element for social and territorial cohesion, a relevant agro-system of high environmental value and configurator of the Andalusian territory and culture.

The Spanish case study is focused on the Andalusian olive crop, covering a gradient of climate and crop management. Although some facilities and advice services are available in this area, the present solutions have not been properly brought into practice, thus desirable results continue to be reached. OPERA will have impact the Andalusian olive sector by:

- Identifying the concrete local barriers that had prevented the transfer of research results into the farmer and water manager practice;
- ii) Defining, adapting and applying regulated deficit irrigation (RDI) in the Andalusian olive orchards, aiming a sustainable balance between water savings and olive production;
- iii) Using those methods upscaled to the territory (by the use of earth observation technologies, territorial analysis and modelling) and tested through OPERA to define goals and advice for policy makers;
- iv) Creating a self-updating, scalable, user-friendly computing tool to be used by farmers, irrigation organizations and policy makers.



The first workshop was carried out in the Seville's Casa De la Ciencia Museum. It is an open space for the polarization of science and educational and cultural fun for everyone. Details about the sectors participated in the first workshop can be found in Table 3.

Table 3. List of institutions assisted to the workshop in Spain.

Institution	Sector	Institution	Sector
Universidad de Sevilla	Research sector	Consejería de Agricultura, Pesca y Desarrollo Rural	Regional government
Evenor-Tech	Private sector	Agencia Andaluza del Conocimiento	Regional government
Galpagro	Land user and advisory services	Confederación Hidrográfica del Guadalquivir	Regional government
EBD-CSIC	Research sector	CSIC-Andalucía	Research sector
IFAPA	Research sector	JRC-ITPS Sevilla	Research sector
IRNAS-CSIC	Research sector	AREDA	Land user and advisory services
CENTA	Research sector	TEPRO	Land user and advisory services
FERAGUA	Irrigation association	ASAJA-Sevilla	Land user and advisory services
Internacional Olivarera	Land user, private sector		

Regarding to the specific requirements for WP4, 20 interviews were carried out by phone during February and March 2019. The interviewed belonged to private sector (farmers) from 20 different entities (See Table 4).

Table 4. List of institutions participated in the interviews in Spain.

Name	Province	Name	Province
Aceites Vizcantar	Córdoba	Valles Opere SL	Granada
Agrocastril SAT	Granada	Olivarera del Genil S.C. Andaluza	Córdoba
SCA San Roque	Jaén	Oleoalgaidas SCA	Málaga
SCA Labradores de Campaña	Sevilla	Oleocampos SCA	Jaén
Santa María S.c.	Jaén	Virgen de la Cabeza – Montejicar	Granada
SCA Agrícola Carmonense	Sevilla	SAT García Morón	Jaén
SCA Agropecuaria de Herrera	Sevilla	S. c. Andaluza Aceites Cazorla	Jaén
SCA Agropecuaria Industrial Capi	Sevilla	Oleocampanas SCA	Sevilla
SCA Ntra. Señora del Rosario	Córdoba	Tepro	Sevilla
SCA Trujal de Mágina	Jaén	Nuestro Padre Jesús SCA	Jaén

2.6 Case Study 6: the Netherlands

The case study in the Netherlands is focussed on the use of weather forecasts in predicting the water availability in the root zone. Since weather forecasts are uncertain, as given by the 51 ECMWF ensemble forecasts, there is also uncertainty in the predicted crop water availability in the root zone. In the less arid region of North-Europe it is common practice to have mobile irrigation (overhead sprinkling) systems. Farmers have to decide when and where these need to be put in practice. Weather forecasts, predicted crop water availability, and additional information via sensors (local or remote) could provide the farmer additional information in optimizing his/her irrigation decisions.

In the Netherlands it was decided to have 1-to-1 interviews rather than a workshop, for similar reasons as listed above for the South-Africa case. In total 5 surveys have been conducted among stakeholders from research, water board and farming practice (Table 5). Three stakeholders participated in Survey 1: a



representative of an innovative farmer (frontrunner), a representative of a waterboard and a representative of research (Table 5). Water availability for irrigation in the Netherlands in the past was not often an issue. However, with changing climate we do experience more drought periods, and locally water boards temporarily forbid farmers to use surface water and groundwater for irrigation. When this will occur more often in the near future, there will be a need for better tuning water supply, water availability and water need.

Table 5. List of institutions assisted to the workshop in the Netherlands.

Institution	Sector	Institution	Sector
Water board Aa en Maas	Private sector	WUR Plant Research	Research
Livestock research	Research	Vandenborneaardappelen	Farmer



3 Results per case study

For each case study the results will be summarized in the following subsections. The results presented have different types of tables and figures depending on the local main focus of the workshop reports.

3.1 Case Study 1: Poland

The results from questionnaire "Adoption of Irrigation Advisory Services" show that for stakeholders in Poland the main actions to increase the competitiveness of farms are "Renewal of existing production processes", "Increasing the size of farm (merge with other farms, rent or purchase)" and "Introduction of innovative processes" (Figure 1). The less important actions were "Improving the marketing strategy of the product" and "The product innovation"

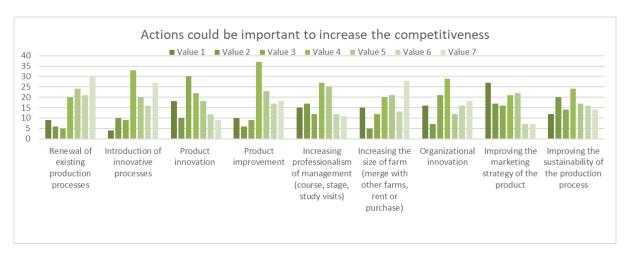


Figure 1. Actions identified as important to increase the competitiveness (Value 1 = Unimportant; 4 = Not important; 7 = Very important) (Poland case).

In the questionnaire stakeholders' approach to the new technologies was examined. They valuated (1= Strongly disagree (very untrue about me); 7= Strongly agree (very true about me) 3 sentences and the results showed that sentence "If I heard about new technology, I would look for ways to experiment with it" was the most valued (Figure 2). This result is related to the below question, the stakeholders are open to use new technologies that allow introducing innovative processes and renewal the existing production processes.



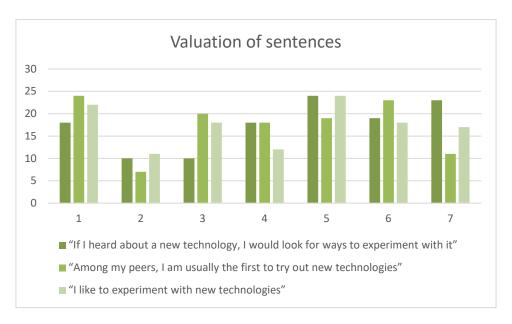


Figure 2. Valuation of sentences regarding to the use of new technologies (Value 1 = Strongly disagree (very untrue about me); 7 = Strongly agree (very true about me) (Poland case).

The stakeholders evaluated the preference between improvements proposed as:

A1: Improving easy access to the information.

A2: Ensuring coherent data and data reporting.

A3: Improving delivery efficiency.

A4: Improving private and public awareness.

A5: Assuring economic sustainability.

The results in Table 6 show us that "Improving easy access to the information" was not selected as an improvement, only when we compare with "Improving private and public awareness) we founded a light preference. Also, "Improving delivery efficiency" was selected in the same case and when we compare with "Improving easy access to the information". "Ensuring coherent data and data reporting" was selected when compare with "Assuring economic sustainability".

Table 6. Results of preferences (Poland case)

	9	7	5	3	1	3	5	7	9	
Α	Absolute preference	Very strong preference	Strong preference	Weak preference	Indifference	Weak preference	Strong preference	Very strong preference	Absolute preference	В
Options		•	•	•	•			•		Options
	12	9	18	15	28	12	18	3	1	A2
A1		12	14	15	18	21	19	12	3	А3
AI	1	9	21	22	21	16	10	10	10	A4
	1	4	12	21	26	13	27	11		A5
	2	7	17	15	43	15	10	4	2	А3
A2	5	10	14	16	27	19	14	5	5	A4
	1	4	26	17	20	12	19	11	2	A5
A3	4	7	21	19	23	14	14	10	2	A4
AS	1	4	18	19	26	12	22	4	8	A5
A4		3	12	16	26	18	12	20	8	A5



The stakeholders identified limitations, economics and administration to improve water efficiency (Figure 3). The main economic limitations were were high investment costs (irrigation equipment, well drilling, water distribution, depreciation), lack of financing forms for irrigation installations, risk of investment return, high planned (resulting from the new Water Law) costs of water abstraction for irrigation for agriculture, lack of catalogue of the best technical and organizational solutions, which would be checked in field conditions. Also, the main administrative limitations were the complexity and the time of obtaining water intake permit, lack of knowledge in administrative procedures, high administrative costs, high partiality in granting permits for water abstraction, too much bureaucracy.

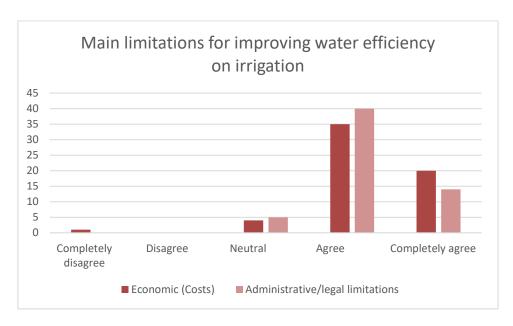


Figure 3. Main limitations for improving water efficiency (Poland case).

In addition, limitations for adopting alternative crops/varieties were identified by the stakeholders. The most was the uncertainity of prediction on market demands as well as economic (cost) (Figure 4). The stakeholders identified the following limitations: lack of specific information on agricultural products contracting (sugar beet is the only crop subject to contracting), low market price stability, limited number of reliable sources of information about market prices and predicting market needs. In addition, high cost of certified seeds and high prices of irrigation equipment necessary to obtain production every year from varieties tolerant to drought could be the main cost limitation. For prediction of market demands stakeholders use Internet, agricultural magazines, newsletters and bulletins. Among additional sources of information, respondents indicated conferences and trainings, agriculture research institutes studies and analysis (by The National Centre for Agriculture Support and Agriculture Advisory Centres, Institute of Agricultural and Food Economics).



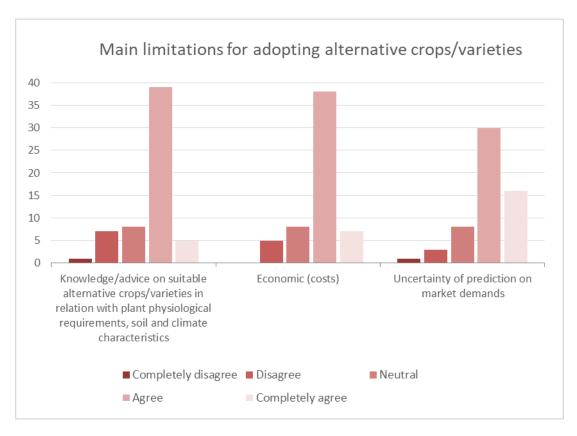


Figure 4. Main limitations identified for adopting alternative crops or varieties (Poland case).

According to the valuation of the relevance as limitation to adopt alternative crops or varieties from farmers and producers specifically, the results did not showe difference between knowledge on suitable alternative crops, costs and uncertainty of prediction on market demands (Figure 5).

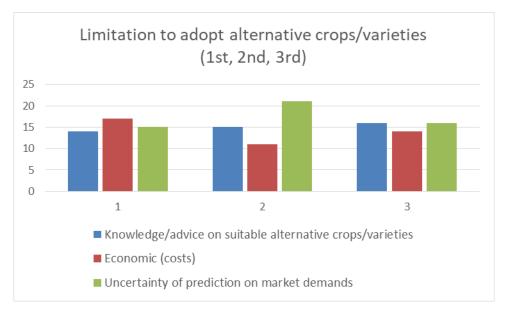


Figure 5. Relevance of main limitations identified to adopt alternative crops or varieties (Poland case).



The options preferred by the stakeholders to increase the water efficiency were improvement of the field infrastructure, improvement of the irrigation strategy and changes in the crop/variety selection (Number of votes in Table 7).

Table 7. Options preferred to increase the water efficiency (Poland case).

	Not preferred	Less preferred	Neutral	Preferred	Highly preferred
Increase on the crop density	7	21	9	21	
Improvement of the irrigation strategy		1	6	36	16
Improvement of the field infrastructure		2	3	31	23
Changes in the crop/variety selection	2	3	3	36	12

The stakholders selected from the proposal list the preferred options that advisory tool should include. The results showed prediction of water demand along the irrigation season and an advice on water restrictions management. The other options most valued were assessment ofn the present costs on irrigation and an advice on alternative crops/varieties.

At the end, the stakeholders valuated known advice tools (Table 8).

Table 8. Current tools (Poland case)

Advisory tool	Main benefits	Main problems
Weather forecast	Current information Easy access Transfer speed Possibility to forecast irrigation periods Possibility of irrigation and work planning Irrigation costs reduction	Low accuracy Incorrectness of the forecast
Weather stations	Weather conditions monitoring (amounts and intensity of precipitation, wind speed and direction) Possibility to forecast irrigation periods High accuracy	Small number of weather stations Limited range of operation
Agricultural advisory centers, chambers of agriculture, individual consultancy	Current issues Information about new products Direct contact Enriching knowledge, also on crop irrigation	Limited time of consultants' work Incorrect and incomplete advice



Brochures, leaflets	Current information Essential information Pictorial representation of information	Availability Small information flow Brief information
Conferences, trainings	Expanding knowledge Consultations Meetings with experts Exchanging experiences Discussions panels	Small number of specialized training and conferences, especially in the periods free from field work
Internet	Easy access Generality	Tendentiousness of information Viruses Limited verifiability and reliability of information
Dynamic program of vegetables farming	Adaptation to market	Weather

3.2 Case Study 2: France

The questionnaires were adapted to the French case study and the stakeholders completed the questions in online format. Although the questions and the format have some differences according to the others case studies, the meaning is the same.

The main actions selected to increase profitability on their farms were "Better sell the products", "Improve the use of water" and "Have access to additional water resources" (Figure 6).

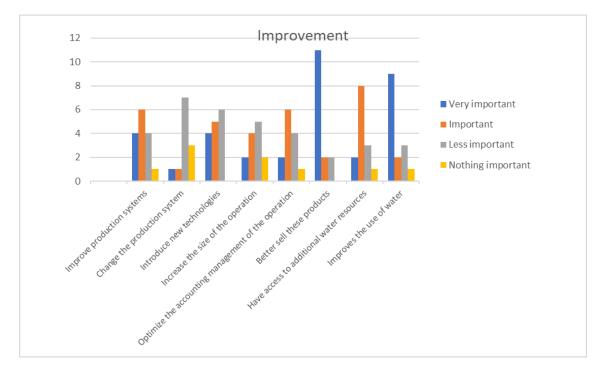


Figure 6. Improvement selected to profitability increase (French case).

Other question was the feeling about the use of new technologies, the farmers answered that they are attracted by the new technologies front "the first to adapt new technologies" and "I am reluctant to use new technologies".

The next question was what they think are the best options that allow a better use of water irrigation. The results show two main options selected "Optimization of irrigation dates and doses" and "Improvement of irrigation infrastructure" (Figure 7).



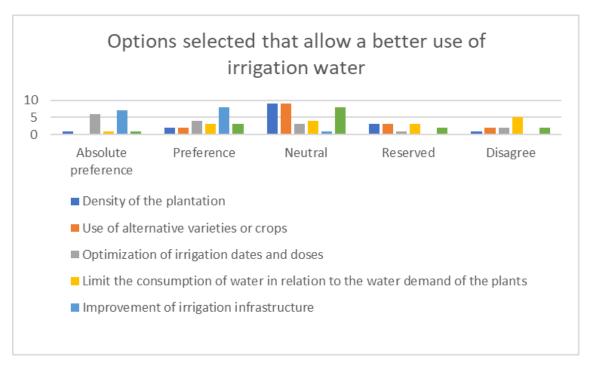


Figure 7. Options selected to water use improvement (French case).

According to the most important characteristics that an irrigation pilot services must have, the stakeholders selected "affordable cost" as the main followed by "Direct access to the information", "Easy use of information" and "Regularity in the delivery of information" (Figure 8). However, there are obstacles to implementing an irrigation control system such as costs (the stakeholders considered that the current tools are too expensive), lack of confidence in recommendations and limitation of the use of the service due to administrative decisions on the use of water (Figure 9).

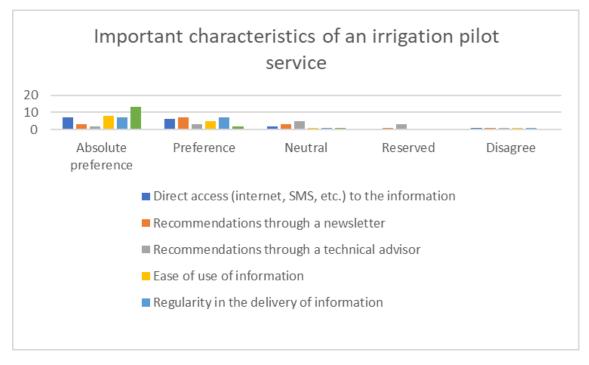


Figure 8. Main characteristics selected for an irrigation pilot service (French case).



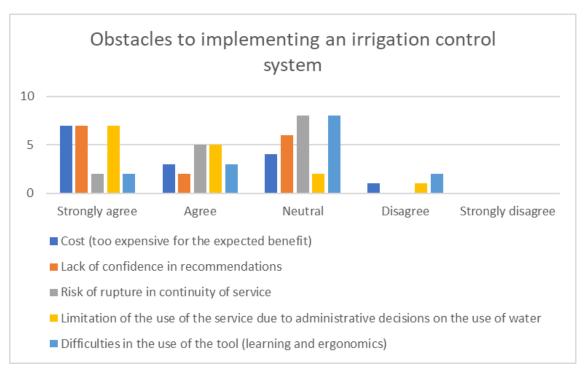


Figure 9. Main obstacles identified to implementing an irrigation control system (French case).

The obstacles identified can see reflected in the 4 barriers highlighted by the stakeholders to the implementation of irrigation control systems: financial aid, support, information and producers in association or group (Figure 10).

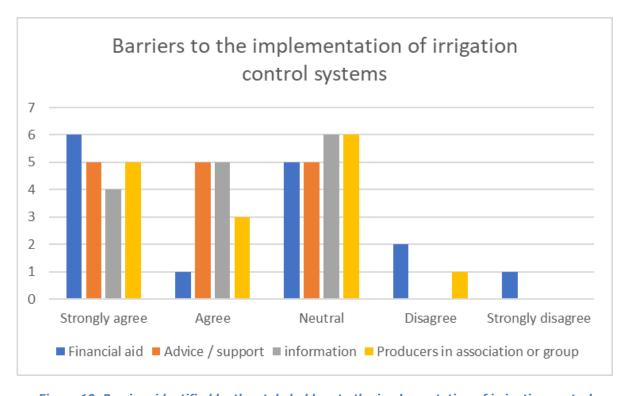


Figure 10. Barriers identified by the stakeholders to the implementation of irrigation control systems (French case).



3.3 Case Study 3: Italy

The main actions identified by stakeholders to increase their competitiveness were "Product improvement" and "Increasing professionalism of management". However, the less importance for them were "existing production processes" and "organizational innovation" (Figure 11).

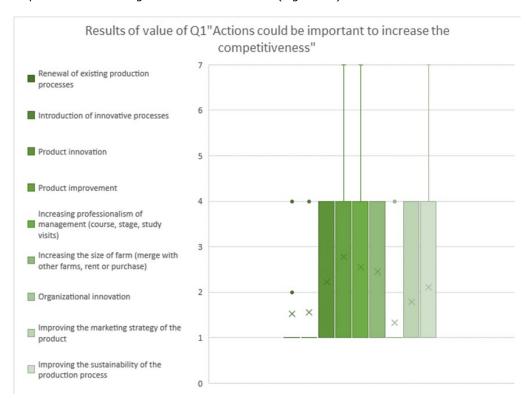


Figure 11. Actions identified to increase the competitiveness (Value 1 = Unimportant; 4 = Not important; 7 = Very important) (Italian case).

Regarding to the question about the preferences in the use of new technologies, we haven't found differences between the options provided ("If I heard about a new technology, I would look for ways to experiment with it"; "Among my peers, I am usually the first to try out new technologies"; "I like to experiment with new technologies")

The section about the preferences between improvements selected by the stakeholders, the results showed that, in many cases, they haven't precerence among the proposed options (see table). In some cases, the stakeholders selected A4 (Improving private and public awareness) and A5 (Assuring economic sustainability) as preferred options. Nevertheless, these results should be further processed with a specific methodology (Table 8).



Table 8. Results of preferences (Italian case).

	9	7	5	3	1	3	5	7	9	
A Options	Absolute preference	Very strong preference	Strong	Weak	Indifference	Weak preference	Strong preference	Very strong preference	Absolute preference	B Options
	1		6	3	10	2	5			A2
A1		1	2	4	8	8	3	1		A3
MI			4	4	9	3	7			A4
			2	1	10	3	9	2		A5
		3	1	3	8		8	4		A3
A2	1		2	2	7	2	4	9		A4
			2		10	1	7	3	4	A5
А3		1	2	1	8		4	5	6	A4
		1	2		8	3	1	10	2	A5
A4			1	·	10		6	9	1	A5

The stakeholders give the same importance to economic and administrative/legal limitations in the improvement of water efficiency. The main economic limitation was the cost of implementation in water efficiency technologies and the administrative limitations was the difficulty in every administrative process (Figure 12).

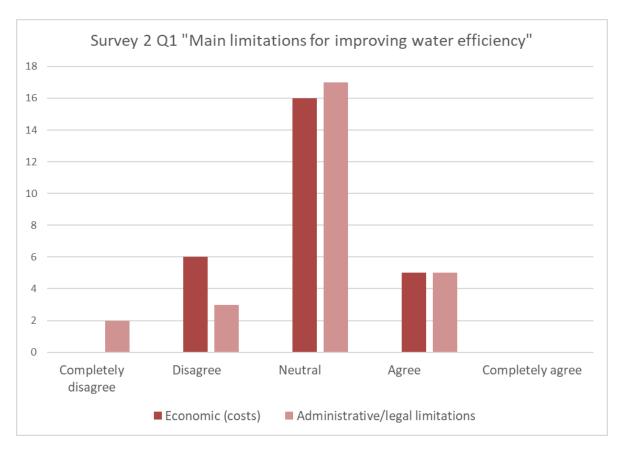


Figure 12. Limitations identified for improving water efficiency (Italian case).

The farmers found many difficulties for change to alternative crops, mainly economic but also the uncertainty of prediction on market demands (Figure 13). The same limitations were founded for adopting alternative crops (Figure 14).



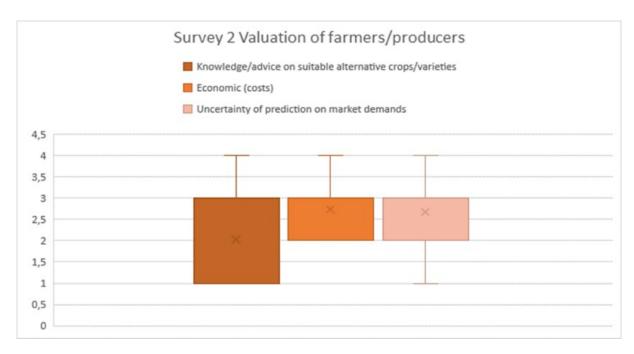


Figure 13. Valuation of main difficulties for change to alternative crops (Italian case).

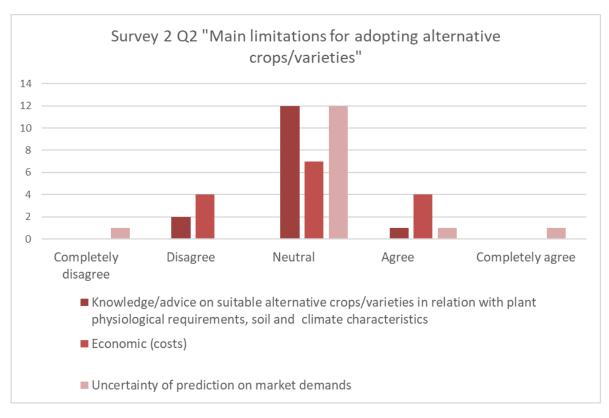


Figure 14. Main limitations identified for adopting alternative crops/varieties (Italian case).

According to the farmers' needs, "Supply chain agreements", "Agreement with the big distribution", "Marketing agreements", "Product labelling and traceability" and "Producer associations" were the preferences identified for prediction market demands tool. In addition, the farmers preferred improvement the irrigation strategy and field infrastructure, but also changes in the crop/variety versus the increase on the crop density. When the farmers were asked about the preferred options an advice tool, they selected



"costs/benefits associated to improvement of the filed infrastructure", "prediction of water demand along irrigation season" and "advice on alternative crops/varieties" as the main preferences (Figure 15).

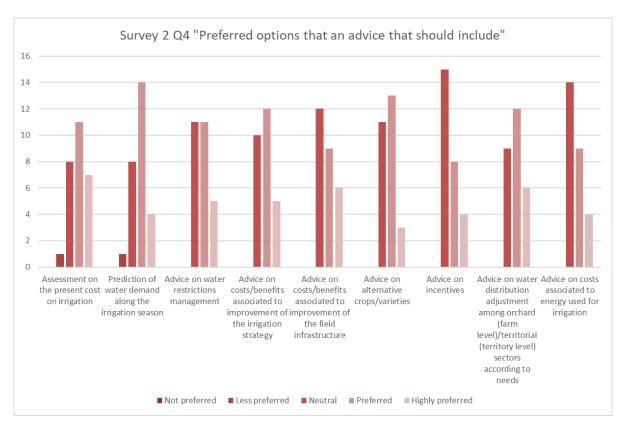


Figure 15. Preferred options selected in an advice service (Italian case).

3.4 Case Study 4: South Africa

From a general point of view, "innovative processes", "product improvement", "training" and "sustainability" were most important actions to increase their competitiveness. But the farmers had different opinions about the main actions according to the way to sell their products. The researchers were of the opinion that a separate analysis (farmers with their own cellars versus farmers selling their produce in bulk) could obtain more accurate results.

The results provided by farms with their own labels, "expanding farms/area under production", "organisational innovation" and "marketing" were the most important actions to increase the competitiveness (Figure 16). On the other hand, "product improvement", "training for their staff" and "sustainability" were the most important for the bulk suppliers (Figure 17).



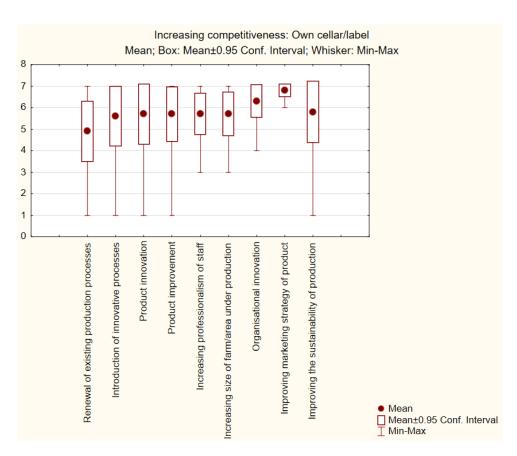


Figure 16. Actions identified to increase the competitiveness (Cellars/own label) (South Africa case).

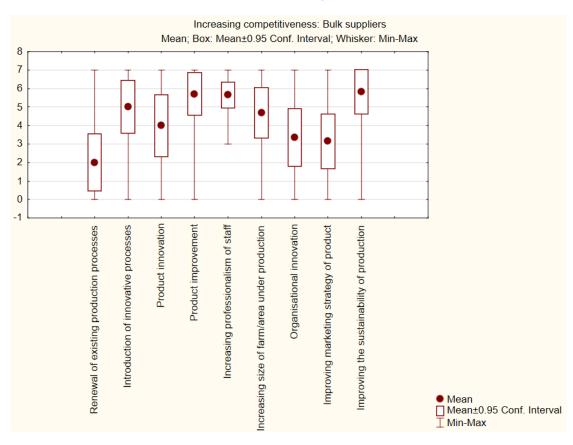


Figure 17. Actions identified to increase the competitiveness (Bulk suppliers) (South Africa case).



Table 9 summarises some key comments made by interviewees with regards to the nine categories.

Table 9. Key comments from interviews regarding to the categories (South Africa case).

Category	Key comments
Renewal of existing production processes	Those farmers with cellars and pack houses regarded this as important. It was emphasised that keeping machinery in the cellar has a big impact on the amount of juice that can be extracted from the grapes; pack houses give farmers a competitive advantage over those who have to sell everything to cooperative pack houses; and many said that continuous upgrading is essential to stay ahead in the market.
Introduction of innovative processes	Farmers described their efforts to constantly try to improve irrigation, fertiliser and equipment to farm optimally. The point was also raised this is expensive and not affordable/profitable for all farms.
Product innovation	Farmers are looking at new clones and cultivars to improve production.
Product improvement	Most farmers agreed that it is important to always try to improve the product they deliver to the market and they are continuously looking at ways to achieve this.
Increasing professionalism of staff	All farmers offer training to their farm workers and believe that this is important. Training is also required by industry standards (e.g. Wieta, Siza). However, some raised the point that the application of what they learned is often lacking.
Increasing size of farm/area under production	Most farmers mentioned that economy of scale is important and that they would like to expand, but that water is the limiting factor. It was also mentioned that there's a "tipping point" at which it makes more financial sense to farm more intensively than to acquire more land.
Organisational innovation	Farmers who ranked this high mentioned the need to "think outside the box" and "try new things" in order to move forward.
Improving marketing strategy of product	This was very important to all farmers with their own cellars or labels, and not at all important to the bulk suppliers who depend on exporters for marketing (they have no control over it).
Improving the sustainability of production	Most farmers rated sustainability very high, particularly ensuring the soils stay healthy.

The question related to how the farmers see themselves as risk-averse, neutral or seeking, the most of them answered that they are risk-neutral, noting that they prefer to take calculated risks. According to the use of new technologies, the most farmers indicated that they like to try new technologies, but, they first want to check what others do or that the new technology has to warrant the cost (Figure 18).



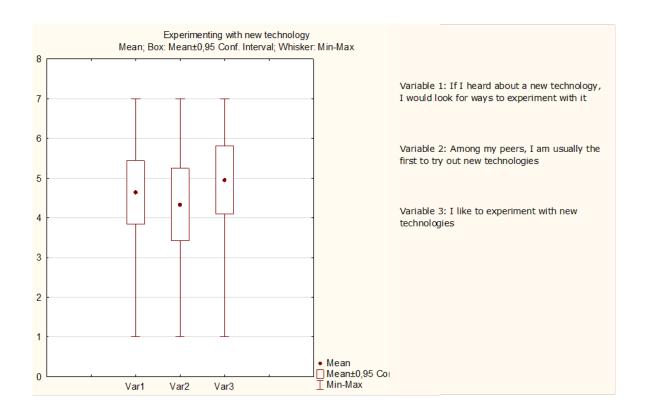


Figure 18. Valuation of sentences regarding to the use of new technologies (Value 1 = Unimportant; 4 = Not important; 7 = Very important) (South Africa case).

To improve the water efficiency, the farmers answered that they are highly efficient and won't change anything further. However, they considered that "cost of infrastrucure" and the need for dams are the most limitating to improve efficiency (Figure 19).

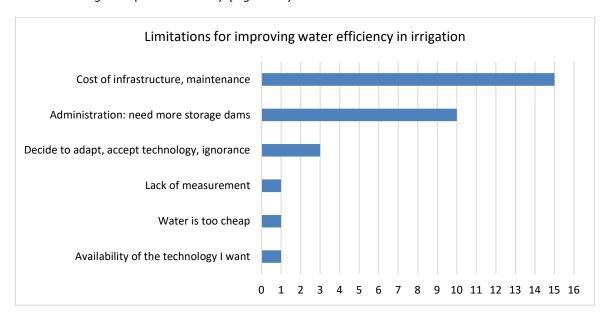


Figure 19. Limitations identified for improving water efficiency (South Africa case).



Three farmers mentioned how the lack of private storage dams leads to inefficiency. Reasons include:

- "What I receive (from the irrigation scheme) is a given. I only have a two-day buffer to apply the water I receive. I have to use what I get, when I get it."
- "If we didn't have a dam, we would have to over-irrigate to get our allocation otherwise it flows into the ocean."
- "People have the fear that 'if I don't use it, I'll lose it'. People will then rather use their water out of fear that it will be taken away."
- Due to old laws, existing dams are too shallow, "this means that there's high evaporation because the dam is shallow. We're a water-scarce country and need deep dams with lower losses."

According to the crop preference, vineyards, apricots and peaches are traditional to this area, although wine grapes are the predominant crop. Over the past few years there has been significant diversification in the area, the main reasons being a good international market (favourable exchange rate for export), as well as stretching the season – and thereby labour use, water use, and importantly the cash flow for the farmers. Citrus (lemons, naartjies, clementines) is particularly popular, with most farms now having at least a small amount (e.g. around 5 ha) of citrus. However, farmers overwhelmingly answered that they are unlikely to switch crops based on climate change predictions. Most farmers consider vineyards to be the best suited crop for the area, being the most water-efficient. Water availability is seen by most in light of the other crops that need more water (fruit), not vineyards. Climate change does not play a big role in farmers' decisions about the crops they are planting and will plant in the foreseeable future – they plant according to market needs and will rather try new cultivars and clones of wine grapes than to switch crops (Figure 20).

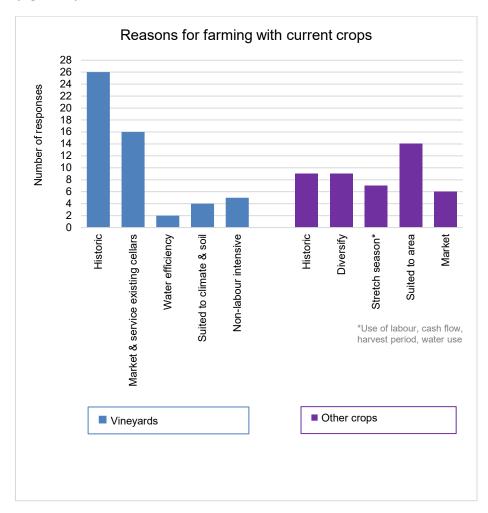


Figure 20. Main reasons provided by farmers to maintaining current crops (South Africa case).



However, the key limiting factor for the type of crops that they can plant is the water availability. There is also a strong emphasis on the current (foreseeable future) market demands and profitability as being a limiting factor to planting new crops, much more so than an uncertainty about the predictability in the market. Infrastructure as a limiting factor relates to the fact that most farms are historically designed (pump houses and irrigation) for vineyards, with a bit of orchards. To change crops might mean that all infrastructure would need to be changed too, which would be too expensive (Figure 21).

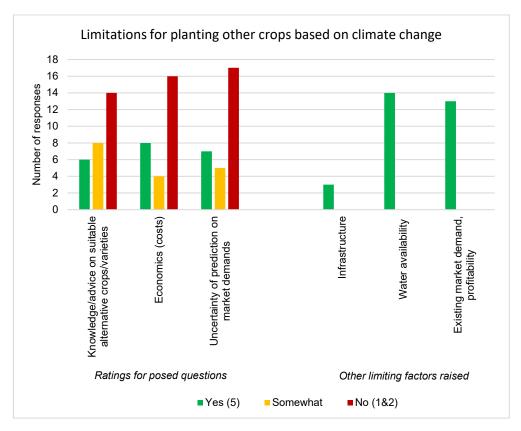


Figure 21. Limitations identified for planting other crops based on climate change (South Africa case).

According to current advice tools, 88% (29 out of 33) of farmers and consultants interviewed said that they have heard about Fruitlook (free remote sensing product that provides 20 x 20m resolution images for most of the Western Cape; data provide are biomass index, leaf area index, evaporation deficit, actual evaporation and plant nitrogen levels) and some have played around with it a bit, but only 3 farmers and 2 advisors actually use the programme.

No one had any knowledge of other similar products available. Three farmers indicated that they would like to have drones that provide these types of images, but the technology is not at a suitable standard in South Africa yet. Farmers who use iLeaf (programme linked to weather station that, with a subscription, clients get 10-day weather forecasts, hourly humidity, ET_0 , rainfall and wind data; the programme also contains climate modelling to predict risk for diseases, as well as reports on cold units, dew and frost risk, amongst others) are mostly interested in the weather forecast (rain and wind) to plan for spraying.

There are no incentives related to water in South Africa (farmers receive their allocation and pay a set price). The cost of different irrigation options (drip vs micro) is known to the farmers, they do not need this in an advice tool.

Farmers are not keen on receiving additional information to what they already have for their farms. 17 persons interviewed use continuous logging soil probes according to which they adapt their irrigation scheduling (in combination with using experience and instinct). An additional three use Neutron moisture meters, with only five not using this technology, relying on topsoil samples and visual plant physiology only. It was clear from the interviews that the farmers trust their probe information and do not see the need for receiving much more information than this. After approximately three years, the farmers perceive



the soil probe data as an accurate reflection of crops' water use patterns and thereby the accuracy of their scheduling. It was quite clear that farmers would prefer personal advice from consultants rather than to rely on an advice tool or modelling product.

With regards to climate data, eight interviewees reported to receive climate data (forecasts, humidity, wind, ET_0 etc.) either from their own weather stations or from the cellar, or from chemical representatives. The rest rely on weather websites and are happy with this approach. The needs for climate modelling products are thus not high – farmers are mainly interested in wind and precipitation forecasts.

Crop-related information, as well as information on alternative varieties, are received at open days, information sessions or from consultants and representatives. Farmers do not see the need to have these in an advice tool.

All farmers were very satisfied with the information they receive from the Water Users' Association regarding water availability for the season, restrictions and other regional information. About half of the farmers did indicate that it would be nice to receive dam levels and other water-related information on an advice tool.

3.5 Case Study 5: Spain

The main actions identified by the farmers to increase the competitiveness were "product improvement", "product innovation" and "increasing professionalism of management" (Figure 22).

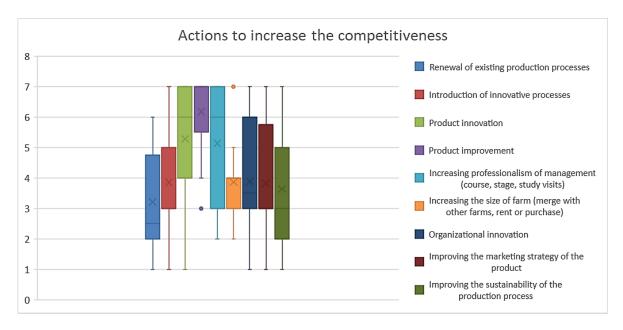


Figure 22. Actions identified to increase the competitiveness (Spanish case).

According to the valuation of sentences to know the feeling from farmers to use new technologies, the results showed that the farmers are curious, looking for information about the technology and ways to experiment with it. However, some farmers answered that they didn't like to experiment with news technologies. In addition, the farmers stakeholders commented that the innacuracy of market demands and the high costs for implementing new technologies are very important risks (Figure 23).



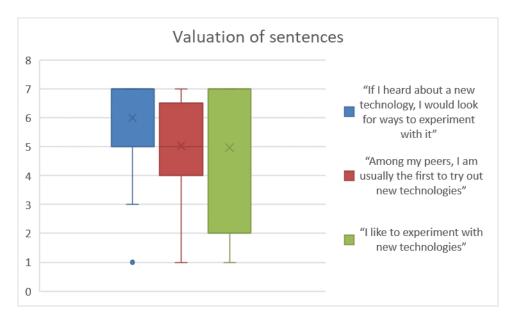


Figure 23. Valuation of sentences regarding to the use of new technologies (Value 1 = Unimportant; 4 = Not important; 7 = Very important) (Spanish case).

According to the potential improvements, the stakeholders evaluated the following 5 preferences:

A1: Improving easy access to the information

A2: Ensuring coherent data and data reporting.

A3: Improving delivery efficiency.

A4: Improving private and public awareness.

A5: Assuring economic sustainability.

The results showed (Table 10) that "Ensuring coherent data and data reporting" was the improve more selected by the stakeholders when was compared with "Improving private and public awareness" and, slightly, with "Improving easy access to information" and "Improving delivery efficiency". This may be due to the stakeholders have access a lot of data but with unfriendly language.

Table 10. Preferences selected by stakeholders (Spanish case).

	9	7	5	3	1	3	5	7	9	
A	Absolute pre	Very strong	Strong prefe	Weak prefer	Indifference	Weak prefer	Strong prefe	Very strong	Absolute pre	В
Options										Options
A1	1	1		1	10	6	3	3	2	A2
		2	3	4	11	2	3	1	2	A3
			3	5	13	4	2	1		A4
		1	. 2	1	11	6	2	2	3	A5
A2	2	2	3	6	7	4	1	2	1	A3
	1		7	7	10	2		1		A4
	1	2	2	5	11	4	1	2	1	A5
A3		2	3	6	12	3		1	1	A4
		2	1	3	15	3	1	2	1	A5
A4			2	1	15	4	2	2	2	A5



The majority of stakeholder answered that Costs and Administration (Figure 24) were the main limitations for improving water efficiency (Expensive products, investment cost, lack of agility by the administration, little promotion of advisory services by public administration, etc.).

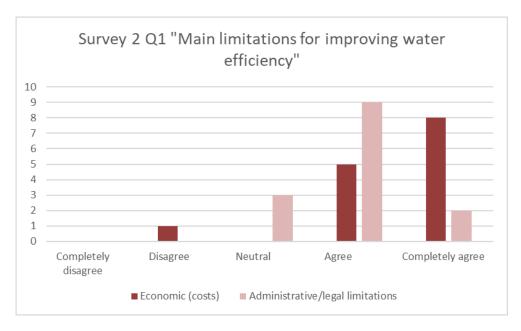


Figure 24. Limitations identified for improving water efficiency (Spanish case).

According to the main limitations for adopting alternative crops, the results showed that the costs and the uncertainty of prediction on marked demands. In this sense, the tools preferred for prediction on market demands are:

Local market Workshops
Infodays Private and sectorial meetings
Regional Administration of Agriculture Consumer surveys

The results show also the flexibility of farmers to change to alternative crops (average: 2.43). Also, the main limitations to adopt alternatives crops are costs and uncertainty of prediction on market demands (similar results of stakeholders group) (Figure 25).



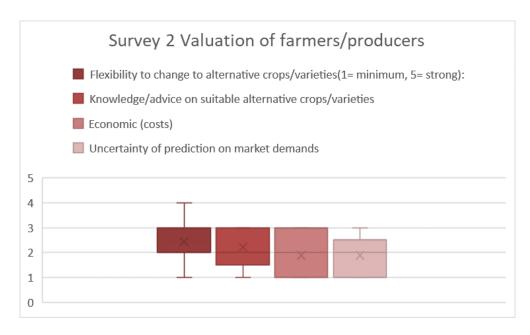


Figure 25. Valuation of main limitations to adopt alternatives crops (Spanish case).

The stakeholders preferred improvement of the field infrastructure, irrigation strategy and change in the crop selection versus the increase on the crop density. In addition, the preferred options that an advice tool should include are "costs/benefits associated to improvement of the field infrastructure" and "the irrigation strategy" also (Figure 26).

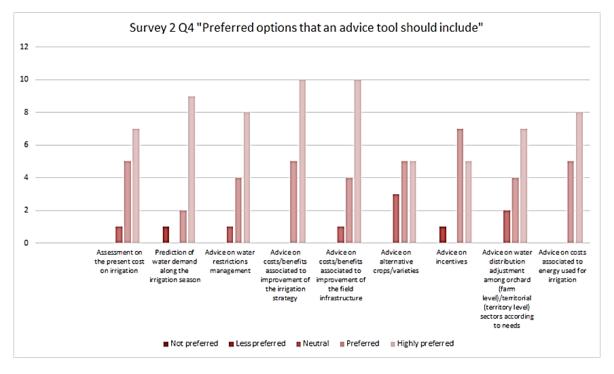


Figure 26. Preferred options selected for an advice service (Spanish case).

The current tools used for stakeholders have many benefits and problems. The summaries of characteristics are represented in the Table 11.



Table 11. Main benefits and disadvantages identified of the current tools (Spanish case).

Name	Main benefits	Disadvantages
Direct consulting of climate forecasts (AEMET)	Free, easy, updated information	Large-scale, inaccuracy, complicated to interpret for irrigation
Estimations through data from Agro-Climate Stations	Free, availability, friendly, more accurate	No prediction, not tell when, how or how much to irrigate, maintenance
Own sensors	Quality and specific data	Need to interpret
Drones	Precision data	High cost
Satellite images	Cheaper than drones	The availability of data is conditioned.

3.6 Case Study 6: the Netherlands

According to the reactions it could be important to increase the competitiveness, and the stakeholders indicated that it is important to improve the sustainability of the production process (Figure 27).

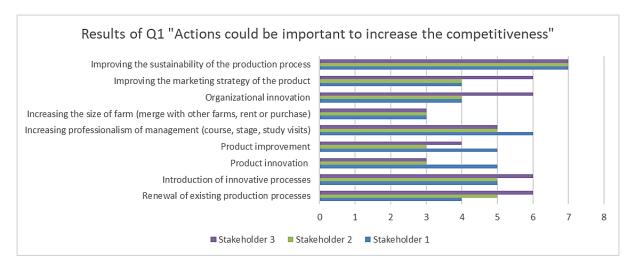


Figure 27. Actions identified to increase the competitiveness (the Netherlands case).

In addition, according to the valuation of sentences, the stakeholders answered that they like to experiment with new technologies and look for ways to experiment with it.

According to the potential improvements, the stakeholders evaluate preferences between improvements proposed.

- A1: Improving easy access to the information
- A2: Ensuring coherent data and data reporting.
- A3: Improving delivery efficiency.
- A4: Improving private and public awareness.
- A5: Assuring economic sustainability.



Table 12. Results of preferences (the Netherlands case).

	9	7	5	3	1	3	5	7	9	
Α	Absolute preferen ce	Very strong preferenc e	Strong prefere nce	Weak prefere nce	Indiff erenc e	Weak prefere nce	Strong prefere nce	Very strong preferenc e	Absolute preferen ce	В
Optio ns										Optio ns
A1							3			A2
			1		1	1				А3
			2	1						A4
					2	1				A5
A2		1	1	1						А3
				2		1				A4
			1		1	1				A5
А3				2			1			A4
						2	1			A5
A4				2			1			A5

The results showed (Table 12) that "Ensuring coherent data and data reporting" had a light preference but the rest did not show differences between improvements. Also, there are no striking economic and administrative limitations for improvements of the water efficiency on irrigation (Figure 28). In the Netherlands, most of the time (in the past), there is enough water and humidity to have good soils and moisture levels. It is only required in some dry periods in the year.

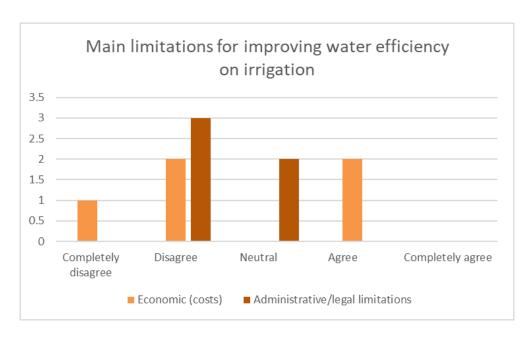


Figure 28. Main limitations identified for improving water efficiency (the Netherlands case).

Investments, when growing high value crops are cost efficient. The frontrunner farmer who is part of the survey points out those measures will lead to increased production and decreased water use. So, he reaches double positive effects. Good systems are quite expensive, especially to cover all production fields. For most crops the growing patterns change every year due to rotating cropping systems. Therefore, drip



irrigation is too expensive. Most farmers do not invest in smart irrigation systems. They use the overhead sprinkling irrigation quite frequently to avoid risks of droughts. Administrative burdens are not limiting very much the decision to invest in improving the irrigation. But it is relevant in dry areas, where the availability of ground water is limited. During dry periods farmers are not allowed to use this groundwater for irrigation and/or they do not easily get permissions. Positive is that provinces are interested in supporting precision farming, to develop regulations to stimulate investments. So, farmers may find support for more sustainable practices and investments.

Respondents are interested in alternative cropping. There is already quite some knowledge about alternative crops. The limitations are merely coming from economic factors and market uncertainties. Most farmers are conservative regarding their farming system; it is a big step to grow new crops. Farmers have contracts with a cooperation. It is not so easy to change productions and value chains. And there is much demand for regular products, so the push for other practices is missing. Most growers think that adaptation of varieties will lead to decrease of production on the short term. Most limiting probably is the uncertainty on required investments versus the prices and the risks that are higher in an initial stage of growing a new crop. Farmers change their practice only when there are urgencies.

There is not much investment of farmers in knowledge development. Plant breeding is focussing in the context of plant diseases. The growers do not struggle with limitations on water and nutrients, so they do not demand for other crops or varieties. The urgency is missing. The frontrunner farmer, a potato farmer, is not interested in other crops, but in other varieties of potatoes, which are better resistant to droughts and wet circumstances. The market uncertainty is the most important aspect. Market demand is leading for decisions on production of certain crops or varieties. But the market asks for the products that the growers actually are delivering. There are yet not many problems in growing them or with their quality. Quality is most important factor for the market. The market demand doesn't lead to limitation in the of use of water; the more use of water, the better results. The less use of water, the more risks of bad quality products. To create a new market, the infrastructure and the production chain needs to be developed. This will take time and it is seen as a risk.

For the participants, the most preferred option is to improve the irrigation systems on field level. The capacity of irrigation is limited, because the majority of the farmers do have only 1 or two overhead sprinkling installations, which cannot be used for all parcels. Next to that, the technique of the nozzle is not perfect. Farmers are often too late, because they wait for the rain, which may not arrive (Figure 29).

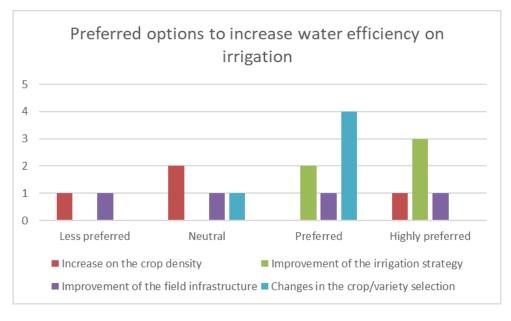


Figure 29. Preferred option selected to increase water efficiency (the Netherlands case).



Next to this option, changes in crops or in varieties are being pointed out as preferred options for improvement, to make them more resistant against wet and drought circumstances. For 2 of the 5 respondents also the improvement of the field infrastructure is seen as a preferred option.

The most preferred options (Figure 30) for an advice tool focus on the following aspects:

- Prediction of water demand along the irrigation season
- Advice on costs/benefits associated to improvement of the irrigation strategy
- Advice on alternative crops/varieties

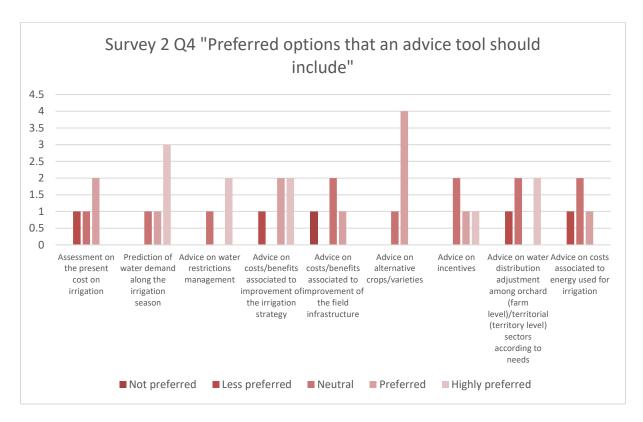


Figure 30. Preferred option selected for an advisory services (the Netherlands case).

There is a growing interest to irrigate more optimal, by using different techniques and combinations of data regarding specific sensors to measure the moisture of the soil, to use remote sensing, to make use of better weather forecasts information systems and predictions. It is clear that the investment costs for famers in technology in relation to expected prices and income, are relevant for the decision to invest in new technologies and information. Big data is entering arable farming. A combination of information will increasingly determine farmers decisions about irrigation. One farmer is already experimenting with robots who are able to make optimal decisions in farming practices.

Next to that, there is a clear interest in the development of alternative varieties and/or in new crops, who are more resistant towards specific dry or wet circumstances, for example due to climate change. Another need is being articulated, namely the relative efficiency of certain crops or varieties compared to other crops, other varieties, in various production areas. Farmers would like to improve and optimize their production in terms of quality and sustainability and would like to show it to buyers and consumers.

These innovative practices need exploration and testing. Therefore, incentives and funding are relevant. Advice on incentives is not mentioned a lot, but the innovative farmer is very keen in seeking support in knowledge, advice and finance.

Famers have already a good overview of the costs of irrigation. A frontrunner farmer who invested in new technologies such as the use of sensors and weather predictions pays 150 euro per hectare per year. He



saves 50% of the amount of water and he realises a 12% higher yield with precision irrigation. Another respondent mentions that there is no clear and convincing insight in the revenues of measures.

Some respondents are interested in improving the field infrastructure, to arrive to more optimally growing structures and irrigation systems. Some respondents are interested in the costs of the use of energy, because it is a relevant cost. Farmers will irrigate less because of the energy costs; they won't take any risks that crops might have to low water inputs. So, energy will not be the main issue for tool or service development.

Next to the suggested tools and services, the concept of the water footprint did come forward in two of the interviews. The farmer mentioned that all his buyers of potatoes make demands on sustainability and efficient use of water for crop growing. But, these companies are not eager to pay higher prices or to support in the investments of farmers. A researcher mentioned that the relevance of the water footprint is known but does not lead to more sustainable investments and practices.

In the Netherlands an irrigation tool has been developed by Wageningen University and Research, the water board and the farmers organisation; www.beregeningssignaal.nl; This tool is built on data and maps of the soil (1:50000), for some crops (maize, grass, potato, sugar beet and spinach), evaporation, soil texture, level of ground water and crop rotation schemes. The tool use weather forecasts (3-5 days) and historic weather information. The tool gives advices on irrigation to arable and dairy farmers. Also economic advice will be given, for example on irrigation of meadows for a higher yield of grass or purchase of feed for cattle. Actually, the tool has 150 users, who pay 200 euro per year. The tool needs 1000 members to be cost effective.

Another tool: www.akkerweb.nl Akkerweb compiles all the information in one central geo-platform. Within Akkerweb, the 'crop rotation application', set up using geo-data, forms the foundation for all the functionalities that provide an added value for farm operations, such as fertilisation and crop protection. Akkerweb consists of basic information of soils, weather forecast, with information on lot level.



4 Evaluation of the workshops and interviews

A total of 233 stakeholders participated in the OPERA project from different types of entities (research sector, private sector, land user and advisory services and governmental administration) (Figure 31).

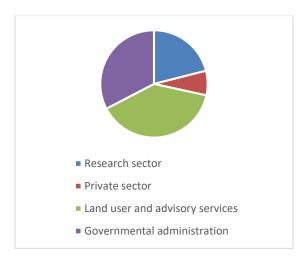


Figure 31. Types of entities participants in the OPERA project.

The number of participants was different between case studies, but the information obtained was in each case very interesting. For example, the Netherlands case study only had 5 stakeholders, however, the information compiled show us that the are no remarkable economic and administrative limitations for improvements of the water efficiency on irrigation. Only in dry areas could these limitations be important. From a general point of view, the stakeholders highlighted the market uncertainty such as the main limitations for adopting alternative crops or varieties.

The flexibility of implementing the methodology for identifying and compiling the information by stakeholders, such as France case study, allows to identify single barriers or limitations according to the country. For example, if we analyse all data compiled about the actions that could be important to increase the competitiveness, the results showed us that the main actions are "product improvement" and "increasing professionalism of management" (course, stage, study visits). This result is similar with Italy and Spain, but not for the other countries. Since not always general conclusions could be obtained for all countries it still can be said that some actions should be performed to the local/national needs.

The strategy adopted by South Africa partner provided a lot of useful information about the needs or requirements of stakeholders. For example, the market needs are the most important driver and they prefer to try new varieties and clones of wine grapes than to switch crops irrespective of climate change scenarios that may arise. According to the questions about current advice tools, this was adapted to the category of stakeholders and local circumstances. For example, farmers are acutely aware of irrigation costs, as well as electricity costs per irrigation type (there is only one electricity service provider in South Africa). Some questions were also combined into one, for example information relating to water restrictions, distribution and demand predictions, as farmer currently receive all this from their Water Users' Association (WUA).

If we compare the results obtained per country, differences between actions to increase the competitiveness and the preferences between improvements could be proposed (Table 13).



Table 13. Compilation of actions to increase the competitiveness and improvements per country.

Country	Increase competitiveness	Preferences between improvements
Poland	Renewal of existing production processes Increasing the size of farm Introduction of innovative processes	Improving delivery efficiency Light preference "Improving easy access to information"
France	Better sell the products Improve use of water Have access to additional water resources	No data collected
Italy	Product improvement Increasing professionalism of management	Light preferences "Improving private and public awareness" and "Assuring economic sustainability"
South Africa	Farms with own label: Increasing the size of farm Organizational innovation Marketing Bulk suppliers: Product improvement Training for their staff Sustainability	No data collected
Spain	Product improvement Product innovation Increasing professionalism of management	Ensuring coherent data and data reporting.
the Netherlands	Improve the sustainability of the production processes	Ensuring coherent data and data reporting.

For example, "Increasing the size of farm" can be found only in Poland and South Africa. "Improving marketing strategies" is important for farmers from France and South Africa and "Training for their staff" was selected by farmers from South Africa, Italy and Spain. In addition, according to the selection of the improvements proposed, the most of the results didn't show great differences; for example, "Ensuring coherent data and data reporting" was selected in the Netherlands and Spain.

If we analyse the barriers per country, we can find similar results for improve in water efficiency and adopting alternative crops (Table 14)

Table 14. Compilation of barriers for water efficiency and adopting alternative crops per country.

Country	Water efficiency	Adopting alternative crops
Country Poland	Economic: High investment costs. Lack of financing forms for irrigation installations. Risk of investment return. Lack of catalogue of the best technical and organizational solutions Administrative:	High cost of certified seeds. Lack of agricultural produces contracting. Uncertainty of prediction prices and market demands. Lack of specific information and trainings on soil, water, climate,
	Administrative: Complexity and time to obtaining water intake permit. High administrative costs. High partiality in granting permits for water abstraction. Too much bureaucracy.	trainings on soil, water, climate, fertilizer and cultivation requirements for plants drought tolerant.



France	Economic: High cost of irrigation control system. Administrative: Administrative limitations according to decisions on the use of water.	
Italy	Stakeholders given the same importance between the proposed factors.	Costs. Uncertainty of prediction market demands.
South Africa	The stakeholders considered themselves highly efficient. However, they mentioned that improving field infrastructure and adapting their irrigation strategies are the best way to improve efficiency.	Crops according to the market demands.
Spain	Economic: Expensive products; investment costs. Administrative: Lack of agility by the administration; little promotion of advisory services provided by public administration.	Costs. Uncertainty of prediction market demands.
the Netherlands	Economic: High prices of good systems	Costs Uncertainty of prediction market demands

The cost of sensors or the high investment costs are the main barriers for the stakeholders involved to improve the water efficiency. The time to obtaining water intake permit, or lack of agility are the main administrative barriers. On other hand, the uncertainty of prediction market demands and the infrastructure costs are the main limitations to adopting alternative crops.



5 Other information

Difficulties encountered:

The availability of time for some users means that meetings (workshops) must be organized in a single day. Also, particular care should be addressed to the timing of agricultural field operations in order to have farmers' presence.

The season of the workshop must be selected carefully, in the case of Spain, the second workshop was cancelled due to storms and the farmers could not attend. However, they were open to participate and provide information by phone.

Changes made concerning the procedure suggested in the workshop guidelines:

Due to the availability of some of the participants in the first Spanish workshop, the groups classified before the workshop had to be modified due to the absence of some participants. However, a proportion according to the objectives of the project was maintained. The questionnaire for the second workshop was adapted to phone interview.

The French case study made the questionnaires by internet allowing to the stakeholders complete the exercises in their available time.

How was the interest and participation of the different stakeholder groups in the workshop?

All the attendees showed a good level of motivation and interest in the Spanish workshop. Only representatives of CSIC-Andalusia and the Guadalquivir Hydrographic Confederation remained during the opening ceremony and after they leaving for reasons of agenda.

All the attendees, in the Italian workshop, showed a good level of motivation and interest but not everyone agreed with the level of proposed innovation. In this respect, it emerged that different stakeholders' groups were interested into different aspects. CONSBIV interest is more oriented to the water management at territorial level including water saving, cost recovery and water consumption monitoring. Farmers seemed to be more interested in economic saving and in the value of agricultural production. Finally, SME was interested to the development of an ICT based solution to be useful for both mentioned stakeholders' groups.



6 References

Blanco-Velázquez, F.J. and M. Anaya-Romero. 2018. Identifying sector needs to increase resource use efficiency. Deliverable D1.1 of the OPERA project. Available at: http://opendata.waterjpi.eu/dataset/opera-operationalizing-the-increase-of-water-use-efficiency-and-resilience-in-irrigation/resource/09d7444c-c5e2-4473-835b-9c28f27d20d3.

Domingo, A. (2008). Descenso literario a los infiernos demográficos. Barcelona: Anagrama.

Dougill A J, Fraser EDG, Holden J, Hubacek K, Prell C, Reed MS, Stagl S, Stringer L C, 2006. Learning from Doing Participatory Rural Research: Lessons from the Peak District National Park. Journal of Agricultural Economics 57 (2), 1477-9552. Doi: 10.1111/j.1477-9552.2006.00051.x 2006

European Environment Agency (EEA). 2016. Climate change, impacts and vulnerability in Europe. An indicator-based report. ISBN: 978-92-9213-835-6

Freeman, R. E., Strategic Management: A Stakeholder Approach, Pitman Press, Boston, 1984

FAO. 2017. Discovery-based learning on land and water management: A practical guide for farmer field schools. Rome. 348 pp. http://www.fao.org/3/a-i6897e.pdf

Leventon J, Fleskens L, Claringbould H, Frelih-Larsen A, Schwilch G, Bachmann F, Stringer L, 2014. Stakeholder and Institutional Analysis (Deliverable 4.1). RECARE Project Report, 147 pp. www.recare-project.eu

Miah JH, Griffiths A, McNeill R, Poonaji I, Martin R, Morse S, Yang A, Sadhukhan J, 2015. A small-scale transdisciplinary process to maximising the energy efficiency of food factories: insights and recommendations from the development of a novel heat integration framework. Sustainability Science 10, 621–637. Doi:10.1007/s11625-015-0331-7

Njoroge R, Birech R, Arusey C, Korir M, Mutisya C, Scholz RW, 2015. Transdisciplinary processes of developing, applying, and evaluating a method for improving smallholder farmers' access to (phosphorus) fertilizers: the SMAP method. Sustainability Science 10, 601-619. Doi:10.1007/s11625-015-0333-5

Orta-Ortiz, D. G. (2018). Assessing Mismatches in the Provision of Urban Ecosystem Services to Support Spatial Planning: A Case Study on Recreation and Food Supply in Havanna, Cuba. Water.

Prell C, Hubacek K, Reed MS, 2009. Stakeholder Analysis and Social Network Analysis in Natural Resource Management. Society and Natural Resources 22 (6), 501-518. Doi:10.1080/0894192080219920

Roberts, A. K. (2018). Sustainable Agriculture- Enhancing Environmental Benefits, Food Nutritional Quality and Building Crop Resilience to Abiotic and Biotic Stresses. Water.

Scholz RW, Steiner G, 2015. Transdisciplinarity at the crossroads. Sustainability Science 10, 521-526. doi:10.1007/s11625-015-0338-0

WWF. 2015. Agriculture: facts and trends, South Africa. WWF-South Africa.



Annex 1 Guide cover and surveys template

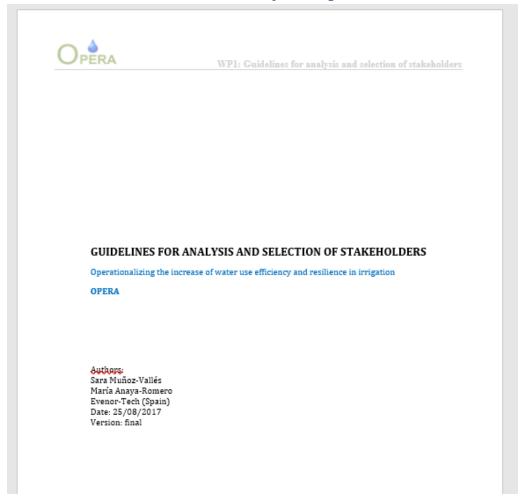


Figure 32. Guide cover

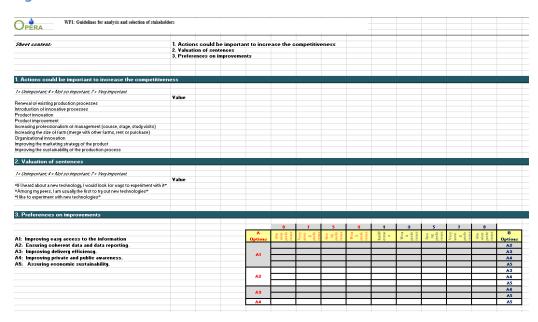


Figure 33. Survey 1 template



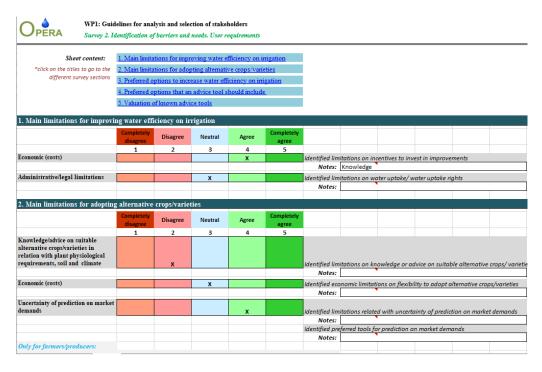


Figure 34. Survey 2 template



Annex 2 Pictures

Figures 35 and 36. Pictures from Italian workshop





Figures 37 and 38. Pictures from Spanish workshop





Figure 39. Drip irrigation from South Africa Case Study. Figure 40. Variable Speed Drives





Figures 41, 42, 43 and 44. Pictures from Polish workshops









