MED-GOLD

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Turning climate-related information into added value for traditional **MED**iterranean **G**rape, **OL**ive and **D**urum wheat food systems

Deliverable 2.1

Report on the Knowledge capitalization of the olive oil sector

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Lead Beneficiary	DCOOP	
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TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

Executive Summary

The production of olives and their processing into table olives and olive oil are heavily affected by weather and climate and their variations. A specific group of climatic conditions occurring in a particular moment of the farming campaign affects radically the pending yield and/or the health of the olive trees. This deliverable aims to identify the critical decisions for the olive sector, which will be used to design a tool able to resolve the current needs for this sector and get added value through Climate Services (CS).

This document provides a guideline for the whole Work Package 2 (WP2), in particular for the development of the olive pilot under the project framework. The document shows the results of data collected during the WP2 workshop, in which 20 agronomists from Dcoop participated. These results are the cornerstone to understand the needs of the agronomist who will use the pilot in the future as a tool for improving farm advising and crop management.

With this deliverable, the project has contributed to the achievement of the following objectives (DOA, Part B Table 1.1):

No.	Objective	Yes
1	To co-design, co-develop, test, and assess the added value of proof-of-concept climate services for olive, grape, and durum wheat	X
2	To refine, validate, and upscale the three pilot services with the wider European and global user communities for olive, grape, and durum wheat	
3	To ensure replicability of MED-GOLD climate services in other crops/climates (e.g., coffee) and to establish links to policy making globally	
4	To implement a comprehensive communication and commercialization plan for MED-GOLD climate services to enhance market uptake	X
5	To build better informed and connected end-user communities for the global olive oil, wine, and pasta food systems and related policy making	X

1. INTRODUCTION

In the past, olive crops have accompanied the rise of the first Mediterranean civilizations because it related to economical, ecological, cultural sectors of the first nations and constituted an enduring legacy for following generations. In the Neolithic period, fruits were harvested from wild olive trees. Cultivation of the domestic trees appears to have been established approximately 6000 years ago. The olive oil and table olives have been produced by many ancient cultures over thousands of years (G. Besnard et al., 2012) [RD.1] Its fruits have been a source of food, and other components, such as wood were used as raw materials. Finally, parts of the tree had a symbol status, underlining the popularity of the olive tree. Nowadays, olives are the most important crop in the Mediterranean region and are cultivated mainly for olive oil and as table olives (both staples of the Mediterranean diet). The olive sector is the principal economic sector for some regions within the European Union (EU) (E. Leguen de Lacroix, 2002) [RD.2].
The European Union is the largest producer of olives in the world (E. Leguen de Lacroix, 2002) [RD.2]. About 5 million hectares of plantations, from which approximately 70% of worldwide olive oil and around 30% of table olives are produced (Rossi, R. 2017) [RD3]. The EU is also the principal consumer olive products (about 70%). Olive crops are a principal element in the agricultural economy of several regions of southern Europe, and the economic value of the European production achieves more than 7.000 million €. The 5 million hectares of olive plantations is divided amongst nine EU Member States: Spain (more than half of the total), Greece, France, Croatia, Italy, Cyprus, Malta, Portugal, and Slovenia. In 2013, regular farm labourers in olive sector exceeded 35% in Spain (Rossi, R. 2017) [RD.3].

According to data from the International Olive Council (IOC), the olive farming campaign of 2016/2017 produced 1.751.500 tonnes of olive oil and 841.900 tonnes of table olives in the EU, which may be compared with the global production of these products, 2.586.500 and 2.929.500 tonnes respectively. In the same season (2016/2017) Spain produced 1.290.600 tonnes of olive oil and 596.100 tonnes of table olives (International Olive Council, 2018) [RD.4] and [RD.5]. In other words, Spain produces a third of the global production (Agencia Andaluza de Promoción Exterior. 2017) [RD.6]. The principal producer region in Spain is Andalusia where approximately 1.561.950 ha of olive land are cultivated in around 170.000 olive farms (Consejería de Agricultura, Pescas y Desarrollo Rural, 2017) [RD.7]. They are located mainly in 5 provinces of Andalusia, in decreasing order: Jaen, Cordoba, Granada, Malaga, and Seville (see Annex A, Figure A-4). Olive trees are the main crop of these regions and almost everyone its population normally has some connection with this trees. Andalusia is divided into 8 provinces where there are 12 PDOs. (see Annex A, Figure A-5) (Consejería de Agricultura, Pescas y Desarrollo Rural. 2018) [RD.8].

The olive crop is considered to be one of the best biological indicators of the Mediterranean climate by some researchers (G. Besnard et al., 2012) [RD.1]. Olives are highly vulnerable to climate change (CC), which alters both average and extreme temperatures and precipitation patterns. These changes in turn influence crop yields, pest levels and weed ranges and the length of the growing season (Anonymous. 2008) [RD.9].

The wider Mediterranean region has been identified as one of the main climate change hot-spots (Giorgi, F. 2006) [RD.11], i.e. one of the most responsive areas to climate change. In particular, as shown by the results of a series of climate model simulations under various emission scenarios temperatures in the Mediterranean are projected to rise significantly by the end of the 21st century, while precipitation is projected to decrease (Giorgi, F., and X. Bi, 2005) (Giorgi, F., and Lionello, P., 2008) (Zanis, P. et al., 2006) [RD.12; RD.13; RD.16]. Furthermore, studies focusing on changes in temperature and rainfall extremes project that heat stress (Diffenbaugh, N.S et al., 2007) (Kuglitsch, F. et al., 2010) [RD.10; RD.15] and the duration of drought periods (Goubanova, K. and L, Li., 2007) [RD.14] will drastically increase in the Mediterranean region in the future.

Spanish researchers have already suggested that some keys area of Spanish olive oil production such as Catalonia may become unviable within 20 years owing to these increasing temperatures and water shortages (Tupper N. 2012) [RD.17]. Spain is thought to be highly susceptible to climate change, with the Mediterranean Sea rising by eight centimeters in the last 50 years and an average increase in temperature of 0.028 degrees Celsius per year (Tupper N. 2012) [RD.17]. Studies have shown that the flowering period of olives trees is highly dependent on the spring temperatures, which are rising steadily over time (Ozdemir Y. 2016) [RD.18].These changes seem to disrupt the olive trees´ behavior in order to adapt to new agronomic and environmental conditions which could affect yields, annual productions and health of the olive trees and farms. Some examples of climate variations and their consequences could be:

- Increasing numbers of storms; they cause damage to the trees and soil erosion. Moreover, the number of days with rain is decreasing and the precipitations are more irregular during the year hence the availability of water in the soils for plants is reduced.
- The trend of increasing drought in the last years is more severe than in the past. For this reason, total olive production from some farms that do not irrigate their crops is reduced due to a shortage of water. Also, the droughts of the last few years are more prolonged, beginning before summer, thus increasing water stress and decreasing the yield.
- The temperature has increased in winter, thus increasing the pest risk for olive trees and hampering the flowering. Rising temperatures during the growing season reduce yields and quality.

- The wind gains importance in some farming activities. The phytosanitary treatments and the harvesting must be carried out in the absence of strong winds.

The climate affects directly the biological cycles of trees; in the specific case of the olive crop the climate determines the production, yield, and quality of olives and of the products derived from them (oil and table olives). Better climate and weather prediction and forecast could assist with the planning of the farming campaign, in order to maximize the production and the quality for the final product offered to the end consumer.

It has been well known for many years now, that the products based on olive crops are very dependent on climate (Anonymous 2008) [RD.9] however; it is during the last years that the connection between Climate Change (CC) and the adaption of the olive trees was recognised as an important parameter affecting the olive sector.

Andalusia is the largest regional producer in the world; consequently, the primary and secondary sector of activity in Andalusia's economy depends upon the production of olives. For this reason, Andalusia, along with other regions in Europe, must take into consideration that CC could force a change in its business model, which should be gradually adapted to these new conditions.

MED-GOLD, inter alia, will design and implement three pilot studies based on climate services to create a useful tool for agricultural sector predictions, in order to strengthen risk management in different scales of time (seasonal and long-term). These services will improve the adaptation capability and resilience of grapes, olives and durum wheat to climate change.

Research has shown that the soil conditions, the climatic variables of the area, the cultural values of its population and even the environmental characteristics are parameters which affect the olive sector (Moral, E et Lanzas, J,. 2008) [RD.19]. Additionally, the type of relief, the management of the olive farms, the types of the olive farms, the ages of the trees, the irrigation systems, among others, influence directly the olive production. For this reason, the scope of the workshop was to recognize the current needs with the most influence in this sector so MED-GOLD considered a participatory workshop to be the principal channel for getting the olive sector´s knowledge planned in WP2.

To achieve the goal of this task, WP2 partners organized and held a workshop in order to obtain knowledge close to the reality of current agriculture practices and realities. The Workshop tapped the real needs agronomists. Furthermore, the event led to the selection of climatic variables and timescales more appropriate and representative to be incorporated in the olive tool. Finally, the WP2 workshop brought together two critical sectors: technology and agriculture. Normally there exists a gap between these two, as the farmers have difficulties in applying new technologies in their traditional activities.

1.1. PURPOSE

This document defines the needs and key decisions in the olive sector; therefore it sums up the workshop held on 12 June 2018 at the Assembly Hall of Dcoop´s offices in Antequera, Malaga, and its conclusions.

The main aim of the workshop was to provide the theoretical framework for the Work Package 2 (WP2) in order to design an useful tool to improve the olive crop through Climate Services (CS) and their predictions.

This document attempts to address some critical issues such as:

- To identify the critical agronomic parameters for olive crops and the key decisions. This must be made during the farming campaign.
- To define the optimal moment for each decision making in the olive sector.
- To define the most relevant climatic and weather variables. This could affect the quality of the crop and decision making regarding production.
- To collect the variables that could be added to the pilot for assisting the olive crop.
- To understand the kind of information needed by agronomist in their daily tasks.
- To study the most important timescale in each key decision.
- To identify the climate indices that could be most useful for the olive pilot service.

1.2. DEFINITIONS AND ACRONYMS

1.2.1. DEFINITIONS

Concepts and terms used in this document and needing a definition are included in the following table:

Table 1-1 Definitions

Concept / Term	Definition
Agronomist	The person who manages the olive fields from Dcoop and advises farmers about best practices for improving their crops.
Farmers	Organization or person associated to DCOOP SCA who owns olive fields.
Field Technical Department (FTD)	Is a Department from Dcoop. This department is a service to farmers and first-degree cooperatives (the olive mills) associated with Dcoop. The workers from this department are agronomists and they work in the fields all year.
Presenter	A MED-GOLD person who facilites the workshops and Interactive Sessions
Time keeper	A MED-GOLD person who is responsible for keeping the time during the workshop
Facilitator	A MED-GOLD person who explains each step of the sessions, clarifies questions and manages the group
Rapporteur	A MED-GOLD person who takes notes during the workshop at the end of Interactive Session 1 and 2 and reports back the conclusions to the wider group.

1.2.2. ACRONYMS

Acronyms used in this document and needing a definition are included in the following table:

Table 1-2 Acronyms

Acronym	Definition
EU	European Union
MED-GOLD	Mediterranean Grape, Olive and Durum wheat food systems
IOC	International Olive Council
CAPDER	Consideraría de Agricultura Pesca y Desarrollo Rural (Ministry of Agriculture, Fish and Rural Development)
AEMET	Agencia Estatal de Meteorología (Spain)
RAIF	Red de Alerta e Información Fitosanitaria
NOAA	National Oceanic and Atmospheric Administration

1.2.3. ABBREVIATIONS

Abbreviations used in this document and needing a definition are included in the following table:

Table 1-2 Abbreviations

Abbreviations	Definition
CS	Climate Services
WP2	Work Package 2
DOA	Description of the Action
CC	Climate Change
FTD	Field Technical Department
FG	Focus Group
PDO	Protected Designation of Origin
ET0	Potential evapotranspiration
ºC	Degrees Celsius
€	Euro
$	Dollar

2. REFERENCES

2.1. REFERENCE DOCUMENTS

The following documents, although not part of this document, amplify or clarify its contents. Reference documents are those not applicable and referenced within this document. They are referenced in this document in the form [RD.x]:

Table 2-1 Reference Documents

Ref.	Title	Date
[RD.1]	G. Besnard, B. Khadari, M. Navascue´s, M. Ferna´ndez-Mazuecos, A. El Bakkali, N. Arrigo, D. Baali-Cherif, V. Brunini-Bronzini de Caraffa, S. Santoni, P. Vargas and V. Savolainen (2012). The complex history of the olive tree: from Late Quaternary diversification of Mediterranean lineages to primary domestication in the northern Levant. Proceedings of the royal society B. 7 pp. collected: http://rspb.royalsocietypublishing.org/content/280/1756/20122833	2012
[RD.2]	Eugene LEGUEN DE LACROIX, European Commission, Directorate-General for Agriculture (2002) The olive oil sector in the European Union 6 pp	2002
[RD.3]	EPRS | European Parliamentary Research Service Author: Rachele Rossi Members' Research Service PE 608.690 (2017). The EU olive and olive oil sector Main features, challenges and prospects.14 pp	2017
[RD.4]	International Olive Council (2018) *World Olive Oil Figures*. Collected: http://www.internationaloliveoil.org/estaticos/view/131-world-olive-oil-figures	2018
[RD.5]	International Olive Council (2018) *World Table Olive Figures. Collected:* http://www.internationaloliveoil.org/estaticos/view/132-world-table-olive-figures	2018
[RD.6]	Agencia Andaluza de Promoción Exterior, Junta de Andalucía. (2017) Estudio del aceite de oliva de Andalucía. 16 pp.	2017
[RD.7]	Consejería de Agricultura, Pescas y Desarrollo Rural, Junta de Andalucía. (2018) Aforo de producción de olivar en Andalucía campaña 2017-2018. 33 pp	2017
[RD.8]	Consejería de Agricultura, Pesca y Desarrollo Rural (2018) *Aceite de oliva virgen extra: Tradición milenaria*. Junta de Andalucía. Collected: https://www.juntadeandalucia.es/organismos/agriculturapescaydesarrollorural/areas/industrias-agroalimentarias/calidad-promocion/paginas/denominaciones-calidad-aceite-oliva.html	2018
[RD.9]	Anonymous, 2008. California Climate Adaptation Strategy - Final Report A report to the Governor of the State of California in Response to Executive Order S-13-2008. California Natural Resources Agency. California, USA.	2008
[RD.10]	Diffenbaugh, N.S., Pal, J.S., Giorgi, F., Gao, X.. Heat stress intensification in the Mediterranean climate change hotspot. Geophys. Res. Lett. 34(11). http://dx.doi.org/10.1029/2007GL030000	2007
[RD.11]	Giorgi, F. Climate change hot spots. Geophys. Res. Lett. 33(8). http://dx.doi.org/10.1029/2006GL025734	2006
[RD.12]	Giorgi, F., *and* X. Bi. Updated regional precipitation and temperature changes for the 21st century from ensembles of recent AOGCM simulations, Geophys. Res. Lett., 32, *L21715, doi:*10.1029/2005GL024288	2005
[RD.13]	Giorgi, F., Lionello, P. Climate change projections for the Mediterranean region. Global Planet. Change 63(2), 90-104.	2008
[RD.14]	Goubanova, K., and L. Li. Extremes in temperature and precipitation around the Mediterranean basin in an ensemble of future climate scenario simulations, Global Planet. Change, 57, 27–42, doi:10.1016/j.gloplacha.2006.11.012	2007
[RD.15]	Kuglitsch, F. G., A. Toreti, E. Xoplaki, P. M. Della-Marta, C. S. Zerefos, M. Türkeş, *and* J. Luterbacher. Heat wave changes in the eastern Mediterranean since 1960, Geophys. Res. Lett., 37, *L04802, doi:*10.1029/2009GL041841	2010
[RD.16]	Zanis, P., Kapsomenakis, I., Philandras, C., Douvis, K., Nikolakis, D., Kanellopoulou, E., Zerefos, C. and Repapis, C. Analysis of an ensemble of present day and future regional climate simulations for Greece. Int. J. Climatol., 29: 1614–163	2009
[RD.17]	Tupper N. 2012. Spanish olive oil under constant threat from climate change. Olive Oil Times, October 26.	2012
[RD.18]	Ozdemir Y., 2016. Effects of climate change on olive cultivation and table olive and olive oil quality. Scientific Papers. Series B, Horticulture. Vol. LX, 2016. 65-69, 2016.	2016
[RD.19]	Moral, E et Lanzas, J., 2008. The exportation of virgin olive oil in Andalusia: dynamics and decisive factors. revista de estudios regionales nº 86, I.S.S.N., pp. 45-70.	2008

3. APPRAISING NEEDS AND CRITICAL DECISIONS

Farmers and agronomists are considered as potential users of olive climate services from WP2. This pilot will focus on the critical decisions for the olive crop hence the first step for developing a climate service for the olive sector is to collect the point of view from farmers or person who works in the olives farms. Through a workshop, MED-GOLD will recognize the needs in this sector and will assess those climatic variables for adding the most useful in order to assist to the farmers with them critical decision because a WP2 goal is improving the olive oil sector in a short and long term.

As a first step in the development of the climate service for the olive sector in order to recognize the current need in the sector, WP2 organized a participatory workshop where farmers, people working in farms and agronomists were the principal actors.

Dcoop has its own Field Technical Department (FTD) with 19 agronomists who work in olive fields and assist the farmers with their olive trees, olive season, etc. It was decided to organise a participatory workshop in which the whole FTD from Dcoop would participate. All the agronomists answered questions set out by WP2 and the information collected has been summarised and studied in order to be the basis for the development for the olive tool.

The workshop was organized by all the partners from WP2, especially the University of Leeds, NOA, ENEA, GMV, BSC, ec2ce, and Dcoop. The Spanish partners in WP2 took part in the workshop and helped to reach a correct working in each FG responding the doubt from agronomists.

Also, Consejeria de Agricultura, Pesca y Desarrollo Rural (CAPDER) was invited by WP2 for participating in the MED-GOLD event. This regional government explained its European projects in the agri-food sector and observed the methodology of the workshop.

3.1. WP2 WORKSHOP

In WP2, MED-GOLD held a participatory workshop with the whole Field Technical Department of Dcoop, which is like a representation of the whole olive sector as Dcoop is the largest producer of olive oil and table olives in the world. The event was held on 12 June 2018 at the Assembly Hall of Dcoop´s offices in Antequera, Málaga. The workshop was an institutional and technical event attended by representatives from several institutions such as the Consejería de Agricultura Pesca y Desarrollo Rural (section of the Andalusian Government focusing in the agri-food sector), and some of the Spanish MED-GOLD project partners (GMV, BSC, ec2ce, and Dcoop). Each organization participated in discussion tables to understand the needs of the sector.

Approximately a total of 30 people attended the workshop, among which whole Technical Field Department (TFD) from Dcoop, 19 agronomists, was involved and grouped in three round tables as participants. The information collected was analyzed and will be used as a starting point for the development of climate services for farmers and agronomists. These services will foster olive trees sustainability, as they will enable fact-based decision making such as deciding the best timing and frequency for olive trees new olive groves plantation. Together with the participants, MEDGOLD identified the main meteorological variables for seasonal forecasts and climatic projections that will affect future decisions in the olive oil sector.

A participatory workshop is one of the most effective methods for gaining knowledge, where the agronomists are the principal actors. The participants were assigned into Focus Groups (FG) in order to pursue the answers to the workshop questions. They also discussed different topics of climatic variables that affect olive farms. The workshop was run by a Presenter and a Timekeeper who controlled time consistency in the workshop. In every FG, 2 people from MED-GOLD acted as Facilitator and Rapporteur. Both helped in achieving smooth discussions of every FG and took notes on the farmers' concerns, the vulnerabilities of the sector and its particular needs. The agronomists wrote their answers and opinions and this information was collected, analyzed and summarized by MED-GOLD

3.1.1. METHODOLOGY:

The workshop language was Spanish, the native language of the agronomists. For this reason, non Spanish partners of WP2 had difficulties in attending the workshop but collaborated in the preparation of workshop. The University of Leeds designed and prepared all material for the WP2 workshop: presentation, matrix, consent form, among others. ENEA and NOA created a list of climatic indices.

The event was divided in two types of activities:

During the first activity, an institutional presentation was organized, each Spanish partner from MED-GOLD (GMV, BSC, ec2ce, and Dcoop) could explain its role in the project and its experience in Climate Services. CAPDER made a brief presentation about the sub-platform called "Traceability and Big Data" for the European agri-food sector. CAPDER could be a potential member of MED-GOLD Community. The aim of this first part of the workshop was to introduce MED-GOLD to the agronomists, explain the meaning of climate services and the capacities of the Consortium in order to improve the olive sector.

The second activity, which was organized in order to be in an interactive session, involved 19 participants who were organized randomly into 3 FGs (see Annex A-2) in order to establish heterogeneity within each FG:

- FG 1 was composed by 6 agronomists from Dcoop as participants and one rapporteur from BSC and one facilitator from ec2ce.
- FG2 was composed by 7 agronomists from Dcoop as participants and one rapporteur from BSC and one facilitator from ec2ce MED-GOLD´s partners.
- FG 3 was composed by 6 agronomists from Dcoop as participants and one rapporteur from GMV and one facilitator from BSC

In this second activity the University of Leeds had created a presentation for using as a guideline in the whole olive workshop. The participants discussed and exchanged information about agronomic variables from the olive crop, just as the parameters of weather (short term) and climate (long-term) which affect the olive value chain. Also, the participants indicate the type of climatic data that could be used by this sector and the ideal moment for supplying the forecast and turned into added value.

The interactive session of WP2 workshop was structured in three sessions:

1. Identifying key farming decisions. In this session the post-it were used (see Annex C) and the agronomists followed next points:
    a. To write the key decisions you normally make to manage your farming operations (write one decision per post-it)
    b. Using the same post-its, describing how often and when each of those decisions are normally made.
    c. Using the same post-its, writing the main weather conditions that mostly affect each of those decisions.
    d. Using the same post-it, describing the weather information you use to help you manage and support that decision.
    e. Within your group discuss the potential similarities regarding: key decisions, timing for such decisions; and weather conditions.
2. Potential for using weather and climate information. In this session the matrix were used (see Annex C) and the agronomists followed next points:
    a. Looking at the key decisions you identified in the interactive session 1, put aside the decisions that can be improved by having access to weather/climate information that would better support your decision-making process?
    b. Using the matrix provided, place the post-its you selected according to the type of weather/ climate information you need and the time of the year you would normally have to make that decision.
    c. Using the matrix, write on the post-its the type of variables required for each decision.
    d. Looking at the matrix and the post-its, identify the 2 or 3 most critical decisions to your production/farming activities
    e. Within your group discuss any potential similarities regarding the weather/climate information required by participants in relation to the decisions identified
3. Potential for using climate indices. In this session, a list with the climatic indices were used (see Annex C) and the agronomists followed next points:
    a. Using the list of climate indices provided, the agronomist answered the next question about every indices:
        i. Would it be helpful to this information?
        ii. Why would it be useful to have access to this information?
        iii. How would this help you with your farming activities?
        iv. When would it be used to have access to this information?
    b. Can you add any other critical aspects in terms of weather than can affect your farming operations?

3.1.2. RESULTS

At the workshop's end, documents filled out by the participants were collected by MED-GOLD. The documents, Post-it notes, Matrix, and lists of climate indices were analyzed to understand the needs of the olive sector. For this task, a full account of the outcomes of the FGs was reported in spreadsheets prepared by the University of Leeds in order to identify the information most relevant to WP2.

In the FGs, the agronomists wrote and answered all questions for every interactive session. Then they had time for discussing within their FGs the potential similarities in the topics of each session, and for sharing opinions. Finally, the rapporteur of the each FG reported on the results and on the resemblances with the other FGs:

Similarities from FG I:

- Interactive Session 1: This FG identified two critical decisions as the most relevant in the olive farms: Fertilizer and irrigation. Both have a connection with some weather variables such as precipitation, humidity, and temperature and will use forecast for 1 week in advance. Finally, this FG indicated that the website of the weather isn´t reliable for more than 15 days ahead.
- Interactive Session 2: Fertilizer, irrigation, and phytosanitary treatment are affected by the weather, mainly precipitation and humidity (in particular the accumulated rain which determines the irrigation and fertilization) and temperature (maximum and minimum temperature because of influences in pests). Also, this FG indicated that soil type determines the humidity of the soil and this agronomic parameter must be known to the agronomists in order to optimize irrigation and fertilization.

Similarities FG II:

- Interactive Session 1: The climatic variables most relevant are precipitation, temperature, and wind. Thi FG identified two scales of time:
    - Short term (between 3 days and 1 month in advance): the critical decisions identified were: Phytosanitary treatment, Irrigation, and fertirrigation, pruning.
    - Long-term (10-20 years in advance): agricultural machinery and design of plantation.
- Interactive Session 2: Fertilizer and phytosanitary treatment are affected by the weather, mainly precipitation (accumulated precipitation in the year and number days with rain). Flowering in spring is affected by temperature and wind.

Similarities FG III:

- Interactive Session 1: This FG identified 3 critical decisions: Fertilizer (it is affected by precipitaton accumulated and forecast in 1 month in advance), phytosanitary treatment and irrigation (it is affected by precipitation accumulated and expected). Both have a connection with some weather variables such as precipitation, humidity, and temperature and will use forecast for 1 week in advance. Finally, this FG accessed the websites from the weather in order to know the parameters for few days in advance.
- Interactive Session 2: Phytosanitary treatment is affected by the weather all the year because usually, it applies 3-4 treatments per year. Another key decision is the fertilizer; for this, it is necessary to use seasonal forecasts from Spring to Autumn. There are 3 climatic variables of most relevance:
    - Precipitation for numerous agronomics tasks in olive fields, the participants needs information about the rainy days, the litres accumulated and forecast during all year.
    - Temperature and wind are important for several tasks in olive farms in particular for knowing the flowering time in spring.

3.1.3. DISCUSSION

In conclusion, the general similarities shared by the 3 FGs were:

- Critical decisions: primarily fertilizer and phytosanitary treatments, secondary the irrigation.
- The most important climatic variables: Precipitation and temperature; secondary, wind speed and direction.
- The timescale of climatic information which is the most useful is the short-term forecast (3 days to 1 month). The long-term projections (10-20 years) are useful only for specific tasks such as the design of the plantation.

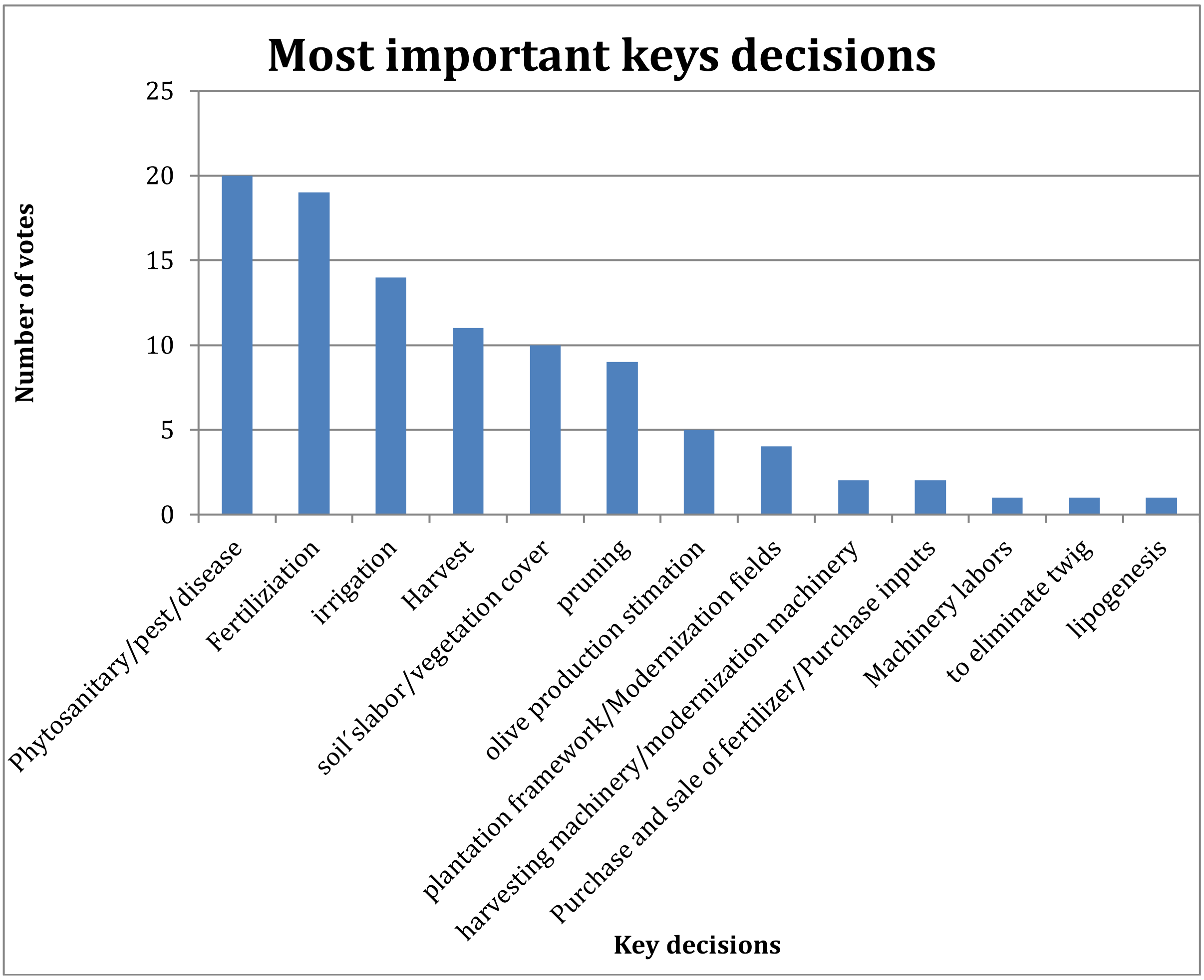
However, these results are dependent on many factors such as the area, relief, the management system, the cropping system and the irrigation strategy. Therefore, priorities of the key decision might change in others areas of Europe. This strong dependence on the type of farming must be incorporated in the tool and be overcome through different options available to farmers. In the workshop participated agronomists who manage a many type of olive farms in different locations, for this reason the needs were identified may be considered the global need for the olive sector. Although the results from similar workshops may change in other parts of the Mediterranean area, these results can be used as a starting point for the tool.
After the workshop, all the information was analyzed and the results from each interactive session are shown in the following paragraphs:

3.2. INTERACTIVE SESSION 1. IDENTIFYING KEY FARMING DECISIONS

In the first point of the Interactive Session 1, the participants of this session wrote on the post-it provided the key decisions that they make to manage your farming activities. Every participant could write as decisions as they want and each written decision was considered as one vote.
The conclusions from the information collected in the first Interactive Session were:

- The agronomists identified 21 key decisions that could be important for the olive crop. However, some of the decisions were common for almost every agronomist while others were highlighted only by one or two agronomists (see Figure 3-1). Hence the decisions can be classified in several critical levels:
    - First critical level:
        - Phytosanitary treatment/pest/disease. This group of critical decision received 20 votes,
        - Fertilization. This group of critical decision received 19 votes
        - Irrigation. This critical decision received 14 votes
    - Second critical level:
        - Harvesting,
        - Soil´s labor/vegetation cover. This group of critical decisions received 10 votes.
        - Pruning. This critical decision received 9 votes.
        - Olive production estimation. This critical decision received 5 votes.
        - Plantation framework/Modernization fields. This group of critical decisions received 4 votes.
    - Last critical level:
        - Harvesting machinery/modernization machinery. This group of critical decisions received 2 votes.
        - Purchase and sale of fertilizer/ purchase inputs. This group of critical decisions received 2 votes.
        - Machinery labours. This critical decision received 1 vote.
        - To eliminating twig. This critical decision received 1 vote.
        - Lipogenesis. This critical decision received 1 vote.

Figure 3-1 Number of votes for each key decision.



Others points from the Interactive Session 1:

- The climatic parameters used by agronomists in the key decisions are: temperature, humidity, precipitation, wind, solar radiation, and evapotranspiration; but the most important are: precipitation, temperature, and wind
- Regarding the type of information, the participants look into average, minimum, maximum, accumulated, real data, forecast. They access several websites: AEMET, eltiempo.es, closest meteorological station (RIA), RAIF, NOAA meteoclimatic and accuweather.com. Some agronomists consult the rain meters. In a particular case, of one agronomist whose work is focused on fertilizer, accesses the website for currency exchange (€/$), TERRENT, Infomac, Fertecam. These websites are visited by the agronomist during the olive season; they access these websites daily, every 3 days, weekly or monthly, but the most common is every 3 days or weekly.
- The most critical season is spring. In this season, many agronomic activities are carried out. However, there is a need for different forecasts that can improve decision making during the whole year.

Finally, some differences were detected based on great heterogeneity of the kind of olive crops, location, productions systems, amongst others, managed by Dcoop. Some agronomists only manage non-irrigated land or only work in mountainous olive plots and other specific situations. For this reason, the needs and priorities can change among the agronomists.

3.3. INTERACTIVE SESSION 2. POTENTIAL FOR USING WEATHER AND CLIMATE INFORMATION

In this session, the agronomist selected which key decisions can be improved by having access to weather and/or climate information thus supporting the making decision. Then, the participants used the matrix indicating the type of weather/

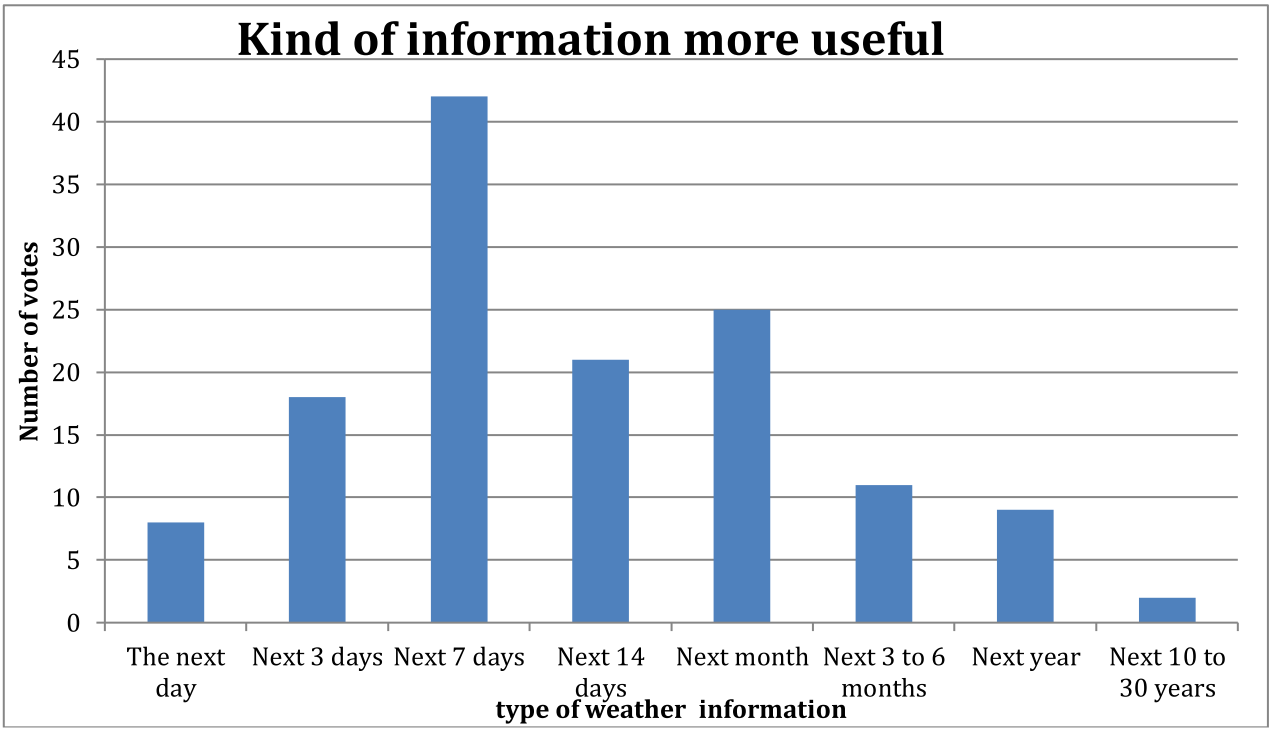
climate information (see Figure 3-2). In this case, the participant had to choose time period(s): the next day, next 3 days, next 7 days, next 14 days, next month, next 3 to 6 months, next year, next 10-30 years.

Each participant identified those key decisions that are considered to be crucial in order to improve the management of the olive crops. In that sense, each of them can identify more than one variable associated to the same type of weather information. As a result, the kind of weather information can be classified according to the usefulness, taking into account that the most useful information given the one which is most voted.

Some weather/climate information was selected by almost every participant while other types of information were identified only by 1 or 2 agronomists. Based on the results, the weather and climate information could be classified into several critical levels:

- First critical level: 7day meteorological forecast; this is the type of information most relevant to the participants and the most useful for their work in the fields.
- Second critical level: meteorological information for the next 3 days, next 14 days and next month.
- Third critical level: the information for the next day, next 3 to 6 months and next year could be used in particular moments, like, for instance, at harvesting.
- Last critical level: climate information for the next 10-30 years is only connected with the planning of new plantations or modernization of the fields. However, this activity is unusual in the work of the agronomists, but this information could improve the decision with the plantation framework and help choose the type of management and irrigation system.

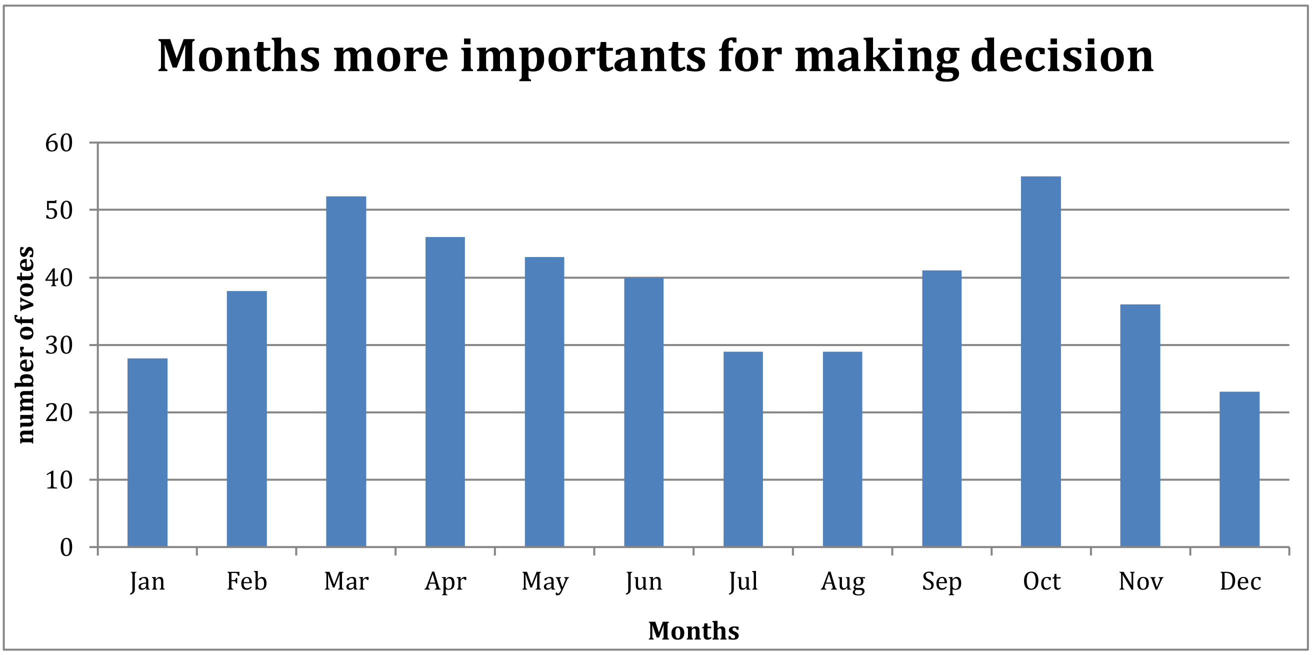
Figure 3-2. Number of votes for each type of weather/climate information.



Another activity of Interactive Session 2 was the use of the matrix by the participants for identifying the period of time within the year when they must make the decision. The participants selected the period of time during which they will consult the weather/climate information for improving the management of the olive crops (see Figure 3-3). The agronomists need more information during October and March. The second critical level is April, May, June, and September. In third place are February and November and the least important months are January, July, August and December.

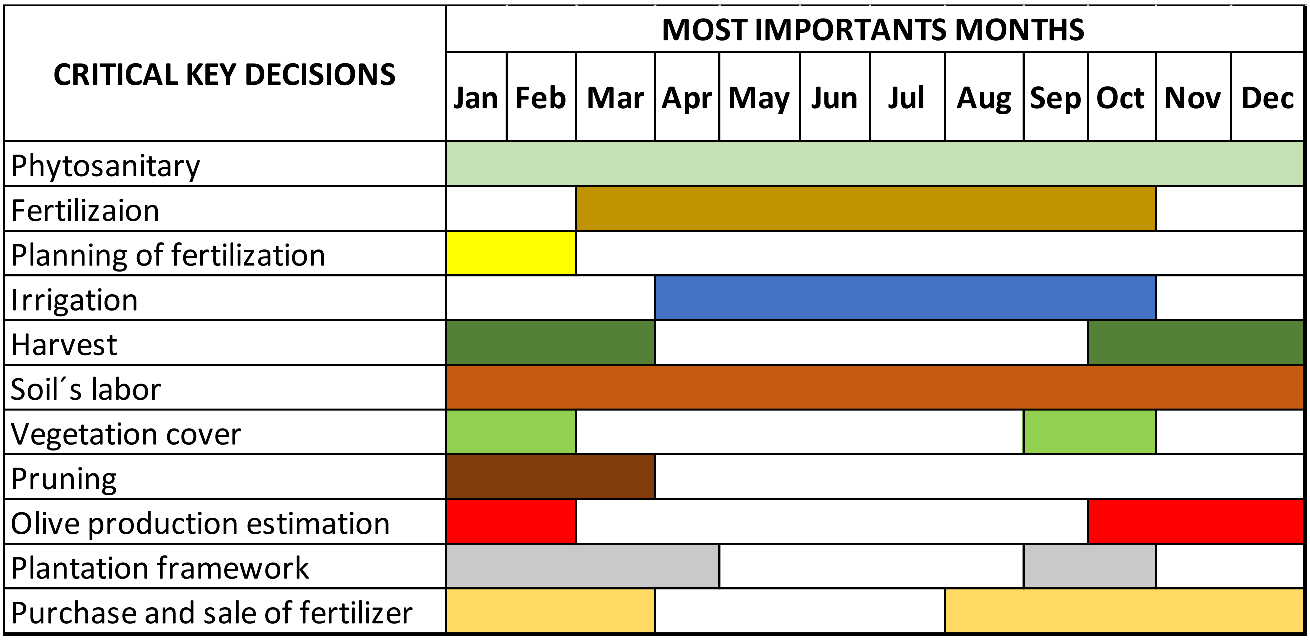
Each participant identified those key decisions that are considered to be crucial in order to improve the management of the olive crops. In that sense, each of them can identify more than one variable associated to the months of the year. As a result, they can be classified according to the usefulness, taking into account that the most useful month is the one which carries more votes within all key decisions that were identified by agronomists.

Figure 3-3 Number of votes for the time of the year of each key decision.



The analysis of the information of workshop confirms that the farming activities are associated to several months of the year. Once, the most important key decisions are identified by the participants and it is known that each activity must be carried out during different months on the whole year; it shows those months that are more recommended for the critical key decisions (see figure 3-4).

Figure 3-4 Months of the year for every key decision.



Also, with the matrix filled by every participant, it can be associated: a critical key decision with the moths to carry out the activity and the weather variables that are more needed. **(**see Figure 3-5)

Figure 3-5 Critical decision and their most important months and weather variables.

CRITICAL KEY DECISIONS	MOST IMPORTANT MONTHS	MOST IMPORTANT WEATHER VARIABLES
Phytosanitary	All year	Temperature, precipitation, wind and humedity
Fertilizaion	From March to October	Temperature, precipitation and humedity
Planning of fertilization	Januaty and February	Temperature and precipitation
Irrigation	From April to October	Temperature, precipitation and humedity
Harvest	From October to March	Temperature, precipitation and wind
Soil´s labor	All year	Temperature and precipitation
Vegetation cover	Januaty, February, September and October	Precipitation
Pruning	From January to March	Temperature, precipitation, wind and humedity
Olive production estimation	From October to February	Temperature and precipitation
Plantation framework	From January to April and from September to October	Temperature, precipitation and evapotranspiration
Purchase and sale of fertilizer	From August to March	Temperature and precipitation

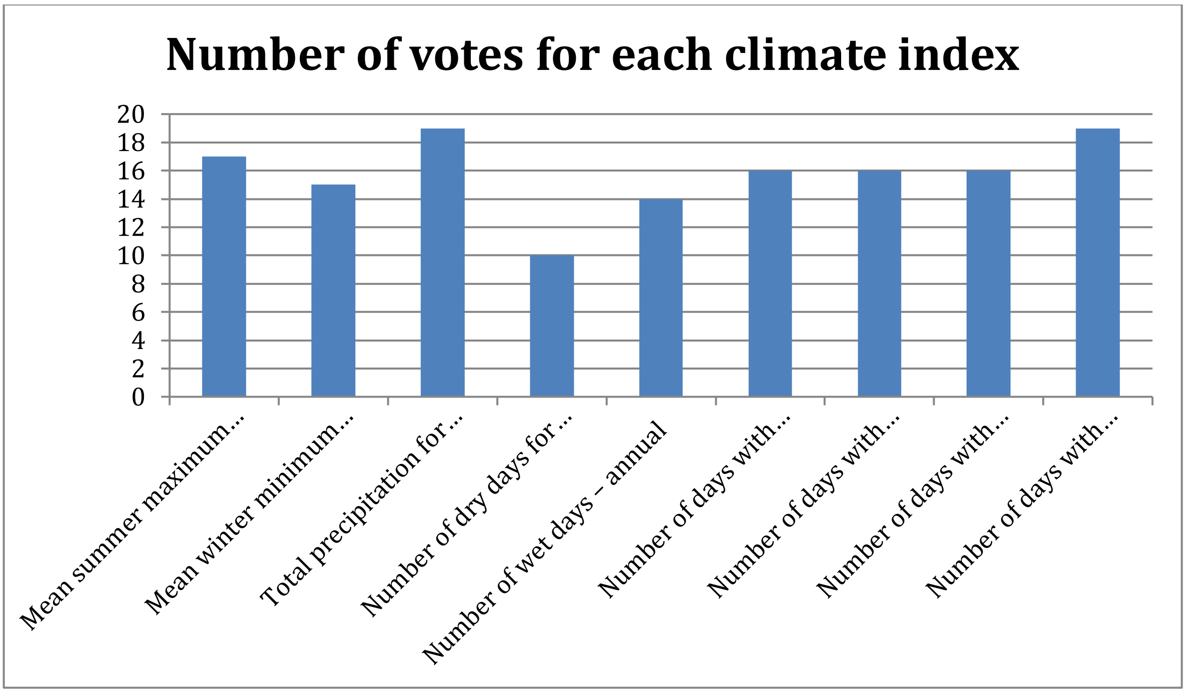
Finally, the main decisions in this session are: phytosanitary (the climatic data) and fertilization (the data is watched especially from March to October). Also, the main climatic variable is precipitation and the agronomists look for information during all year. The agronomists prefer short-term forecasts, from the next 3 days to 1 month in advance; only in special cases do they require long-term projections.

3.4. INTERACTIVE SESSION 3. POTENTIAL FOR USING CLIMATE INDICES

For interactive Session 3, MED-GOLD provided a sheet with a list of proposed climatic indices. The participant filled in their preferences and comments for improving the list based on agronomic and climate knowledge. The list of climate indices initially contained 9 indices and the participants indicated whether these indices were useful in their work (see Figure 3.4). Moreover, some participants proposed new indices. The results for the 9 indices by the FTD are, in decreasing order:

- Total precipitation for winter, summer and annual for: plant treatment, fertilization, irrigation, harvest planning, to determine annual production, nutritional needs, pruning, vegetation cover, pests and diseases, crop yield and soil management, to reinforce plants against extreme temperatures, frosts. These variables could be useful all year.
- Mean summer maximum temperature for irrigation and hydrologic stress, evapotranspiration, olive fly spraying, crop production and fertilization. Sometimes this parameter must be access from April to October.
- Number of days with minimum temperature below -3 ºC in winter, in spring or for the whole year is necessary to predict, plan and manage Harvesting, Pruning, Fertilization, pests and diseases, Flowering, frost damage, new plantations, crop yield and quality. This variable could be useful from autumn.
- The number of days with maximum temperature above 30 ºC in spring for: plant treatment, Irrigation, to reinforce plants against extreme temperatures, Hydrologic stress, potential evapotranspiration (ETo), Subsequent trading, Pests and diseases Prediction of crop yield, Flowering. This variable could be useful in summer as well.
- The number of days with maximum temperature above 40 ºC in summer for: Irrigation, protection of plants against heat stress, olive fly pest, and diseases, Fruit fattening, Prediction of crop yield. This variable could be useful from May.
- The number of days with maximum temperature below -8 ºC in winter for: harvest, fertilization, frosts, yield loss, pest and diseases, Limit for new plantations, Prediction of crop yield and quality. This variable could be useful from the autumn.
- The number of dry days annual in winter could be important for: plant treatment, irrigation, harvesting planning, pest and diseases, soil management, prediction of crop yield and fertilization. This variable could be useful from October to February.
- Mean winter minimum temperature for: harvest planning, plant treatment, fertilization, pest and disease, frost, irrigation, the forecast of fruit production and pruning. In autumn and winter.
- The annual number of wet days could be relevant for harvest planning, pruning, pest and diseases, irrigation, prediction of crop yield, soil management, and fertilization. This variable could be useful from September to January.
- The number of dry days in winter and annual could be important for: irrigation, harvest planning, pest and diseases, soil management, prediction of crop yield and fertilization. This variable could be useful from October to February.

Figure 3-6 Number of votes for each climate index.



Finally, the participants described new critical aspects of the weather and some can be included in the list of the climate indices such as:

- The anomaly of the minimum daily temperature.
- The anomaly of the maximum daily temperature.
- Daily precipitation.
- Daily wind velocity.
- Number of days with temperature above 30º C: useful in autumn for pests and diseases control, fertilization and irrigation.

3.5. CONCLUSIONS

During the workshop, MED-GOLD had the opportunity to have a good grasp of the needs of the agronomists from Dcoop and additionally, after the analysis of the information and data recollected in the participatory event, it concludes:

- Phytosanitary treatments, fertilization, and irrigation are the most important key decision from the participants because these activities have an impact in the olive production and quality. Also, these decisions are connected directly with the weather variables. The agronomists can act over these key decisions for improving them and consequently, the olive production and quality can be increased.
- The most relevant weather parameters are precipitation, temperature, and wind. because this variables condition the olive crops process.
- The type of information of weather parameters most significant is accumulated, expected, maximum and minimum.
- The kind of weather/climate information most useful is next 7 days in advance. This weather forecast is quite accurate with low level of mistakes and the agronomists can base their advice for the farmers on these forecasts.
- In October and March, the agronomist needs more climate information. because in these months they have to make decisions about different farming activities. In March the olive field must be prepared for the next season, for this reason, over this month the agronomists planning about irrigation, pruning, and fertilization, among others activities. However, In October the fields must be ready for the harvesting without problems that decrease the production and/or the quality of the olives.
- Total precipitation in winter is the most practical climate index because it affects several critical key decisions as the harvesting or possible damages in the olives.

ANNEX A. MAPS OF ANDALUSIA.

Figure A-1 Location of Andalucía in Europe. Olivié, I. (2015) *Lo global desde lo local: ¿cómo contribuye Andalucía a la presencia global de españa?* 2012-2019, Real Instituto Elcano - Elcano Royal Institute. Collected: (**https://blog.realinstitutoelcano.org/lo-global-desde-lo-local-como-contribuye-andalucia-la-presencia-global-de-espana/**)

Figure A-2 relief maps of Andalusia. Fernández, A. and Jerez, V. *Bienvenidos a eraselahistoria.* Google Site 2019. Collected:(**https://sites.google.com/site/eraselahistoria2/indice-de-contenidos/2-aspectos-fsicos-de-espaa-y-andaluca/4-el-relieve-de-andaluca**)

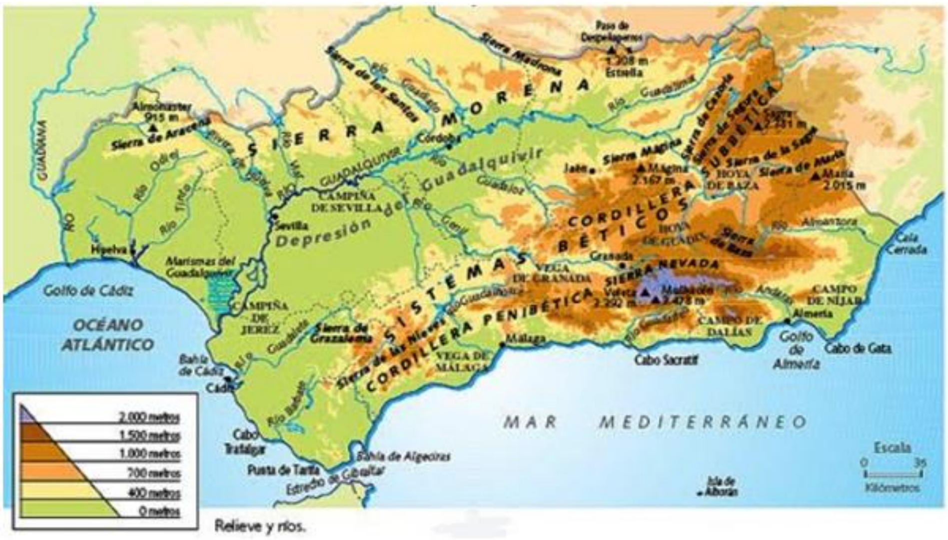


Figure A-3 % area of olive farming of each Andalusia province (2016 data). Consejería de Agricultura, Pesca y Desarrollo Rural (2017) *Aforo de producción de olivar en Andalucía Campaña 2017-2018*. Jaén. Junta de Andalucía (https://www.juntadeandalucia.es/export/drupaljda/AFORO_2015-2016.pdf)

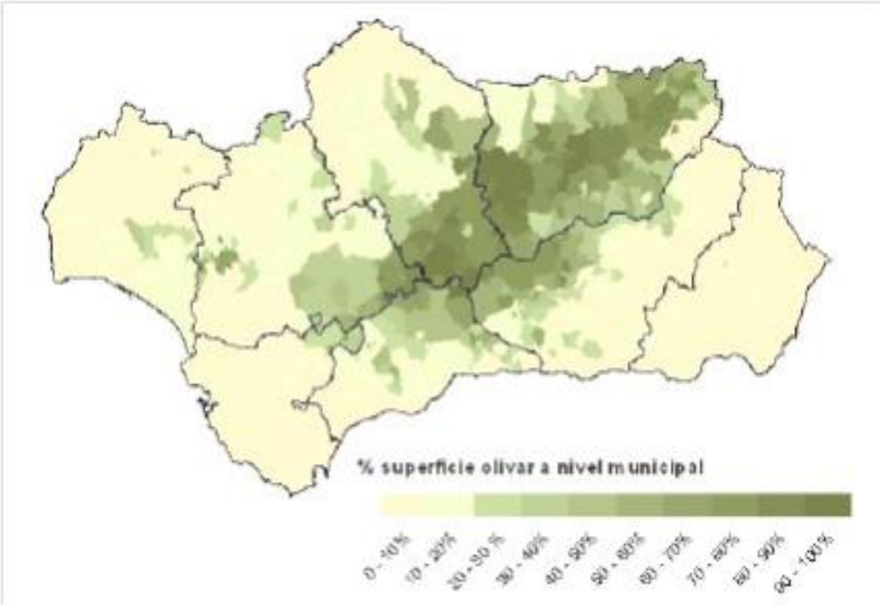


Figure A-4 Hectares (2018 data) of olive of each Andalusia province Consejería de Agricultura, Pesca y Desarrollo Rural (2015) *Aforo de producción de olivar en Andalucía Campaña 2017-2018*. Jaén. Junta de Andalucía. Collected: (https://www.juntadeandalucia.es/export/drupaljda/Presentaci%C3%B3n_OLIVAR_2017-2018.pdf)

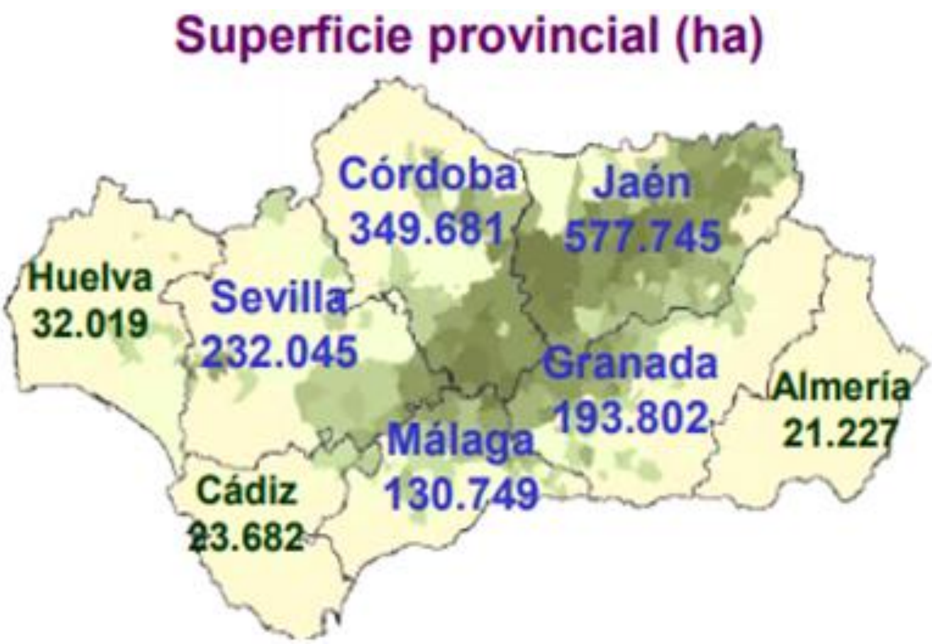
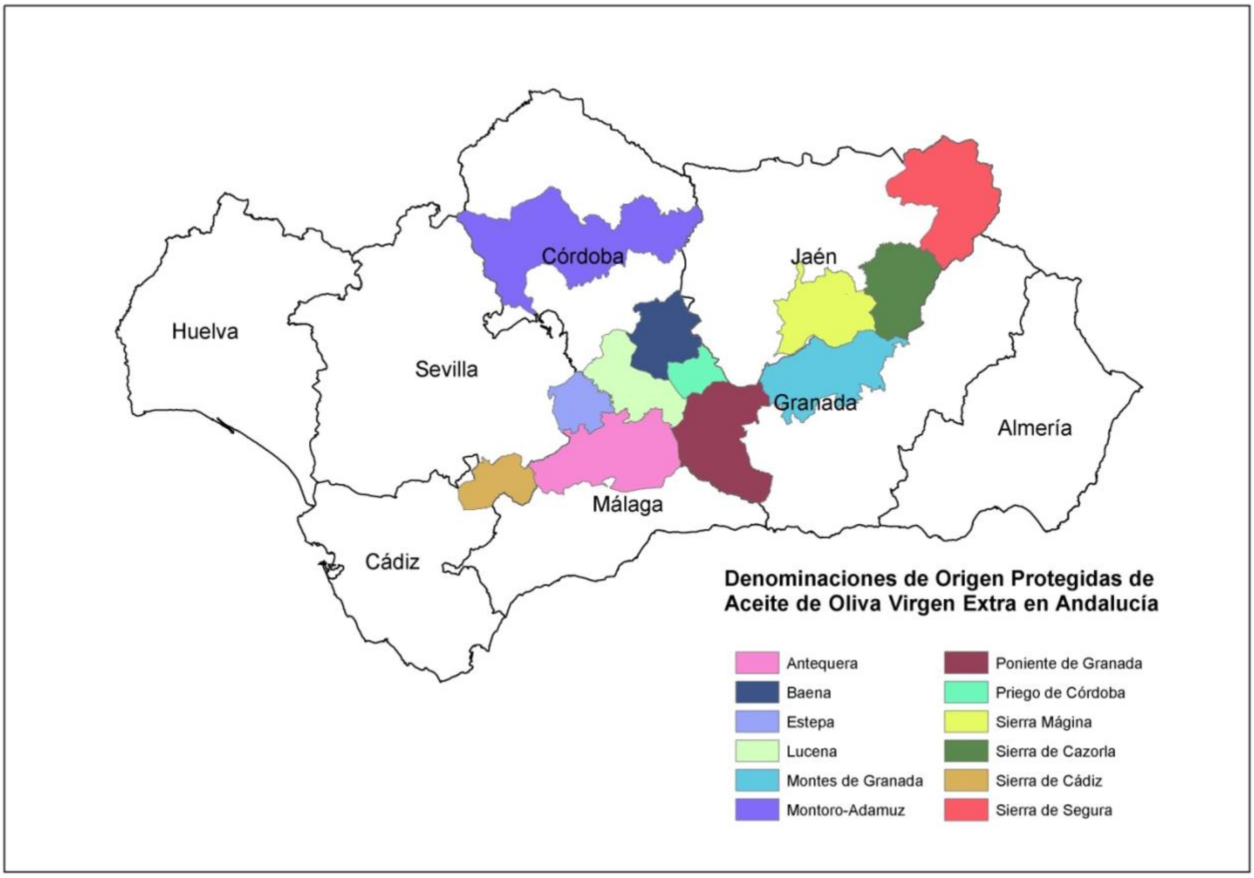


Figure A-5 The 12 P.D.O in Andalusia and its location Consejería de Agricultura, Pesca y Desarrollo Rural (2015) *Plan director del olivar andaluz*. Junta de Andalucía. Collected: (https://www.juntadeandalucia.es/export/drupaljda/Plan%20Director%20del%20Olivar.pdf)



ANNEX B. PARTICIPANTS IN FOCUS GROUPS.

Name of participant	Role	Organisation	Focus Group
Agronomist 1	Participant	Dcoop	1
Agronomist 2	Participant	Dcoop	1
Agronomist 3	Participant	Dcoop	1
Agronomist 4	Participant	Dcoop	1
Agronomist 5	Participant	Dcoop	1
Agronomist 6	Participant	Dcoop	1
N. Gonzalez	Rapporteur	BSC	1
R. Arjona	Facilitator	ec2ce	1
Agronomist 7	Participant	Dcoop	2
Agronomist 8	Participant	Dcoop	2
Agronomist 9	Participant	Dcoop	2
Agronomist 10	Participant	Dcoop	2
Agronomist 11	Participant	Dcoop	2

Agronomist 12	Agronomist	Dcoop	2
Agronomist 13	Agronomist	Dcoop	2
J. López	Facilitator	ec2ce	2
R. Marcos	Rapporteur	BSC	2
Agronomist 14	Participant	Dcoop	3
Agronomist 15	Participant	Dcoop	3
Agronomist 16	Participant	Dcoop	3
Agronomist 17	Participant	Dcoop	3
Agronomist 18	Participant	Dcoop	3
Agronomist 19	Participant	Dcoop	3
M. Terrado	Facilitator	BSC	3
E. Zamora	Rapporteur	GMV	3

ANNEX C. POST-ITS, MODEL OF MATRIX, MATRIX IN THE WORKSHOP AND LIST CLIMATE INDICES.

Figure C-1 the posit-its were filled and placed on the matrix by the participants

Figure C-2 Results of the Session Interactive 1 and 2 for one participant.

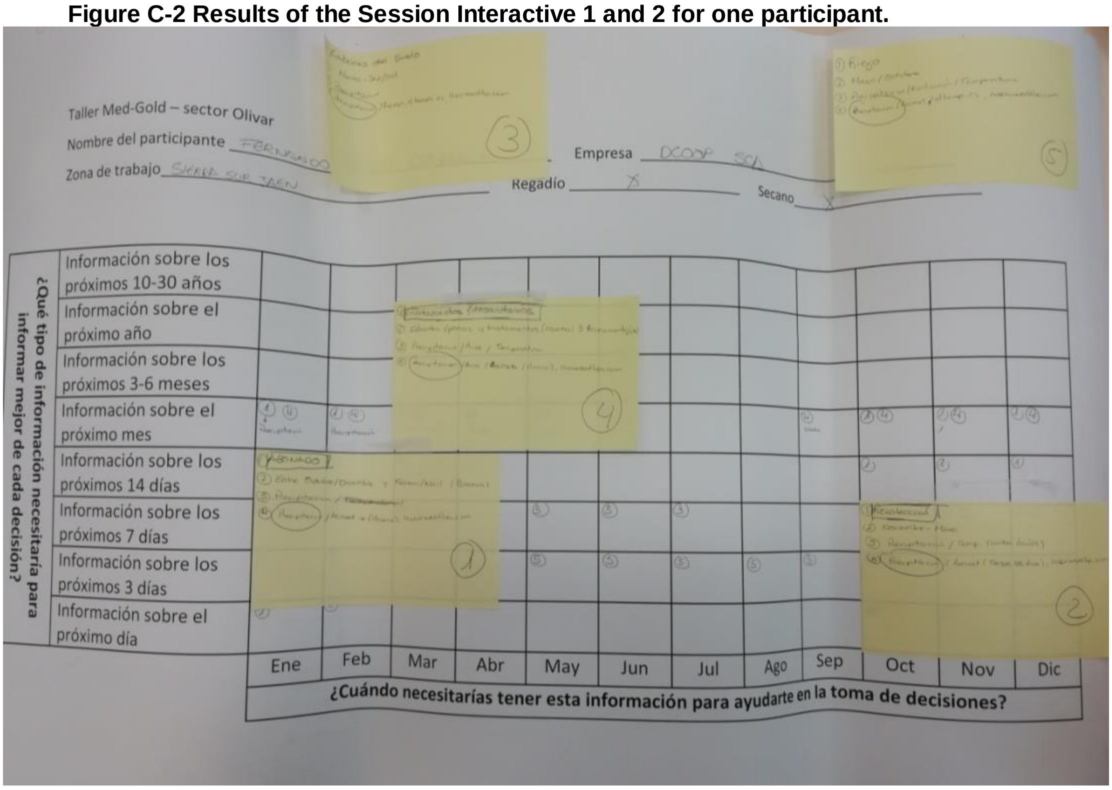
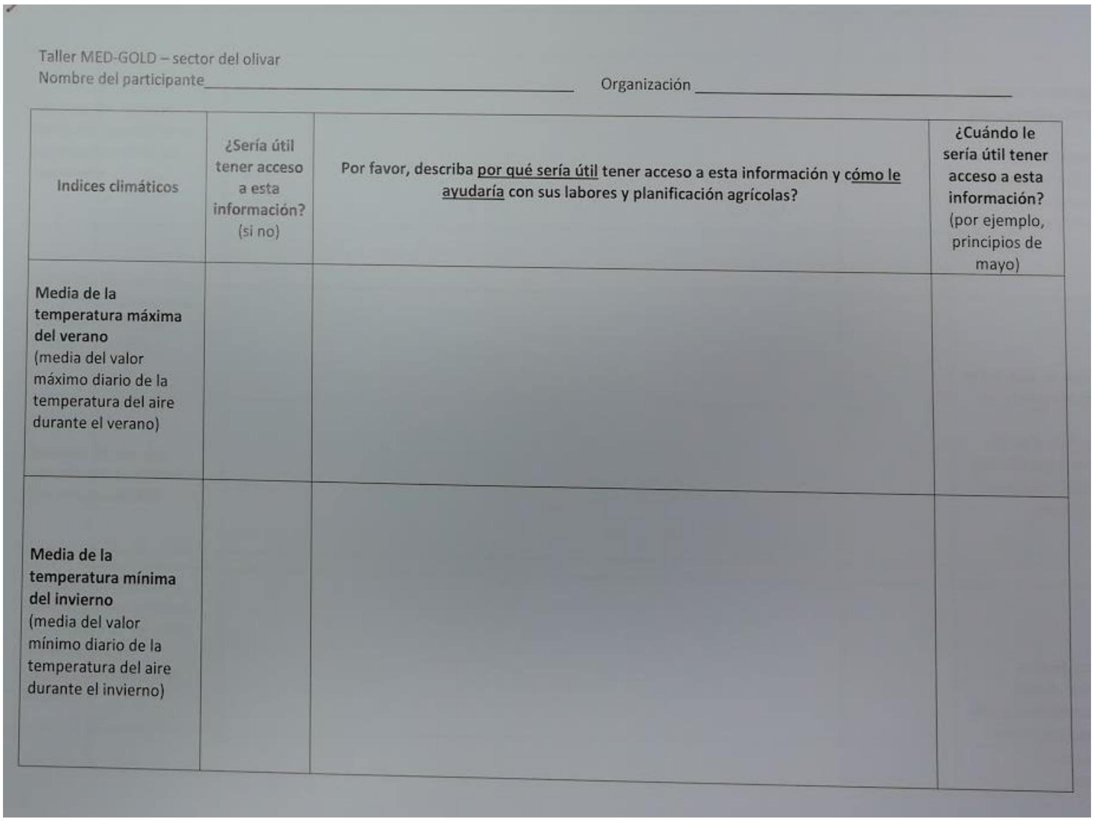


Figure C-3 first page of the climate indices (Spanish version)



Taller MED-GOLD – sector del olivar
Nombre del participante____________________ Organización ____________________

Indices climáticos	¿Sería útil tener acceso a esta información? (si no)	Por favor, describa por qué sería útil tener acceso a esta información y cómo le ayudaría con sus labores y planificación agrícolas?	¿Cuándo le sería útil tener acceso a esta información? (por ejemplo, principios de mayo)
Media de la temperatura máxima del verano (media del valor máximo diario de la temperatura del aire durante el verano)			
Media de la temperatura mínima del invierno (media del valor mínimo diario de la temperatura del aire durante el invierno)			

ANNEX D. WORKSHOP´S PHOTOGRAPHS.

END OF DOCUMENT