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MED-GOLD

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

Deliverable 2.6

First feedback report from users on olive oil pilot service development

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EXECUTIVE SUMMARY

This report summarizes the results of the first feedback focus group, carried out as a liaison between the tool developers and end-users. The three sections of the beta version of the tool were demonstrated to the

DCOOP users. The participants were asked to rate the event and provide answers to questionnaires that were provided to them. The event took place at DCOOP´s offices in Antequera (Malaga, Spain). Overall, the participants found useful the focus group meeting and expressed their willingness to continue to be involved. Moreover, they concluded that the online tool developed would be of great use if future predictions could be included in addition to historical data.

With this deliverable, the project has contributed to the achievement of the following objectives (DOA, PartB Table1.1):

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	
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

Climate information for the next days, seasons and longer time scales is critical for various decision-making aspects of the olive/olive oil sector. MED-GOLD seeks to create innovative climate services to adapt agricultural management to climate changes at these time scales.

Key decisions for the management of the olive crop were identified during the first workshop that took place in April 2018 in Spain, and they are summarised in Deliverable 2.1 [RD.1]. This deliverable describes the essential climate variables and bioclimatic indices that users from DCOOP indicated to be potentially useful to support the main challenges faced by the olive/olive oil sector. Based on the user needs gathered during the first workshop, a proposal (beta version) of a climate service tool for the olive/olive oil sector was developed in WP2. The beta version of the tool consists of three sections: i) seasonal forecasts of climate risk based on artificial intelligence, ii) climate change projections of bioclimatic indices, and iii) regional recommendations for crop management. A second workshop was organised in May 2019, again involving DCOOP staff, as end-users of the tool, who provided feedback on the olive oil tool proposal. This feedback is reported in the present Deliverable 2.6.

The information on user needs and the subsequent work undertaken by MED-GOLD for the development of the tool, allowed the creation of the Info Sheet 'Climate services for the olive and olive oil sector' [RD.2]. The info sheet illustrates the challenges and related decisions that can be optimized by using appropriate climate services' tools that support a long-term strategy, as well as shorter-term agricultural and commercial management (available both in English and Spanish).

1.1. PURPOSE

This report summarizes the results of the first feedback focus group, carried out as a liaison between the tool developers and end-users. The three sections of the beta version of the tool were demonstrated to the DCOOP users. The impressions, suggestions and remarks of the end-users from the olive/olive oil sector were listed in order to contribute to the co-development and improvement of the tool, in accordance to their needs and expectations.

1.2. SCOPE

Agriculture is very sensitive to climate variability and change. Seasonal and long-term climate predictions provide essential information to the end-users, enabling them to adapt their decision making strategies. MED-GOLD aims to adapt the agricultural management of the three staple crops of the Mediterranean diet - durum wheat, grapes and olives - to the information provided by seasonal forecasts and long-term predictions. The co-development of the climate services' tool for olive/olive oil sector engages both scientific partners and decision makers through specifically designed activities for feedback collection (e.g., workshops, focus group discussions).

1.3. Definitions and Acronyms

1.3.1. 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
Field Technical Department (FTD)	DCOOP Department which provides services to farmers and to first-degree cooperatives (the olive mills) associated with DCOOP. The workers of this department are agronomists, who work in the fields..
DCOOP	Second degree cooperative.The first producer of olive oil and table olives in the world
Focus Group	In this deliverable, it refers to the group of people from DCOOP who represent the end-users of the olive/olive oil sector

1.3.2. Acronyms

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

Table 1-2 Acronyms

Acronym	Definition
MED-GOLD	Mediterranean Grape, OLive and Durum wheat food systems
CASAS Global	Center for the Analysis of Sustainable Agricultural Systems
PBDM	Physiologically Based Demographic Models
UTCI	Universal Thermal Climate Index
PET	Physiologically Equivalent Temperature
WCT	Wind Chill Temperature
SAT	Steadman apparent temperature

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	Code	Version	Date
[RD.1]	Report on the knowledge capitalization of the olive oil sector	Deliverable 2.1 / D.2.1		2018
[RD.2]	Climate services for the olive and olive oil sector	Info Sheet		2019
[RD.3]	MED-GOLD Core Sectors Description and Analysis	Deliverable 1.1 / D1.1		2018
[RD.4]	Guidelines for collecting feedback from the users involved in the development of the climate services	Deliverable 1.7 / D1.7		2019
[RD.5]	Assessment of the vulnerability of each sector	Deliverable 1.2 / D1.2		2019
[RD.6]	Gutierrez AP (1996) Applied population ecology: a supply-demand approach. John Wiley and Sons, New York, USA. 320 pp	Gutierrez, 1996		1996
[RD.7]	Gutierrez A.P., Ponti L., Cossu Q.A. (2009) Effects of climate warming on olive and olive fly (Bactroceraoleae (Gmelin)) in California and Italy. Climatic Change 95:195–217. https://doi.org/10.1007/s10584-008-9528-4	Gutierrez et al., 2009		2009
[RD.8]	Ponti L., Cossu QA, Gutierrez AP (2009) Climate warming effects on the olive-Bactroceraoleae system in Mediterranean Islands: Sardinia as an example. Global Change Biology 15:2874-2884. http://doi.org/10.1111/j.1365-2486.2009.01938.x	Ponti et al., 2009		2009
[RD.9]	Ponti L., Gutierrez AP., Ruti PM., Dell'Aquila A. (2014) Fine-scale ecological and economic assessment of climate change on olive in the Mediterranean Basin reveals winners and losers. Proceedings of the National Academy of Sciences, USA 111:5598–5603. https://doi.org/10.1073/pnas.1314437111	Ponti et al., 2014		2014
[RD.10]	Toko M., Neuenschwander P., Yaninek J.S., et al. (2019) Identifying and managing plant health risks for key African crops: cassava. In: Neuenschwander P., Tamò M. (eds) Critical issues in plant health: 50 years of research in African agriculture. BurleighDodds Science Publishing, Cambridge, UK, doi:10.19103/AS.2018.0043.07	Toko et al., 2019		2019
[RD.11]	Potchter, O., Cohen, P., Lin, T.-P., Matzarakis, A. (2018) Outdoor human thermal perception in various climates: A comprehensive review of approaches, methods and quantification. Science of The Total Environment 631–632, 390–406. https://doi.org/10.1016/j.scitotenv.2018.02.276	Potchter et al., 2018		2018
[RD.12]	Mayer H., Höppe P. (1987) Thermal comfort of man in different urban environments. TheorApplClimatol 38:43–49. https://doi.org/10.1007/BF00866252	Mayer et al., 1987		1987
[RD.13]	Osczevski, R., Bluestein, M. (2005) The new wind	Osczevski AN Bluestein.,		2005

	chill equivalent temperature chart. Bull. Amer. Meteor. Soc. 86, 1453–1458. https://doi.org/10.1175/BAMS-86-10-1453	2005		
[RD.14]	de Freitas, C.R., Grigorieva, E.A. (2017) A comparison and appraisal of a comprehensive range of human thermal climate indices. Int J Biometeorol 61, 487–512. https://doi.org/10.1007/s00484-016-1228-6	de Freitas et al., 2017		2017
[RD.15]	Quayle, R.G., Steadman, R.G. (1998) The Steadman wind chill: an improvement over present scales. Wea. Forecasting 13, 1187–1193. https://doi.org/10.1175/1520-0434(1998)	Quayle et al., 1998		1998

3. Preview of the tools for olives/olive oil

Following the previous workshops (First scoping workshop in Antequera in June 2018 and User perceptions workshop in Brussels in February 2019, https://www.med-gold.eu/events-news/), WP2 team organized a workshop, which was held on May 9th, 2019 at DCOOP´s offices in Antequera (Malaga), in order to collect end-users' feedback on the olive oil pilot services tool under development. The beta version of the tool, which consists of three different sections, was presented to a group of four (4) DCOOP workers with different background (Table 3.1-1), who represented the end users of the olives/olive oil sector. The average age of the participants was 36 years old, one was female and the rest were male technicians.

The results from the first scoping workshop for the olives/olive oil sector, revealed that the agronomists and technicians from the Field Technical Department were more interested in short term climate services (here, short-term refers to days up to months ahead). Following a discussion of this issue during the workshop in Brussels, people from the management and administrative departments of DCOOP were included in this latest event (focus group in May 2019). These departments could have an interest in making strategic decisions in the medium and long term and could recognise the usefulness of the long-term climate services. In addition, WP2 decided to reduce the number of participants with respect to the first scoping workshop. This was done in order to facilitate the discussion regarding the first beta version of the tool for the olive/olive oil sector that was developed according to the outcome of the previous event (from the agronomists' point of view). For this reason, a group of four people (focus group) was selected for the presentation of the first beta version of the WP2 tool.

3.1. About the Focus Group

The focus group was an interactive working session between MED-GOLD and the participants from the olive/olive oil sector of DCOOP. The session was organized into three sections, in which the three tools were discussed in detail, and an additional session for conclusions. The agenda of the event is described in Table 3-2.

The event was focused on knowledge exchange between experts from the olive/olive oil sector and MED-GOLD partners (BSC, University of Leeds, ec2ce and GMV). Following the demonstration of the current versions of the three tools by MED-GOLD partners to the DCOOP participants, the participants commented on the usefulness of the tools, providing useful feedback for their further development and improvement.

Table 3-1 Focus group participants

Name	Organisatio n	Role in DCOOP or profile in MED-GOLD	Attended the workshop in June 2018
Participant 1	DCOOP	Director from the Department of supplies and services	Yes
Participant 2	DCOOP	Coordinator from the Department of olive oil logistics and yield forecast provider	No
Participant 3	DCOOP	Technician from the Department of quality of olive mills	No
Participant 4	DCOOP	Technician from the Department of R&D	No
Marta Terrado	MED-GOLD (BSC)	Communication and dissemination of project results	Yes
Elena Mihailescu	MED-GOLD (University of Leeds)	Knowledge generator and development of the MED-GOLD community	No
Ricardo Arjona	MED-GOLD (ec2ce)	Artificial intelligence expert	Yes
Miguel Ángel Marques	MED-GOLD (ec2ce)	Artificial intelligent expert	No
Eduardo Zamora	MED-GOLD (GMV)	Earth Observation expert	Yes
Javier López	MED-GOLD & DCOOP	MED-GOLD champion user from the olives and olive oil sector	Yes

DCOOP focus group participants were directors and coordinators of DCOOP departments as well as technicians. The value chain of the olive oil sector was represented by this focus group as follows:

- DCOOP's supplies and services department is in continuous contact with the farmers.
- The quality of olive mills department works closely with first degree cooperatives.
- The olive oil logistics department is the liaison between the oil produced and the customers.
- The research and development department is a transversal department which aims to improve all phases of the value chain of the olives/olive oil sector.

MED-GOLD partners had a critical role in this focus group meeting:

(i) they demonstrated the tools, explained any necessary technical knowledge and run the conversation;

(ii) they ensured that the event ran smoothly;

(iii) they kept notes of all the participants' suggestions, questions or comments.

Following the guidelines described in Deliverable 1.7 [RD.4], the participants discussed and exchanged information about agronomic practices as well as essential climate variables and bioclimatic indices that affect the olive value chain at different time scales.

The WP2 team created a presentation that was used as a guideline during the focus group in order to describe the tools more efficiently, show some key issues and facilitate the discussion among the participants. The three tools presented were:

1. Seasonal forecasts of climate risk based on artificial intelligence
2. Climate change projections for bioclimatic indices
3. Regional recommendations for crop management

During the presentations, the participants asked questions to better understand the tools produced by the MED-GOLD team. Once each tool had been explained, MED-GOLD asked the participants several questions identified as key missing information from the previous deliverables (D1.2 and D1.7) [RD.4,5]. These questions were directed to improve the development of the climate service and foster discussion of each tool. Two coffee breaks were organized to avoid the fatigue of the participants. The final part of the workshop was for recapitulation and conclusions, where the focus group highlighted the most important conclusions and gave suggestions for improving the tools.

Table 3-2 Olive/Olive Oil Focus Group meeting agenda

Time	Topic
09:00 – 09:15	Welcome and introduction to MED-GOLD
09:15 – 10:15	Seasonal forecasts of climate risk based on artificial intelligence
10:15 – 10:45	Coffee break
10:45 – 11:30	Climate change projections for bioclimatic indices
11:30 – 12:15	Regional recommendations for crop management
12:15 – 12:30	Coffee break
12:30 – 13:00	Wider discussion about the tools
13:00 – 13:30	Recap and next steps
13:30 – 14:30	Lunch

3.2. Users' Feedback

Users' feedback is reported separately for each tool. The participants rated the event as follows:

General satisfaction: 7.0/10.0

Duration: 8.0/10.0

Organisation: 8.3/10.0

Materials provided: 8.8/10.0

Location / room: 9.0/10.0

Speaker skills: 8.3/10.0

The usefulness of the climate services was rated 7.4/10.0

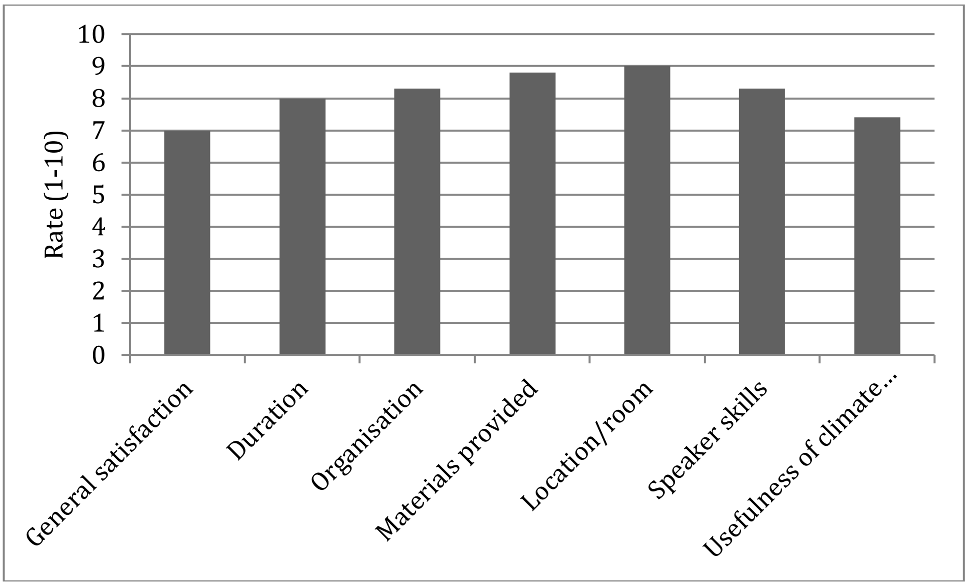


Figure 3-1. Graph summarising participants' satisfaction of the event

3.2.1. Seasonal forecasts of climate risk, based on artificial intelligence

The artificial intelligence model for the expected olive productivity, developed by EC2CE, was presented to the participants. It was explained that, based on the model results, EC2CE is able to issue recommendations on the best time for farmers to irrigate and fertilize the olive trees. Information about the quality of olive oil as a result of the harvest time can also be provided. The EC2CE model gives access to information about farmers' lots (Fig. 3-1). The types of information that can be accessed via the tool are:

- Expected productivity.
- Irrigation (a recommendation is provided month by month).
- Meteorological data.
- Access to the database with all the farmers' information.
- Information about agricultural practices.

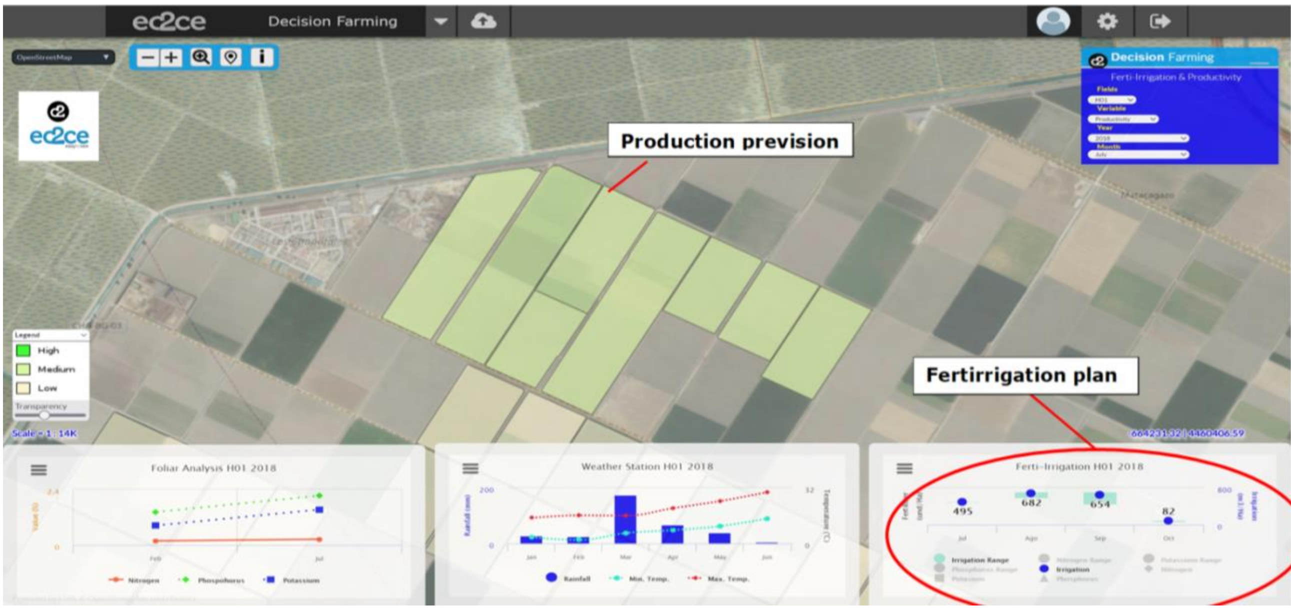


Figure 3-2. EC2CE's model output for farmers' lot

Participants' questions and remarks:

Question/remark 1: *Is the model able to take into account the alternation of production? (i.e. after a year of high olive yields, a year of lower yields follows)*

Response: The model takes into account information from previous years, considering many different input variables. Overall, the results depend on the input data that the clients make available.

Question/remark 2: *The recommendations regarding irrigation and fertilization are more useful to the rainfed areas, since irrigated areas have less variation in production.*

Question/remark 3: *The most important information to be provided by the model is the expected productivity. Farmers are most probably interested in productivity at field scale, while DCOOP is interested in productivity at a national (or even world) level. There is also great interest in the expected yield, because even if the expected olive oil quality may be lower, the market price may potentially increase with potentially lower yield.*

3.2.2. Climate change projections of bioclimatic indices

A list of indices, identified as relevant during the first workshop in June 2018 and computed by NOA, was presented to the participants (Fig. 3-2, 3-3). Feedback received on some of the indices is detailed below:

- Mean summer maximum temperature: the participants mentioned that this information is more useful during the blooming months (Apr-May) rather than during summer
- Number of spring and summer heat days: the participants found interesting to know the number of heat days during spring but not in summer (in some cases, only the first month of summer is useful), since by then the pit has already been formed.
- Total winter precipitation: the participants were interested in total precipitation from October to May.

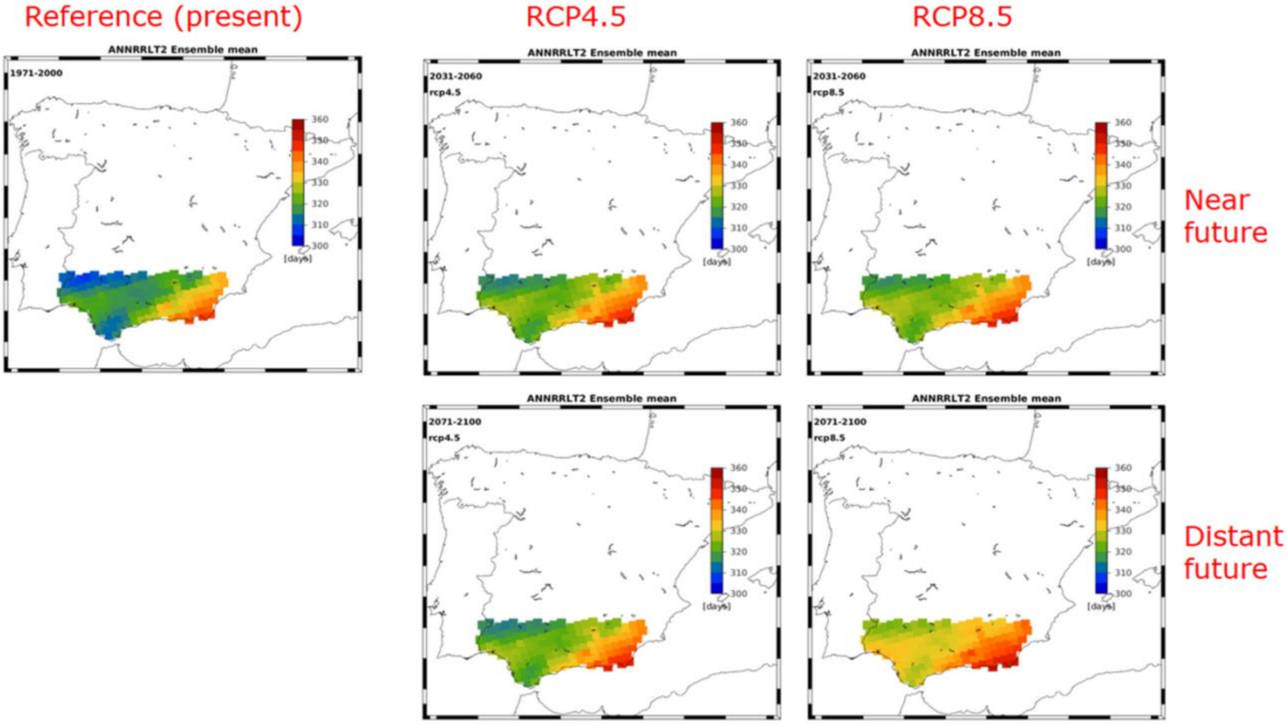


Figure 3-3. Average Annual Number of Dry Days RR < 2mm (ANNRRLT2) as projected for the near and distant future under two different emission scenarios (RCP4.5 & RCP8.5)

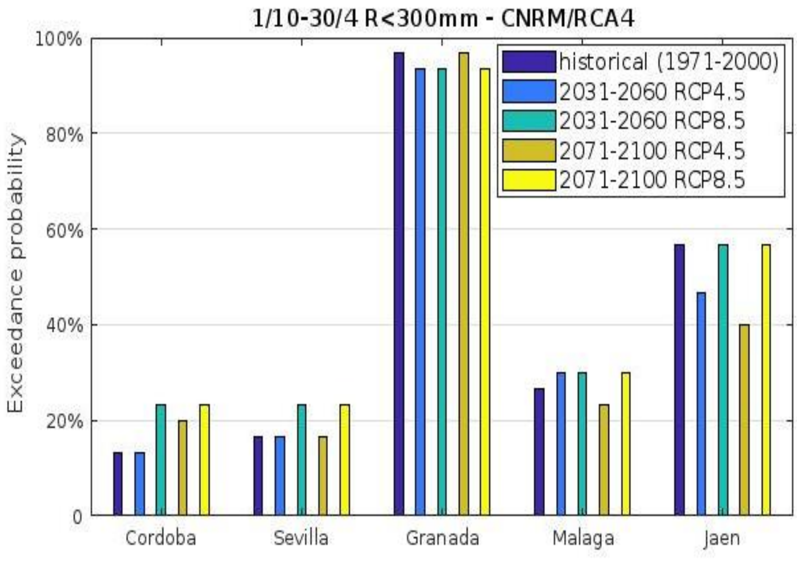


Figure 3-4. Return periods of bad years. The probability (%) for low production (based on total precipitation Oct-Apr) for every coming year and for 5 different regions is presented. The results are presented for two emission scenarios (RCP4.5 & RCP8.5) and for two future periods (near and distant future).

Participant's questions and remarks:

Question/remark 1: *All the indices are useful; the more variables & indices provided, the better, since that means more information that can be integrated into the EC2CE model and improve the results.*

Question/remark 2: *Additional indices that would be useful are: number of consecutive frost days (November to January), consecutive hot days in April and May, which is the flowering period for the olive trees, and wind speed during the flowering period.*

Response: Apart from wind speed which is not recommended as a variable for long term projections since evaluation with observations is difficult, the suggested indices can be included in the tool developed by NOA

Question/remark 3: *The indices are presented in a map format, which is good. Nevertheless, the tool will be more useful if there is access to quantitative data to enable in-house calculations.*

3.2.3. Regional recommendations for crop management

During the focus group meeting, sample output from CASAS Global (Center for the Analysis of Sustainable Agricultural Systems, (http://www.casasglobal.org/) physiologically based demographic models (CASAS-PBDMs) was presented to DCOOP participants (Fig. 3-4).

CASAS-PBDMs are one of the key existing technology components of the MED-GOLD project (note CASAS Global CEO Andrew Paul Gutierrez is part of the project's External Advisory Committee). The capacity for modeling tri-trophic agroecosystems (i.e., crop/pest/natural enemy systems, [RD.6]) using PBDM agro-ecosystem models including the olive/olive fly system is being implemented under MED-GOLD as a scalable modern computing platform in the form of an application as a service accessible via a dedicated Application Programming Interface (API). The CASAS-PBDMs API is already part of the MED-GOLD ICT platform (https://platform.med-gold.eu/) as the *pbdm* workflow.

The information and related added-value resulting from PBDMs mostly accrues in terms of improved management strategy. Development of the climate service tool also entails exploration of how currently used approaches to modeling olive yield and olive fruit fly infestation, based on machine learning as implemented by EC2CE, can be complemented by the weather-driven PBDM approach.

PBDMs explicitly capture the weather-driven biology of the interaction between olive and the olive fruit fly *Bactroceraoleae* [RD.7]. The PBDM of olive and olive fly predicts the geographical distribution and relative abundance of the two species across time and space, independently of the actual species distributions, using extant and climate change weather scenarios as drivers for the system.

A PBDM analysis of the olive/olive fly system that included comparison of model output with field data was performed on a geographic scale similar to that of Andalusia for the island of Sardinia, Italy [RD.8]. The linked PBDM for olive and olive fly has also been used in a geographic information system (GIS) context to estimate the fine-scale ecological and economic impact of climate warming on olive yield and fly infestation across the Mediterranean Basin [RD.9].

The added value of PBDMs generally accrues mostly in terms of regional recommendations for crop management as opposed to precise prediction at field level. This is because PBDMs provide an assessment of the olive/olive fly systems at the regional level that is independent of space and time, and hence provide insight on how to best allocate limited resources for agroecosystem management.

The key message delivered during the focus group meeting was that using process-based PBDMs it makes possible to project the biology of olive and olive fly across regions such as Andalusia and its provinces under present climate and climate change scenarios to quantitatively assess climate risk (e.g., increased infestations by olive fly) as a basis for regional crop management (e.g, olive fly management). Crop management options can also be assessed prospectively.

It was stressed that PBDMs make it possible to assess crop management options because these process-based models simulate the actual biological processes of development and growth of the olive plant (leaves, stem and shoots, roots, as well as flowers and fruit) and of the olive fly (inside fruit as well as reproductive and dormant adults, with description of life stages including eggs, larvae, pupae, and adults).

As an example, it was illustrated how the biology of olive fly is simulated by BPDMs on a daily basis in terms of population of insects of different ages and stages (actual numbers per plant or numbers of olive fruit infested by the fly), and hence how control strategies may be superimposed as additional mortality factors that add to the various sources of mortality (e.g., due to high temperature) on a daily basis.

Simulation of the interaction of plant phenology and fly development is driven by site-specific weather at all locations in a certain region, and this enables general regional recommendations for improved crop management. It is like running a field experiment for 30 years at each of the climate grid locations (or weather stations) available for Andalusia: it would simply be impossible logistically and economically to do it otherwise (e.g. [RD.10]).

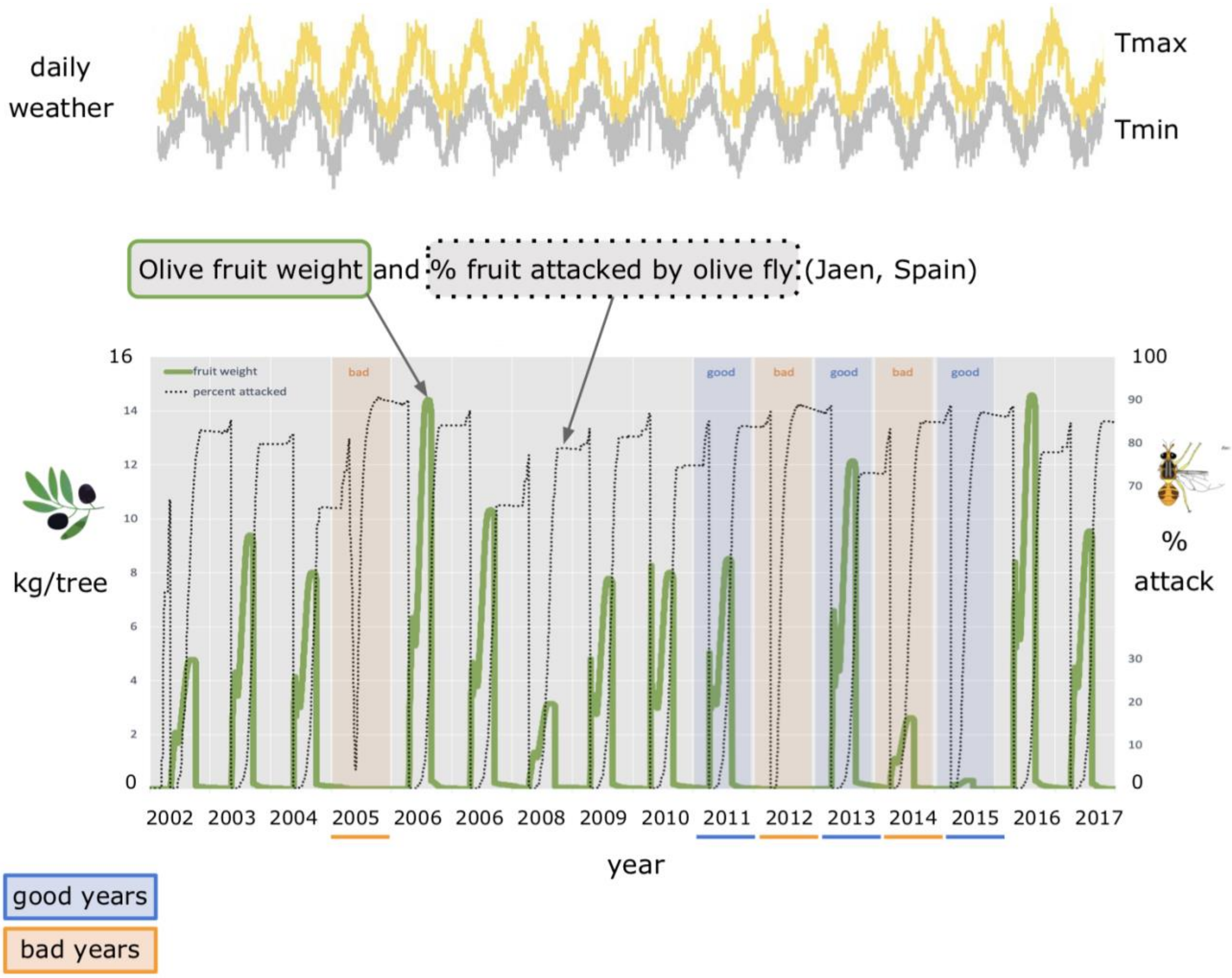


Figure 3-5.Simulating the daily biology and interaction of olive and olive fly using PBDMs appears to capture the observed pattern of good and bad years for olive production, except in 2015. Olive fruit weight (kg dry matter per tree) and % fruit attacked by olive fly simulated using physiologically based demographic models (PBDMs) as driven by observed weather for Jaen, Spain for the period 2002-2017 with indication of "good" and "bad" years for olive oil production as identified by DCOOP (weather data source: IFAPA, Andalusian Institute of Agricultural and Fisheries Research and Training - Instituto de Investigación y FormaciónAgraria y Pesquera).

Participants' questions and remarks:

Question/remark 1: *The information about the olive fly is useful just 15 days in advance, when the farmers have to prepare the appropriate treatment. The predictions for months or years in advance are not useful.*

Question/remark 2: *The information about the production at local level is more useful than the production per tree.*

Question/remark 3: *Heavy rainfall events can affect soil water availability and it would be really useful if calculations about the proportion of water that the soil can absorb were at the agronomists' disposal.*

3.3. Discussion

After the presentations, the discussion turned around the following aspects:

- Seasonal predictions of precipitation and temperature.
- Projections of bioclimatic indices.
- Regional recommendations.

Based on the outcome of the discussion, a set of comments and questions was developed (Annex E), translated to Spanish, and sent to DCOOP requesting for further feedback and more generally as part of activating a continuous feedback loop with DCOOP.

3.3.1. Seasonal predictions of precipitation and temperature

The participants mentioned that having information on temperature is useful only for minimum and maximum values, while information about the mean temperature is less useful. They suggested the variable 'thermal sensation' ("real feel") as an option that provides more useful and specific information. Thermal sensation takes into account both temperature and wind.

Table 3-3 Relevant information regarding temperature and precipitation

	Temperature (thermal sensation)	**Precipitation**
Interest	Tmin below -5ºC Tmax above 28ºC Tmean – not required	Total monthly precipitation
Type of decision	Winter: When to harvest (since it affects fruit quality ("freezing fruit" defect[1]) and the yield of the next campaign) Summer (during blooming and fruit setting, in particular) : irrigation, fertilization, phytosanitary treatments, superficial soil labour	Commercial strategy (when to sell). Olive oil price[2]
Spatial resolution	At the province level (olive area – *zona olivarera*)	At the province level (olive area – *zona olivarera*)
Temporal resolution	Winter: Nov-Jan Summer: Apr-Jun	Oct-May

Other variables of interest are evapotranspiration (and, if possible, the 4 factors influencing it, for added value of this variable) and soil water balance.

[1] As a clarification of “freezing fruit” defect:The olive oil is the only food which must be analyzed for its physical-chemical and sensorial properties in order to determine its category: extra virgin, virgin or unfit for consumption. If olives are harvested under low temperature, the physical and chemical properties may not be affected, but the smell of the oil, which is detected as part of the sensorial test, could be affected. As a result, oil harvested under these conditions might not be classified as extra virgin olive oil. In other words, although the chemical-physical analysis fulfills the prerequisites of an extra virgin, if the sensorial test detects any unusual smell (it can be a consequence of the freezing), the olive oil cannot be characterised as extra virgin. Consequently, it would fetch a lower price.

[2] As a clarification of olive oil price: The price of olive oil is also strongly related to olive production. The price fluctuates between years because the annual production itself varies considerably between different years. For instance, 2019 is a year with high production so the price of olive oil is low. If 2020 is a year with low production of olives, the price of the olive oil will increase significantly (the price could double).

3.3.2. PROJECTIONS OF BIOCLIMATIC INDICES

For all the indices, calculations need to be adapted to the biological cycle of the olive tree (Oct-May). The participants suggested that MED-GOLD should not use the seasons in the ‘conventional way’. The olive sector focuses on certain months that are most important according to the olive phenology. Calculations can be of interest at province level - olive areas (Jaén, Córdoba, Sevilla…) - and for other countries that are important global olive producers (Italy, Portugal, Greece…).

The participants mentioned that they could have a look at the maps, but they are more interested in the total numbers and graphs, so that they can use the results in their in-house calculations. Regarding the long term projections, this is a service that can be provided to the end-users.They also asked if the ‘price’ variable was used in the forecasts.

The general feeling was that they seemed to be less interested in the use of climate projections compared to shorter term climate predictions.

Table 3-4 Bioclimatic indices tailored to the olive/olive oil sector

Bioclimatic indices	Interest	Decision	Spatial resolution	Temporal resolution
Mean summer maximum temperature	Not interesting It could be interesting during blooming (April and May, in some cases first weeks of June too)		At the province level (olive area)	
Mean winter minimum temperature	Yes	Change of crop Change of variety Modernisation*		Nov-Jan
Number of cold winter days	Refer to thermal sensation (above)			
Number of spring and summer heat days**	Interesting in spring but not in summer			
Total winter precipitation	Total precipitation from October - May	Change of crop Change of variety Modernisation*		From Oct-May. Month by month for the next 6 months or 1 year
Number of annual dry days	Yes	Change of crop Change of variety Modernisation*		Oct-May

*modernisation involves change of agricultural management, change of irrigation, change of the crop system, etc.

**"heat" is not well-defined. We clarified the threshold was 32ºC, 36ºC or 40ºC (for summer). It seems relevant to include the specific definition of this index in the tool. Regional recommendations

The olive yield-olive fly relationship was not identified as particularly useful by the participants at the proposed time scale.On the other hand, heavy rainfall events (torrentiality) was identified as an interesting index to know 6 months in advance. It could be useful for the period when fertilization is planned (in March), when there is high risk of fertilizer leaching into the soil or lost through surface run-off soil. Therefore, this information can be valuable for supporting decisions relating to soil management and fertilisation at the regional scale (ideally, local scale).

3.3.3. Exploring the use of 'thermal sensation'

After the focus group meeting, a literature review was performed on the "thermal sensation" concept that DCOOP is currently using and deems important and relevant to decision-making (Table 3-4). A recent review by Potchter et al. (2018) (RD.11] indicates that the Universal Thermal Climate Index (UCTI) is the second most used thermal sensation index. UCTI was developed under a specific COST action (http://www.utci.org/) that provides the Fortran source code. UCTI is computed using a polynomial regression that approximates the actual UCTI, and has a nontrivial set of input variables [RD.11]. The most used thermal sensation index is the Physiologically Equivalent Temperature (PET), an older index by Mayer and Höppe (1987) [RD.12] that is also of nontrivial computation.

Further interaction with DCOOP, showed that DCOOP is using two different equations: one for computing thermal sensation below -7°C and one for computing it above +28°C. Although DCOOP was not able to identify a reference describing the two equations, they use them to compute thermal sensation. Probably DCOOP is currently using an older version of the Wind chill temperature described by Osczevski and Bluestein (2005) [RD.13] that only uses temperature and wind as input [RD.14]. The Osczevski and Bluestein (2005) WCT index is only defined for temperatures in the range of +10° to -50°C.Therefore, it seems preferable to use the apparent temperature index proposed by Quayle and Steadman (1998) [RD.15] (Steadman apparent temperature, SAT), as its mathematical form is the same as that of the WCT by Osczevski and Bluestein (2005), and more importantly the apparent temperature by Quayle and Steadman (1998) [RD.15] is defined for temperatures in the range of +45° to -40°C.Hence, the same algorithm can be used to compute apparent temperatures below -7°C and above +28°C.

Although only few information was found in the literature for the application of the "thermal sensation" idea into a crop management context, it was agreed that the idea will be further investigated by the WP2 team. Options for computing the following indices (including a drought index indicated by DCOOP), which were characterised as interested by the focus group participants, will be assessed in WP2:

- **Number of cold winter days** = cumulative number (count) of days with Tmin below -7ºC in November, December, and January (temperature computed as **SAT** according to Quayle and Steadman 1998).
- **Number of spring heat days** = cumulative number (count) of days with Tmax above 28ºC in April, May and June (temperature computed as **SAT** according to Quayle and Steadman 1998).
- **Number of annual dry days** = cumulative number (count) of days with total precipitation below 2 mm.

3.3.4. Potential - wider - discussion topics

In this section, potential discussion topics, identified during the Focus Group meeting, are presented.These discussion topics have been uploaded on the MED-GOLD online forum, to gather additional information needs from MED-GOLD community members, which can be of use for the tool development.

1. Irrigation and fertilization of olive trees

Questions asked:

- Is your olive plantation rainfed or irrigated? If it is irrigated, which factors affect the timing of the irrigation?

- Would it be of interest for you to receive recommendations on the timing of irrigation for your olive trees? If yes, at what spatial scale and for which time scales?

The participants of the Focus Group agreed that it is very important for the farmers of irrigated plantations to know which is the best (recommended) timing for irrigating the olive trees. This information is not considered as useful for the rainfed olive plantations.

2. Estimated quality of olive oil

Question asked:

- What information do you use to estimate the expected quality of your olive oil for every season?

In MED-GOLD project, there is the possibility to estimate the expected quality of the olive oil, but the estimation will be based only on the estimated harvest date. The quality of the oil depends on other factors, such as harvest conditions, ripeness level of the olives, separation of the olives harvested from the tree and olive collected from the soil, detection of the damaged olives, pest conditions, transport conditions of olives from the farms to the olive mills and production conditions in the olive mills.

3. Estimated olive yields

Questions asked:

- Would you be interested in knowing the expected yield? If yes, for which spatial scale and time period?

- In your case, which decisions could be affected by the availability of the information on the expected olive yield?

In the MED-GOLD project, the expected olive yield can be modelled based on the expected temperature and rainfall during the growing season, as well as on selected olive productivity parameters.

The participants of the Focus Group agreed that it is very important to know the expected olive yield. They noted that there might be different opinions regarding the preferred spatial and time scales and that the decisions can be affected by the availability of the information on the expected yield.

4. Bioclimatic indices and affected decisions

During the last focus group discussion with olive stakeholders, there were identified some climatic factors and bioclimatic indices which are expected to affect olive production decisions. Some examples are given below:

Climatic factors:

- Tmin below -5ºC;
- Tmax above 28ºC.
- Bioclimatic indices:
- Number of cold days ;
- Number of annual dry days ;
- Number of spring and summer heat days;
- Total winter precipitation.

In your case:

- How important is for you to be aware of variations in critical bioclimatic factors for the olive tree in order to implement future planning?
- Are the bioclimatic indices listed above important for your production?
- If yes, which decisions would be affected by these indices?
- Can you think of any other climatic factors that may affect your decisions?

3.3.5. Next steps

The next meeting to be organised for the preview of the tool is expected during the first Trimester of 2020. Since major changes are expected after this focus group, intermediate feedback may be necessary through the organisation of a webinar or online survey, for example.

Overall, the four participants stated that they would like to continue to be involved, with a face-to-face meeting potentially during the first trimester of 2020.

It was very difficult for DCOOP participants to see the usefulness of the online tool giving results only for the past. It was explained to them that the MED-GOLD team is developing and testing the tools for the past (historical data) in order to demonstrate and validate their potential future application.

The next steps for the development of the first section of the tool (seasonal forecasts) will refer to spatial scale, the availability of the predictions (before April) and the time scale for which they should be available (at least for the critical months: April-September). Other important considerations are the types of indices (which ones will be available?), the availability of the prototype (when?), the precision of the historical data, current stage of tool development, (where are we at?), to whom are these tools suitable for (larger producers most likely, compared with small traditional producers).

Participants liked the tool presented by EC2CE integrating seasonal climate predictions with other data through the use of artificial intelligence. This tool contains future predictions of expected productivity and provides advice for management.

ANNEX A. PHOTOGRAPHS FROM OLIVE/OLIVE OIL FOCUS GROUP

Figure A-1 Participants of the olive/olive oil focus group, during which the beta version of the tools was presented (9th May at DCOOP SCA´s corporate headquarters in Antequera, Málaga).

ANNEX B. PHOTOGRAPHS OF THE WORKING MATERIALS

Figure B-1 Conclusions for the tool of seasonal forecasts of climate risk based on artificial intelligence

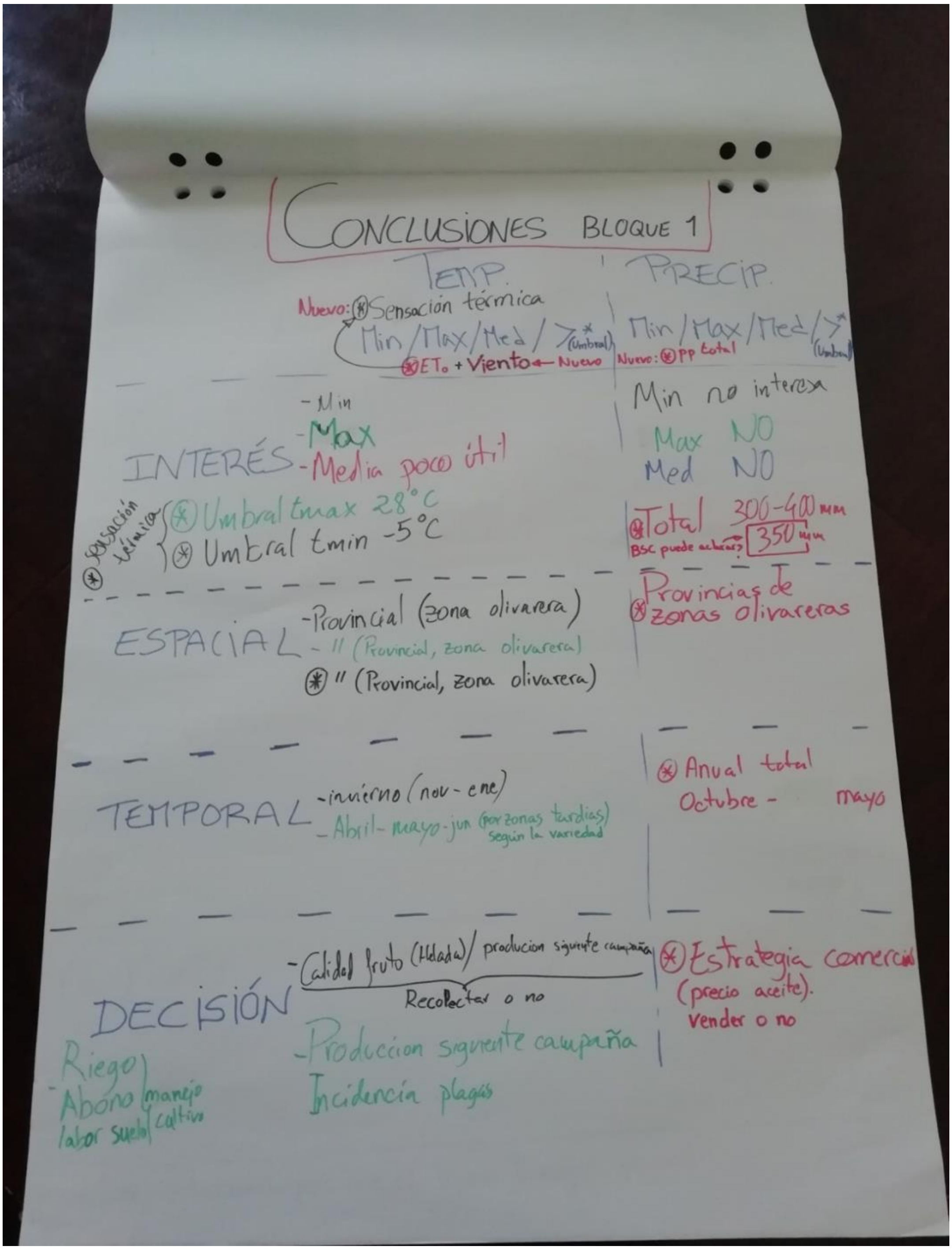


Figure B-2 Conclusions for the tool of Climate change projections of selected bioclimatic indices.

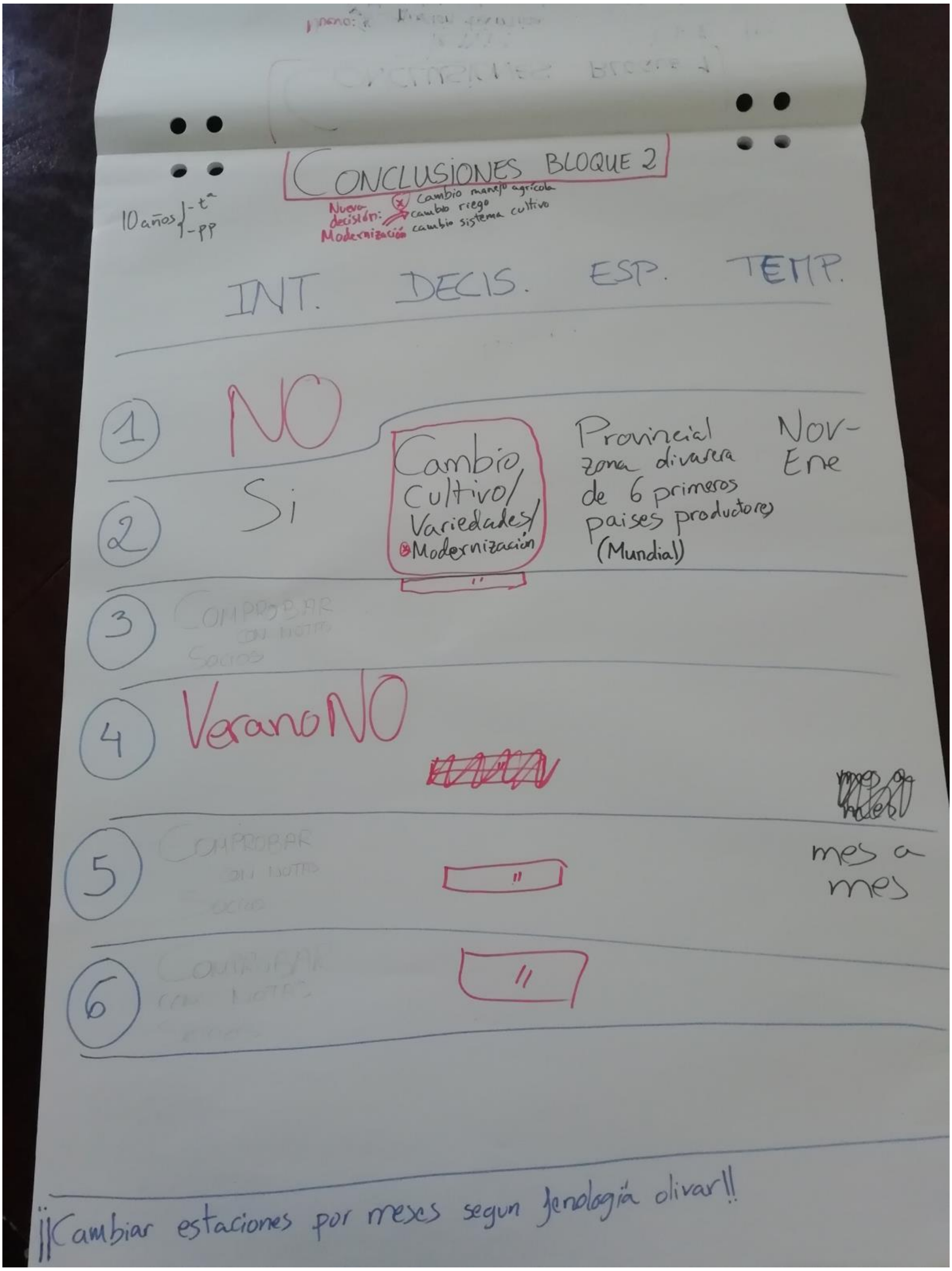


Figure B-3 Conclusions for the tool of regional recommendations for crop management using holistic analysis.

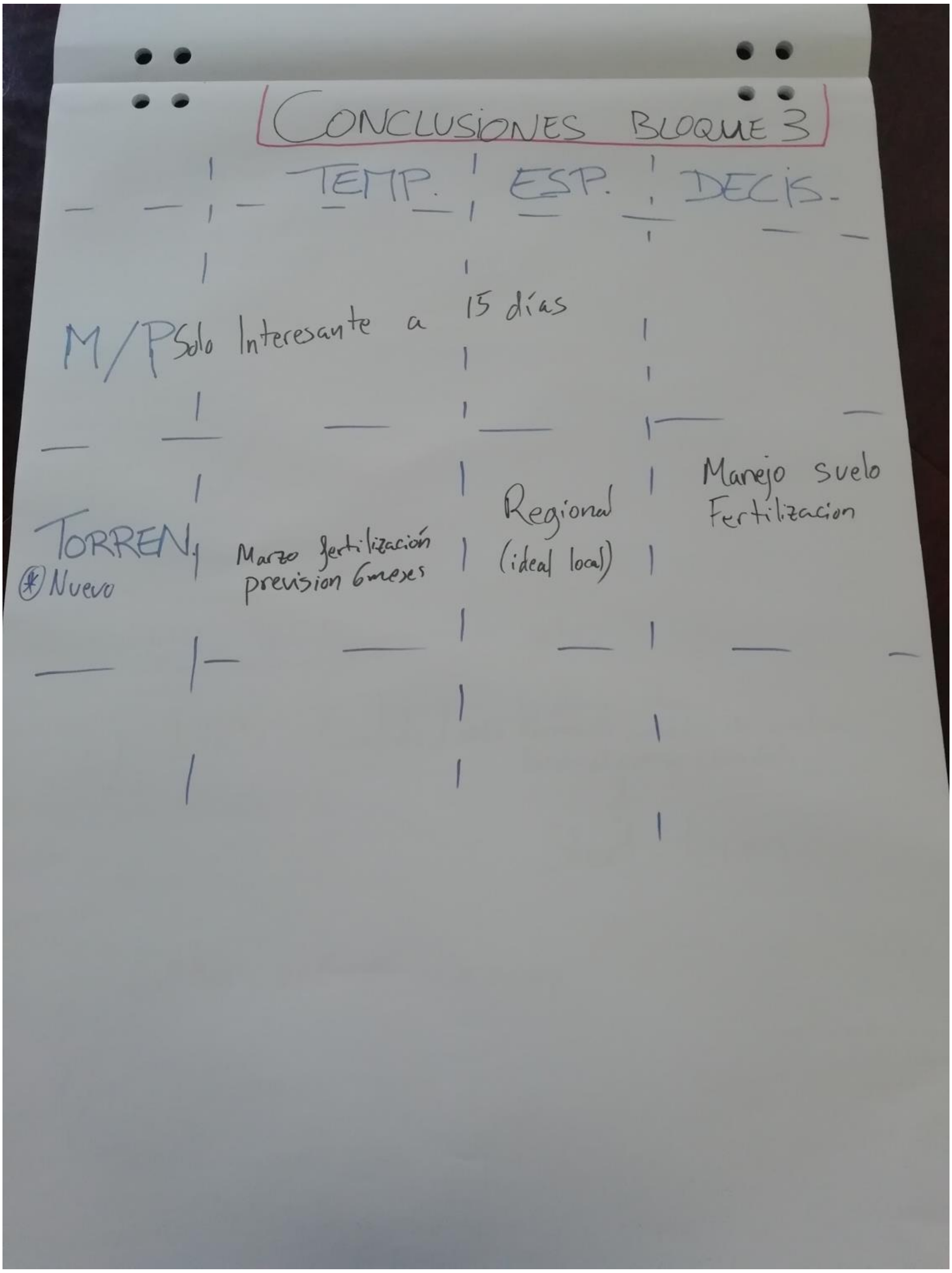


Figure B-4 Conclusions from the final discussion about the shown tools.

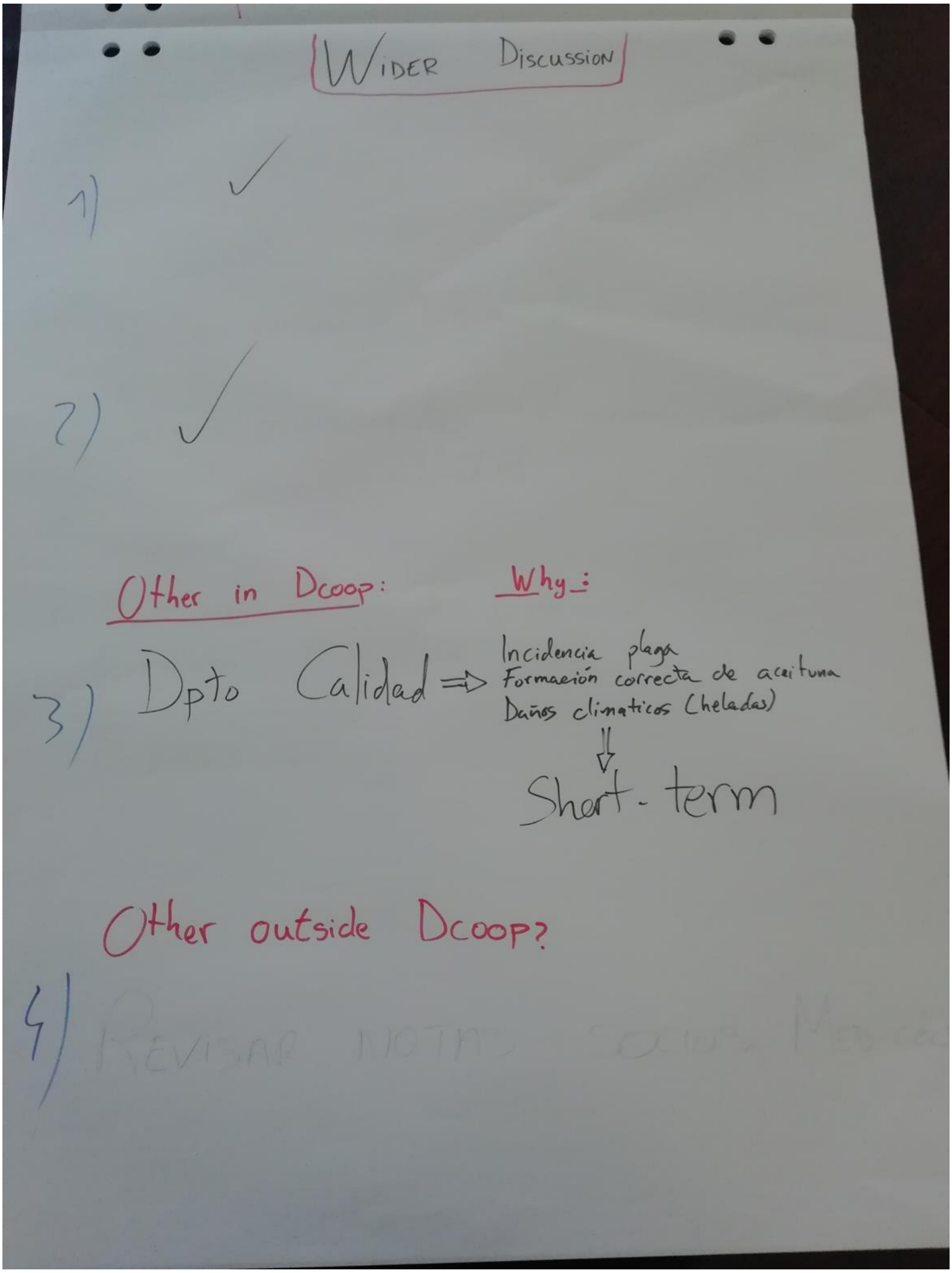
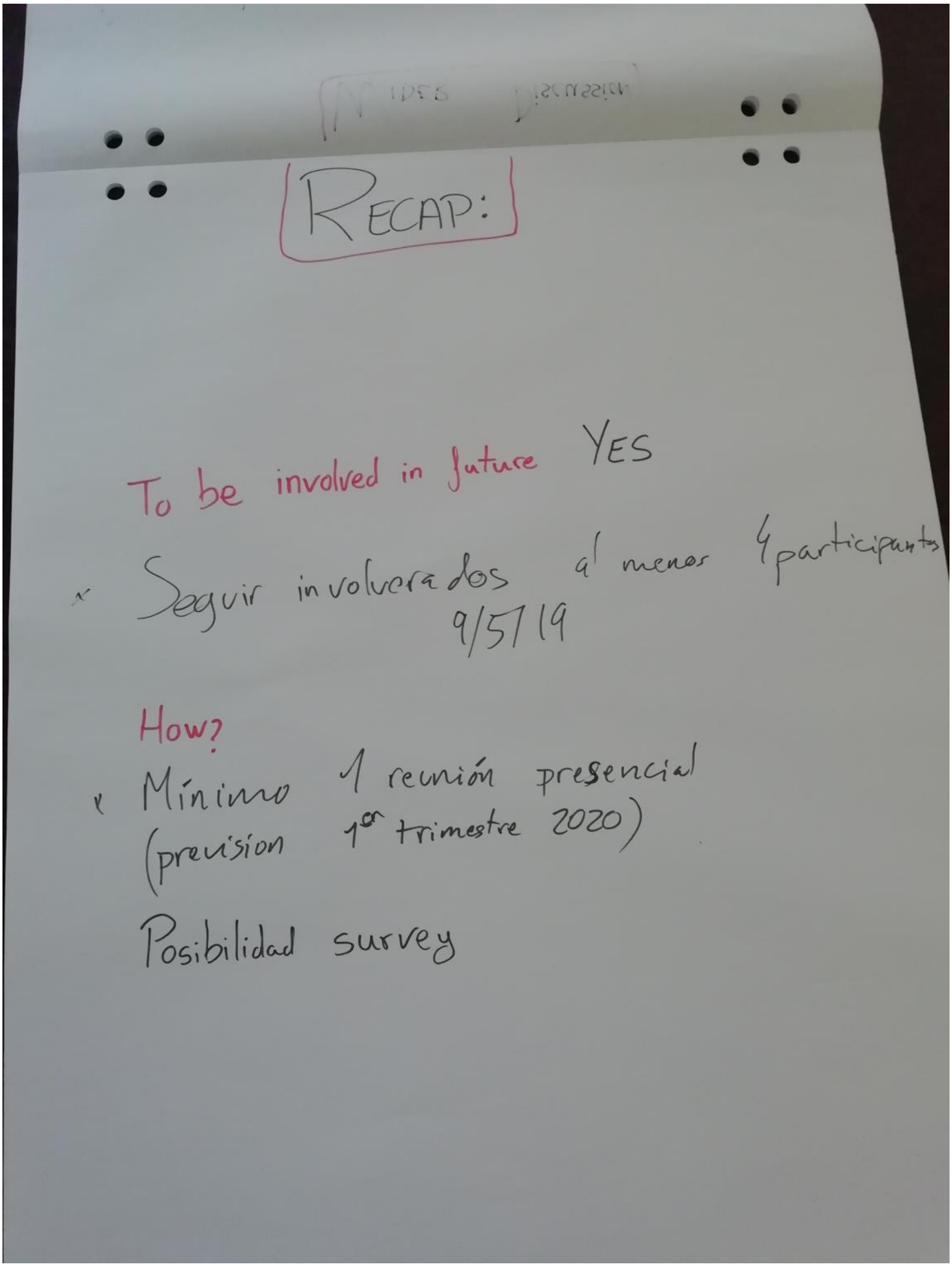


Figure B-5 Notes about the recap of the day and next steps.



ANNEX C. SATISFACTION SURVEY FROM PARTICIPANTS IN THE OLIVE/OLIVE OIL FOCUS GROUP

Table C-1 Result from Impact activity evaluation of Focus Group 2019

ID	Partner' organiser	Name of the event	Date of the event	Location of the event (city, country)	Description of the event	Nº of attendees	Evaluation sheet results
6	DCOOP S.C.A	First Focus Group olive sector	9th of May 2019	Antequera, Malaga (Spain)	The beta version of the tool was presented to the Focus Group. The Spanish partners from WP2 explain this tool and the olives experts provide their feedbacks about it. MED-GOLD collected the information from the olives expert in order to further improving the tool.	4 technical experts from several department of DCOOP: -Supplies and services department. One services of this department is the team of agronomists who advises to the farmers with their crops. -Logistics department. -Quality in olive mills department. -R&D department.	Average age: 36.3 years-old Gender: 25% females / 75% male Profile. Technicians General satisfaction: 7 Duration: 8 Organization: 8.25 Material provided: 8.75 Location: 9 Speaker skills: 8.25 Usefulness of climate services: 7.375

ANNEX D. INFORMATION SHEET FOR THE OLIVE/OLIVE OIL SECTOR

Figure D-1 Information sheet for olive oil case study: a version of the information sheet was presented during the focus group meeting, where comments and suggestions for improving it were provided by DCOOP participants resulting in the improved version below.

MED-GOLD

CLIMATE SERVICES FOR THE OLIVE AND OLIVE OIL SECTOR

Olive and olive oil production is heavily affected by weather and climate, and is thereby highly vulnerable to climate change. MED-GOLD will use a range of tools to support decision-making in the olive and olive oil sector over a range of timescales, from months to decades. These tools will include climatic indices, numerical models, and agroecosystem analyses to turn climate and other data into customized products. This process of turning climate-related information into products with added value for decision-making is called climate service. Climate information underlying the services will be provided at higher spatial resolution and with less bias than currently available.

Olive and olive oil producers face a variety of climate-related challenges in the long, medium and short term that need to be tackled by climate-informed decision-making. Some of the main challenges are presented below, with an indication of how the related decisions can be optimized using appropriate climate services tools that support a long-term strategy as well as shorter-term agricultural and commercial management.

Time scale	Decision type	Challenges	MED-GOLD climate services tools	Benefits
Short-term (e.g., 30 days)	Agro-management	• Optimize pest treatments • Optimize irrigation planning	• Temperature • Precipitation • Numerical modelling of pests and evapotranspiration • Insolation	• Reduce pest damage while protecting the environment • Optimize the use of water resources
	Quality management	• Better estimate pest affectation and frost damages • Correct olive formation		• Optimize olive and olive oil quality
Mid-term (e.g., 6 months)	Agro-management	• Optimize fertilization planning • Optimize irrigation planning	• Temperature • Precipitation • Numerical modelling of productivity	• Sustainability • Optimization of the use of fertilizers
	Stock management	• Better estimation of olive production • Improve the selling process		• Improve stock and selling planning
Long-term (e.g.,10-20 years)	Long-term strategy	• Select production areas • Decide type of exploitation (traditional, intensive, etc.) • Select tree spacing, varieties, etc.	• Temperature and precipitation patterns • Bioclimatic indices (see glossary): - Mean summer max. temperature - Mean winter min. temperature - Num. of winter cold days - Num. of annual & spring heat days - Num. of summer heat days - Total annual, summer & winter precipitation - Num. of annual & winter dry days • Numerical modelling of pests and productivity	• Future productivity per geographical area • Regional recommendations for improved crop management strategy • Cost-benefit analysis per productivity area • Exploitation adaptation and investment evaluation

Control of olive fruit fly *(Bactrocera oleae)*

Olive fruit fly is the major pest of commercial olives worldwide and its dynamics is strongly linked to both olive fruit development and the local climate, with mild temperatures and medium to high air humidity being especially favorable. In Andalusia (Spain), adult flies first emerge in spring and attack olives remaining on trees from the previous season, but damage typically starts in summer (usually in mid-July). When pits begin to harden, fly eggs are laid in olive fruits, and larvae that hatch from these eggs cause direct damage by feeding on olive fruit pulp. Larval feeding also causes indirect damage by both inducing fruit drop and allowing microorganisms to invade the fruit, which results in increased acidity and lowered quality and value of olive oil (losses can be up to 80%).

Currently, olive producers advised by DCOOP (MED-GOLD's champion user for the olive sector) use traps with sex-pheromones or diammonium phosphate food bait to monitor olive fruit fly. To control this pest, they apply phytosanitary treatments as well as other less common methods such as biological control.

Advantages of having access to mid-term (seasonal) climate predictions:

1. **Identification of regions at risk for olive fruit fly attack.**
2. **Improved control of olive fly pest** through anticipation of pest attacks and application of treatments during early stages of the fly lifecycle.
3. **Efficient management of phytosanitary treatments,** by applying them when more effective and by avoiding them when not needed, thus reducing environmental damage.

Glossary

Agroecosystem analysis: holistic approach required to analyze the complexity of agricultural systems that considers aspects from ecology, sociology, economics and politics (e.g. in the form of agro-technical inputs, invasive species, climate change…)

Climate pattern: a calculated value or profile used to describe the state and changes in the climate system

Climate projections: probabilistic estimates of climate variables that extend well into the future (long-term), from decades up to the end of the century

Climate services: transformation of climate-related data and other information into customized products such as trends, economic analysis, advice on best practices, and any other climate-related service liable to benefit that may be of use for the society

Mean summer maximum temperature: average daily maximum air temperature during summer

Mean winter minimum temperature: average daily minimum air temperature during winter

Numerical modelling: a computer model that is designed to simulate and reproduce the mechanisms of a particular system

Number of annual and spring heat days: count of days with maximum temperature above 28°C per year and in spring

Number of annual dry days: count of days with precipitation below 2 mm per year

Number of winter cold days: count of days with minimum temperature below -7°C in winter

Seasonal predictions: probabilistic forecasts of climate variables for the next season (up to 6 months)

Total annual, summer and winter precipitation: total amount of rainfall per year, in summer and in winter

Weather forecasts: probabilistic forecasts of climate variables for the next hours and days (up to two weeks)

About MED-GOLD

MED-GOLD, Turning climate-related information into added value for traditional **MED**iterranean **G**rape, **OL**ive and **D**urum wheat food systems, is a 4-year project contributing to make European agriculture and food systems more resilient, sustainable and efficient in the face of climate change by using climate services to minimize climate-driven risks/costs and seize opportunities for added value

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 776467

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ANNEX E. LIST OF COMMENTS AND QUESTIONS REQUESTING FURTHER FEEDBACK FROM DCOOP BASED ON THE OUTCOME OF THE FOCUS GROUP

Table E-1 Based on the outcome of the focus group meeting held on 9 May 2019 at DCOOP headquarters in Anquera, Spain, the following set of comments and questions was developed, translated to Spanish, and sent do DCOOP participants to the focus group as part of activating a continuous feedback loop with DCOOP

1)	Issue:	During the focus group meeting, it was stressed that systematic observational farm data are difficult to obtain. Compared to Portugal where olive farms are usually larger and managed by companies, olive farms are smaller in Andalusia and managed by farmers who do not usually record data related to olive production.
	Question:	It would be interesting to know if statistical data collected by third parties (e.g., local government, etc.) describing, for example, type of ownership, farm size, and intensity of management (e.g., plant density, main varieties, irrigated .vs. rainfed, training system) are available. If these data were available, it would be nice to have them georeferenced.
	Answer:	

2)	Issue:	During the focus group meeting, participants talked about % insolation during the olive flowering as an important parameter.
	Question:	Please explain what is the meaning of "% insolation”. Please provide a definition for it.
	Answer:	

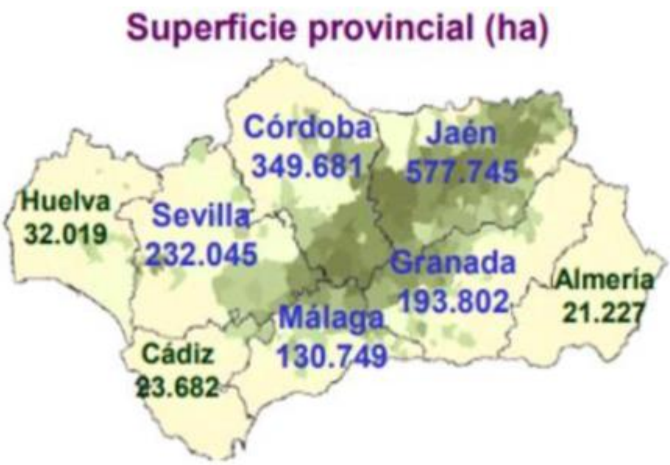
3)	Issue:	During the focus group meeting, total winter precipitation was mentioned by participants as interesting information that can be computed as precipitation from October to May, month by month for the next 6 months or for the next year.
	Question:	Please elaborate on why this is information is important. For example, it may be because rain during that period influences the ability to enter fields and harvest olives (i.e., related to the machinery involved) or maybe the rain itself affects the quality of olives to some extent. Also, please an operational definition such as the following one, for example: total monthly precipitation for months from October to May (eight months). Please, clarify the meaning of “for the next 6 months or for the next year”; it would appear to indicate„ the lead time (i.e., information available 6 or 12 months in advance).
	Answer:	

4)	Issue:	During the focus group meeting, it was mentioned that indices based on climate change projections are not very interesting to DCOOP in the form of a map. Maps or graphics can be good, but access to the underlying quantitative data would also be of interest, as DCOOP has experts that use this information for their own analysis. Further, it was mentioned that DCOOP can have a look at the maps, but they are more interested in the total numbers and graphs, so that they can use the results in their in-house calculations.
	Question:	It would be interesting to know who in DCOOP (e.g., role in the organizational chart) uses that kind of information as well as how is that information used and to what end. That would be important to know, as it is part of the user's decision-making process. Could this information about what DCOOP would do with the numbers and plots, be made available to the MED-GOLD project and to what extent? This is again about the climate-related decision-making process of DCOOP that should be reviewed by the project as per the project proposal. Would it be possible to prepare a description of the decision-making process (as analytical as possible) for the three key farming decisions of first critical level of interest, as identified in Deliverable 2.1? ● Phytosanitary treatment/pest/disease ● Fertilization ● Irrigation We are still missing this part and it would be of crucial importance to fill this gap. Even in the project abstract, we mention that we will review the decision-making process of users -- it is at the very core of the project, see: https://cordis.europa.eu/project/rcn/212919/factsheet/en The description of the decision-making process for the three decisions above (see Deliverable 2.1 for details) should be a list of steps and could also be illustrated graphically as a flowchart indicating **how the three decisions are made as well as where and how climate-related information enters the process**. Decisions can be both operational and strategic, see e.g. https://smallbusiness.chron.com/difference-between-strategy-operational-decisions-31075.html For crop protection (i.e., Phytosanitary treatment/pest/disease), for example, this review paper provides a good overview of the complexity involved the related decision making: Rossi, V., Caffi, T., & Salinari, F. (2012). Helping farmers face the increasing complexity of decision-making for crop protection. Phytopathologia Mediterranea 51: 457-479. http://www.fupress.net/index.php/pm/article/download/11038/11466 One can have different crop protection strategies for different pests, such as using a fixed number of sprays per season; using an economic threshold above which one decides to spray; or using integrated pest management (IPM), defined by Kogan (1998) as "a **decision support system** for the selection and use of pest control tactics, singly or harmoniously coordinated into a management strategy, based on cost/benefit analyses that take into account the interests of and impacts on producers, society, and the environment". Kogan, M. (1998). Integrated Pest Management: historical perspectives and contemporary developments. Annual Review of Entomology 43: 243-270. https://doi.org/10.1146/annurev.ento.43.1.243

		See also: https://www2.ipm.ucanr.edu/What-is-IPM/ IPM has been mandatory in the EU for some years now under Directive 2009/128/EC, see also: https://ec.europa.eu/food/plant/pesticides/sustainable_use_pesticides/ipm_en It may be therefore be assumed that DCOOP implements some kind of IPM decision-making process. If that is the case, it would it be good to have the IPM decision-making process of DCOOP described in detail. What is the Integrated Pest Management decision-making process that DCOOP currently implements? Or what is the most prevalent IPM decision-making process that is used in Andalucia and does climate-related information enters that decision-making process somewhere and how?
	Answer:	

5)	Issue:	During the focus group meeting, participants agreed that they would generally expect the South of Spain to become drier and hotter in the long term as that is what research is showing and everyone is more or less aware of.
	Question:	Does this also imply that DCOOP is much more interested in the seasonal forecasts of the bioclimatic indices? Please confirm.
	Answer:	

6)	Issue:	During the focus group, it was stated that it would be interesting to aggregate climate-related information according to olive zones - *zona olivarera* - that are more homogeneous. Participants asked if MED-GOLD is using weather information from public weather stations. They recommended that MED-GOLD selects the public station of olive areas most important in Andalusia. (the same for the rest of the tools, if it is possible). As an example, the central area of Andalusia (south of Cordoba, the eastern zone of Seville, North of Malaga, And North of Granada) and Jaen (Jaen we can consider the whole province, only a little part in the north and in the south of this province hasn´t olive farms) are very relevant in Andalusian olive production. The south of Granada and the coastal area of Malaga are not considered olive growing areas. Participants believe MED-GOLD should focus on olive areas so as to avoid using information that is not relevant to the olive sector. Also, if MED-GOLD makes estimates for Andalusia or every province of Andalusia, the results will be different than the results from the olive crop areas. In other words, MED-GOLD should analyze the representative regions of the olive crop, not the average of the province because the climate of the coast is very different than inland.
	Question:	This is important to know for the project. Please provide more detail. Are those zones the 8 provinces of Andalucia? Specifically, it would be important to know whether "*zona olivarera"* means the fraction of the green area (olive growing area)

		in the map below (from D2.1) that is included in each of the provinces of Andalusia (Jaén, Cordoba, Sevilla, etc.)? If that is the case, we would need a GIS raster layer for the olive growing area to work with. Would DCOOP be able to provide a GIS raster map of "*zona olivarera*"?  In the map above, yellow indicates municipalities where olive crops cover less than 10% of the area (not sure if that is 10% of the total agricultural area or total administrative area, as it is not specified in the figure in D2.1) or just in the light/dark green areas? If the green areas (more intensely planted to olive) are of interest, we need the GIS file version of the map above including that info. Would that be available?
	Answer:	

7)	Issue:	During the focus group, it was asked whether there will be a final tool and, if yes, what will it be.
	Question:	The idea is that DCOOP co-develops the tool, and hence they should also say what they would like to see in the tool and how they would like the tool to look like. No user requirements came out of the first interaction with DCOOP in terms of tool design/development -- the scoping workshop on 12 June 2018 was about appraising needs and critical decisions. It is important to reiterate that DCOOP is the co-leader of the olive case study. Now we need to go from the user needs (first scoping workshop) to the requirements (including software requirements) of the tool, which are starting to come out from the recent focus group. It is DCOOP that decides to a significant extent what the final tool will look like (obviously based on what the project can offer). Because we are starting to design a simple interactive dashboard as a graphical user interface to the WP2 climate service prototype for olive, it would be nice if DCOOP would provide indications and ideas for functionality that they would like to find the interactive dashboard.
	Answer:	

8)	Issue:	During the focus group, it was stated that in the MED-GOLD project, there does not seem to be continuous input of station data in the models and continuous

		generation of predictions, as far as participants could tell. Participants said that it would be much more useful to be able, at any moment, to check the predictions for temperature or precipitation for a certain month or year.
	Question:	If that is a requirement, we can work on that. But what is the decision that would be made based on continuous predictions? Without that, how can MED-GOLD figure out, assess, and demonstrate the benefit of climate services for the DCOOP user? To say that "it would be much more useful" is a good starting point. The next step is to analyze why and how "it would be much more useful" to DCOOP (e.g., where would that information enter the decision-making process). This is not to criticize but just to point to the fact that DCOOP includes an incredibly wide range of stakeholders that may make decisions based on climate-related information, such as people working in DCOOP's own departments but also people working in cooperative oil mills, as well as agronomists and farmers. When we talk about DCOOP as a user, it is actually a very diversified and fragmented set of users. Hence we absolutely need to identify the decision-making processes.
	Answer:	

9)	Issue:	During the focus group, when addressing regional recommendations for crop management, participants stated that they did not see any result in terms the olive tree production and its relationship with the olive fly that could be interesting for DCOOP. The usefulness of this type of information appears to be in the long term (e.g., 10 years) and is not clear either. It would be useful to have information on the areas expected to be under the risk of olive fly incidence. However, having long-term predictions of the occurrence of the olive fly is not seen as useful by DCOOP participants, who use that information for the next 1-2 weeks. Further, olive fly models seem to be relevant for periods no longer than 15 days as chemicals change a lot. The focus groups also discussed if other actors of the value chain (we focused on producers of phytosanitary products) could need the olive fly information in the long term but (currently) in Spain, this does not seem to be the case because the storage of chemical products (including phytosanitary products) for several months is made difficult by current regulations. Another point was that olive fly infestation levels at regional scale could be interesting for Governments/Ministers for allowing and planning the phytosanitary treatments, as insecticide treatments are more effective if all the farmers of a specific area treat at the same time
	Question:	What is being provided is information on the risk of pest infestation as affected by climate. The information on the areas expected to be under risk of olive fly attack can be provided, and it is indeed already planned. Is there an interest here for the olive growing areas/provinces as above? What does it mean that “chemicals change a lot”? Some further questions follow. 1. Ok, long-term info on pest risk is not of interest to farmers. 2. Please elaborate more on the difficulties and laws that affect chemical product storage in Spain. 3. From what it was said during the focus group, it seems that there are local authorities that authorize phytosanitary treatments and have a role in planning the treatments. Please provide more detail on who does what and describe the decision-making process, if possible, and the associated regulations/laws.

		4. Area-wide integrated pest management (IPM, i.e., when all farmers in a specific area are coordinating pest monitoring and control) is known to be especially important for pests like fruit flies, including the olive fruit fly, because of their enormous reproductive potential (and density independent action of natural enemies). This is exactly what was said during the focus group meeting when a participant stated “insecticide treatments are more effective if all the farmers of a specific area treat at the same time”. Hence one question would be if DCOOP has considered the potential usefulness of seasonal forecasts in improving area-wide IPM coordination of farmers in the different provinces of Andalucia (e.g., at the oil mill level).
	Answer:	

10)	Issue:	During the focus group, it was raised the point of heavy rainfall events (torrentiality). Participants stated that a higher frequency of extreme events of precipitation has the potential to change soil conditions, leading to conditions of desertification and soil loss that would have an impact on the development and production of the crop. This information would be required at a regional scale. More information would be provided by such an index if it could be combined with the previous precipitation and soil slope. Its applicability will be on soil management, which is not an easy work. The time scale at which this information be useful is the medium-long term. Again in terms of regional recommendations, participants mentioned that (torrentiality) would be an interesting index to know also 6 months in advance. It could be useful when fertilization is planned (in March), since fertilizers will be lost. Therefore, it would be an interesting value for production management (soil management and fertilisation) at the regional scale (ideally, local scale).
	Question:	Please provide more detail on what kind of information is needed (operational definition), what is the associated decision-making process, and how would the information be used. The interest in a torrentiality index at the seasonal (6-month) time scale is important new information that also unveils some decision-making. Please provide more details to define an operational definition for the index as well as a clearer description of the decision-making process where the related information would feed into.
	Answer:	

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