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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 1.1

MED-GOLD core sectors description and analysis

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DOCUMENT STATUS SHEET

Deliverable Title	**MED-GOLD core sectors description and analysis**	
Brief Description	This document outlines sectoral landscape for the three MED-GOLD sectors (olive, grape and durum wheat) involved in the project. An analysis of the sectors in figures and the relevant EU policies and global regulatory trends affecting the sectors is performed. Current market for climate services is also analysed.	
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1.5	22-10-2018	GMV	33	Final document
1.6	30-05-2019	GMV	34	Update on literature references and climate impact analysis

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EXECUTIVE SUMMARY

This deliverable describes the main characteristics and figures of the three MED-GOLD sectors (olive, grape and durum wheat) in order to map the associated production and industry, and investigate for the potential market for climate services in Europe. This map is undoubtedly affected by the global market and policies, mainly from the European Union, so this document explores in greater depth the role and weight that policies may have in each sector and the trends that it overshadows. All this with the focal point of drafting an initial analysis of the potential of climate services in each of the sectors considered.

With this deliverable, the project has contributed to the achievement of the following objectives (GA, Part B 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 climate 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

1.1. PURPOSE

This document provides an overview of the olive, grape and durum wheat sectors to understand and document the current landscape.

This is reflected in the achievement of the following objectives:

- Understand and map the main characteristics and figures of the three MED-GOLD sectors at global and particularly at European level.
- Analyse the role and weight of the EU policies in the three MED-GOLD sectors and their impact on the sectoral landscape and governance framework.
- Draft an Initial snapshot of current climate service market potential for the three MED-GOLD sectors in Europe.

1.2. SCOPE

A description of the three MED-GOLD production systems is necessary to understand the role that climate services can play in each one of them. Identification and understanding of their particular issues are essential to draw and assess the potential that climate services can play either from a farm management, private investment and policy-maker point of view. Aggregation of production figures and related policies generates useful information to draw the stakeholder map and the initial market point.

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
Climate Service	Timely production and delivery (translation and transfer) in customized products (projections, forecasts, information, trends, economic analysis, assessments, etc.) of useful climate-related data, information and knowledge that support adaptation, mitigation and disaster risk management to decision makers
Climate service provider	An organization that composes climate service products based on own and / or acquired data from observations and simulations with the aim to serve others in the climate service value chain.
Climate service purveyor	An organization that largely focuses on mediating of climate service, the value added of these services is largely in improving access and presentation of CS.
Climate service user	An organization, which uses CS for the purpose of improving its own products and services, as well as for better management of risks.
EU-MACS	European Market for Climate Services is an H2020 project for developing mechanisms that match climate service providers and users and make the climate information truly accessible and applicable for a large variety of applications.
MARCO	Market Research for a Climate Service Observatory is an H2020 project for assessing the market for climate services in Europe, carry out case studies, forecast future user needs, unveil opportunities, raise awareness, connect service providers and users and enable the creation of an EU climate services market observatory.
Common Agricultural Policy (CAP)	Agricultural and rural development policy of the European Union, originally introduced in 1962 which has undergone several changes subsequently.

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
%	Percentage
C3S	Copernicus Climate Change Service

Acronym	Definition
CAP	Common Agricultural Policy
CMCC	Euro-Mediterranean Center on Climate Change
CMO	Common Market Organization
COGEA	Business Management Consultants
CR	Commission Regulation
CS	Climate Services
CSP	Climate Services Partnership
EAGGF	European Agricultural Guidance and Guarantee Fund
EC	European Commission
EP	European Parliament
ERA	European Research Area
EU	European Union
EUROSTAT	Statistical Office of the European Union
FADN	Farm Accountancy Data Network
FAO	Food and Agriculture Organization of the United Nations
GA	Grant Agreement
GFCS	Global Framework for Climate Services
GIS	Geographical Information System
ha	hectares
ICT	Information and Communication Technologies
IOC	International Olive Council
IPO	International Pasta Organisation
IPRT	Inward Processing Relief Traffic
ISBN	International Standard Book Number
MARCO	Market Research for a Climate Services Observatory; project currently running under H2020
MT	Millions of tonnes
MS	Member State
OIV	The International Organization of Vine and Wine
PDO	Protected Designation of Origin
PGI	Protected Geographical Indication
t	tonnes
USA	United States of America
USDA	United States Department of Agriculture
USNRC	United States Nuclear Regulatory Commission
WMO	World Meteorological Organization
WP	World Package
WTO	World Trade Organization

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]	COGEA. Study on the competitiveness of European wines. Final Report. ISBN: 978-92-79-40735-2	2014
[RD.2]	IOC. Estudio internacional sobre los costes de producción del aceite de oliva. Consejo Oleícola Internacional.	2015
[RD.3]	Comité Européen des Entreprises Vins. European wine: a solid pillar of the European Union economy.	2015
[RD.4]	Cortekar, J., Themessl, M. Report on mapping of ERA4CS member states' national activities for climate services. European Research Area for Climate Services.	2016
[RD.5]	CSP. (2015). Toward an ethical framework for climate services. A white paper of the climate services partnership working group on climate services ethics.	2015
[RD.6]	European Commission. Economic analysis of the olive sector. Directorate General for Agriculture and Rural Development.	2012
[RD.7]	European Commission. EU olive oil farms report based on FADN data.	2012
[RD.8]	European Commission. A European research and innovation roadmap for climate services. Directorate General for Research and Innovation.	2015
[RD.9]	European Commission. EU crops market observatory – cereals https://ec.europa.eu/agriculture/market-observatory/crops_en	2018
[RD.10]	European Parliament. The EU olive and olive oil sector – Briefing 2017.	2017
[RD.11]	Eurostat. Crop production in national humidity. https://data.europa.eu/euodp/en/data/dataset/UQgumlTS42JuEqfyfufKg	2016
[RD.12]	Eurostat. Agriculture, forestry and fishery statistics. http://ec.europa.eu/eurostat/statistics-explained/index.php?title=Agriculture,_forestry_and_fishery_statistics_pocketbook	2018
[RD.13]	FAO. Climate services for food and agriculture.	2018
[RD.14]	International Pasta Organisation. The World Pasta Industry Status Report 2013. http://www.internationalpasta.org/resources/World%20Pasta%20Industry%20Survey/IPOstatreport2014low.pdf	2014
[RD.15]	Larosa, F. & Bombelli, A. Mapping innovation: a global outlook of Climate Services. CMCC Webinar	2018
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[RD.18]	Otto, J., Brown, C., Boutempo, C., Doblas-Reyes, F., Jacob, D., Juckes, M., Keup-Thiel, E., Kurnik, B., Schulz J., Taylor, A., Verhoelst, T. and Walton, P. Uncertainty lessons learned for climate services. American Meteorological Society.	2016
[RD.19]	Ranieri, R. Geography of the durum wheat crop. Pastaria International 6/2015	2015
[RD.20]	Siad, S., Gioia, A., Hoogenboom, G., Iacobellis, V., Novelli, A., Tarantino, E. and Zdruli, P. Durum wheat cover analysis in the scope of policy and market price changes: a case study in Southern Italy. Agriculture, 7, 12.	2017
[RD.21]	Soret, A., Gonzalez, N., Torralba, V., Cortesi, N., Turco, M., Foblas-Reyes, F.J. Climate predictions for vineyards management. Sustainable grape and wine production in the context of climate change.	2016
[RD.22]	Tilche, A. The European landscape on climate services. A short note with focus on climate service initiatives promoted by or with the support of the European Commission. European Commission – Research and innovation.	2014
[RD.23]	USDA. EU Wine Policy Report.	2016
[RD.24]	Vossen, P. Olive oil: history, production and characteristics of the World's classic oils. HortScience, 42, 1093-1100	2007
[RD.25]	WMO. Climate knowledge for action: a global framework for climate services – empowering the most vulnerable.	2011
[RD.26]	WMO. Valuing weather and climate: economic assessment of meteorological and hydrological services. ISBN 978-92-62-11153-1.	2015
[RD.27]	WMO. Guidance on good practices for climate services user engagement.	2018

Ref.	Title	Date
[RD.28]	WMO. Step-by step guidelines for establishing a national framework for climate services. ISBN: 978-92-63-11206-4	2018
[RD.29]	EC. The common agricultural policy at a glance. https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/cap-glance_en#Timeline	2018
[RD.30]	DG AGRI Dashboard - Olive Oil https://ec.europa.eu/agriculture/sites/agriculture/files/dashboards/olive-oil-dashboard_en.pdf	2018
[RD.31]	EU Wine Market Data Portal https://ec.europa.eu/agriculture/wine/statistics_es	2018
[RD.32]	The winemaking process https://www.plantandfood.co.nz/growingfutures/case-studies/unique-yeasts-for-winemaking/winemaking-process	2018
[RD.33]	Annual cycle of the grapevine and vineyards maintenance activities https://www.evineyardapp.com/blog/2016/02/04/annual-cycle-of-the-grapevine-and-vineyard-maintenance-activities/	2018
[RD.34]	Reynolds, A. Viticultural and vineyards management practices and their effects on the grape and wine quality. Managing wine quality. 365-444	2010
[RD.35]	Willems. E. Durum wheat market. An EU perspective. DG Agriculture Unit G.4	2017
[RD.36]	Lesk, C., Rowhani, P. & Ramankutty, N. Influence of extreme weather disasters on global crop production. Nature, 529, 84-87.	2016
[RD.37]	Sathyaseeelan, N., Kumar-Biswas, A., Subba Rao, A., Impact of climatic factors on crop production – a review. Agriculture Reviews, 34 (2), 97-106	2013
[RD.38]	OIV Statistical Report on World Vitiviniculture http://www.oiv.int/public/medias/6371/oiv-statistical-report-on-world-vitiviniculture-2018.pdf	2018
[RD.39]	Barrila Center For Food Nutrition. Cambiamento climatico, agricoltura e alimentazione https://www.barillacfn.com/it/pubblicazioni/cambiamento-climatico-agricoltura-e-alimentazione/	2008
[RD.40]	Caride, A. Lorenzo, M.N. Efecto de la variabilidad climática sobre la producción del olivo en España. ACT, 5, 55-71	2014
[RD.41]	Soddu, A, DeiddA, R, Marrocu, M., Meloni, R., Paniconi, C., Ludwig, R., Sodde, M., Mascaro, G, Perra, E. Climate variability and durum wheat adaptation using the AquaCrop model in southern Sardinia. Procedia Environmental Sciences, 19, 830-835.	2013
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3. MED-GOLD SECTORS IN FIGURES

3.1. OLIVE CROP AND OLIVE OIL PRODUCTION CHARACTERISTICS

The majority of olive groves (*Olea europaea* L.), although a large number of varieties and cultivars exists, are located in the Mediterranean basin. More than 11 million ha [RD. 2] of olive groves are planted in over 47 countries in the five continents. In Europe, this crop is located mainly in Spain, Italy, and Greece, Smaller amounts are grown in Portugal, France, Cyprus, Slovenia, Malta, Croatia, Former Yugoslav, Republic of Macedonia and Turkey (Figure 3-1) [RD.12]. Overall, Europe accounts for 70-75% of global olive oil production about 30% of table olives. Spain, Italy and Greece alone account for around 73% of world production (Figure 3-2), and 97% of the EU-28 production [RD. 32]. In fact, olive-based products are primary elements in the agricultural economy of the EU's southern countries, with an economic value of around 7.000 million euros per year [RD. 6 and 10]. Olives are also grown in Tunisia, Morocco, and Algeria as in many Mediterranean countries, but new plantations also exist in California, Chile, Argentina, South Africa and Australia.

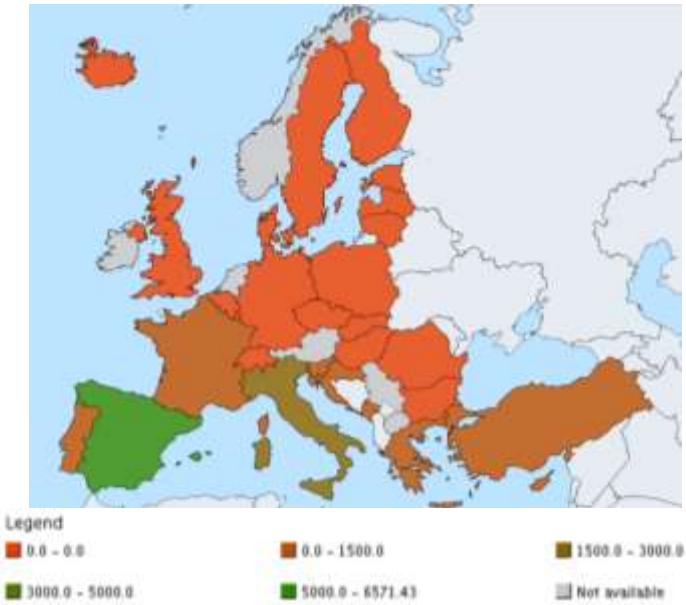
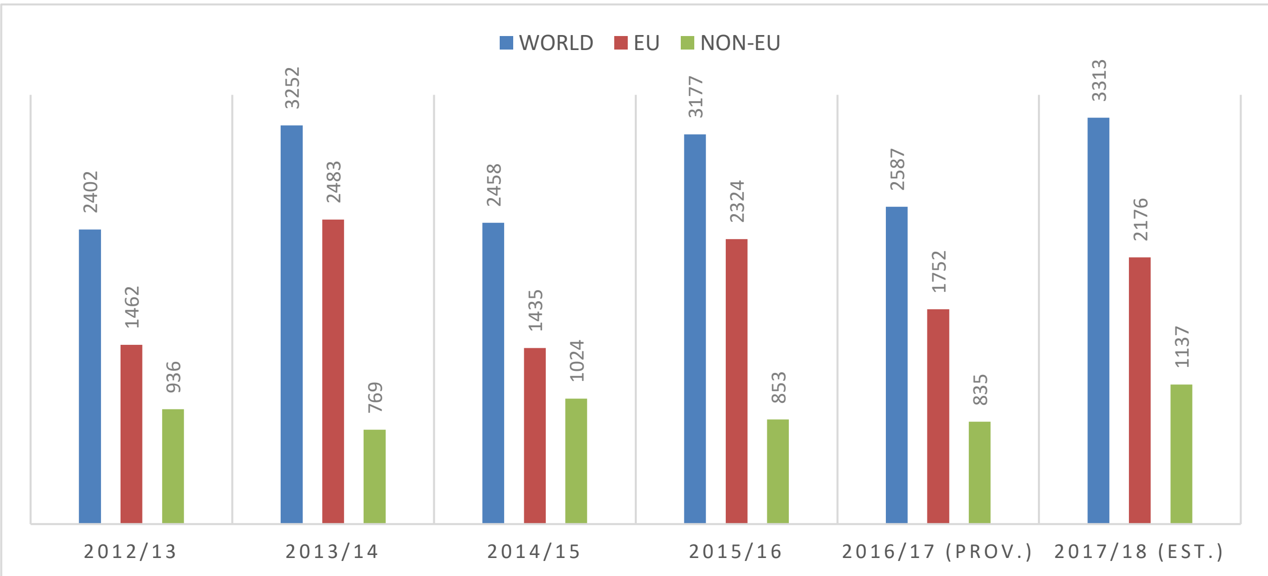


Figure 3-1. Olive production for olive oil and table use in 2016 [RD.12].



Amounts expressed in 1000T

Figure 3-2 World olive oil production [RD. 30].

Olive tree is a perennial Mediterranean crop, which was traditionally grows in relatively poor rainfed areas since it tolerates hot and dry conditions, is characterized by low external inputs and is practiced in hilly areas with shallow soils.

In these dry-farmed areas, traditional olive production systems can be found. Nevertheless, modern olive production systems have incorporated irrigation and mechanization in order to increase sustainability and profitability. So, a number of different production systems can be found. The major production systems are summarised in Table 3-1, although multiple combinations are possible.

Table 3-1 Main characteristics of olive production systems

	Traditional system	High-density system	Superhigh-density system
Density (trees / ha)	<180	180-800	>800
Full production (years)	15-40	7-10	5
Yields (t/ha)	1.1-4.5	11	2.7-17.5
Oil yield (%)	17-20	17-19	18
Average cost (euros/kilo)	2.86 - 4.45	3.5	2.9
Main costs	Harvest and fertilization	Harvest and fertilization/ Irrigation	Harvest and pruning
Technologies	It can be rained or irrigated It can be mechanized (depending on slope)	It can be rained or irrigated Mechanized	Irrigated Mechanized
Observations	Severe biological alternation		Arbequina, Arbosana and Koroneiki varieties are mainly used.

Data obtained from RD.2, RD.7 and RD.24.

Global olive oil production is around 3 million tonnes which represents about 1.7% of all vegetable and animal fats. The EU production is mainly in Spain (65.6%), Italy (19.4%), Greece (9.5%) and Portugal (4.8%) (Eurostat, 2016). These figures show the strategic position of the EU in olive-based products whose influence and idiosyncrasy for reasons of consumption and production has been at a global level [RD.10].

The degree of organization differs greatly from one EU member state to another. Although Spain is the main producer in EU, with specialized farms controlled by few big groups, a higher number of processing businesses are in Italy which, for example, controls around 50% of the virgin olive oil market [RD. 2]. In Greece, the majority of production is put on the market by few companies and farms equally specialized in olives for oil and table olives.

The profile of the olive-producing farms is also different. A sectorial characterization done by Eurostat in 2013 indicates that, while in Spain and Portugal 40% of the farming systems have a size larger than 20ha, with an average of 52-67ha, 90% of the farming systems present in the rest of the EU countries have a size smaller than 5ha. So, many small-size farms cohabit with large and modern olive plantations. This is also relevant since labour, specially harvesting, is the main production costs and the scalability in resources is limited.

Different plantation types are present all over the world and mainly focus on olive oil production. There is a predominance of non-irrigated olive groves, although an increasing area has been irrigated. This production depends on a wide number of factors:

- Operating system (i.e.: variety, soil);
- Planting density;
- Growing practices (i.e.: irrigation),
- Climate conditions;
- Biological variation;

In the Mediterranean region, farmers perceive that climate is a major risk, probably due to the broad spectrum of possible adverse climate impacts and to the uncontrolled aspects of extreme events. Moreover, olive is primarily grown in southern areas where the water scarcity is an important issue.

Economic forecasts indicate that non-producing countries will increase their demand. Production is also expected to increase all over the world, with the EU still leading the export market (especially Spain) [RD. 10]. A shift towards even greater intensification and mechanisation is to be expected.

Olive oil production can be commercialized in different ways. From a nutritional and health point of view, olive-based products have a positive image and quality. The classification related to olive oil products (Regulation EU nº 1308/2013 – Annex VII, part VIII) is mainly related to quality and organoleptic characteristics. Thus, olive oil quality is influenced, for example, by the moment of harvesting and the time between harvesting and pressing. The relevance, since the price is higher, is to produce the higher amount of extra virgin oil which depends mainly on climate conditions. Figure 3-3 shows the process to obtain different commercial products:

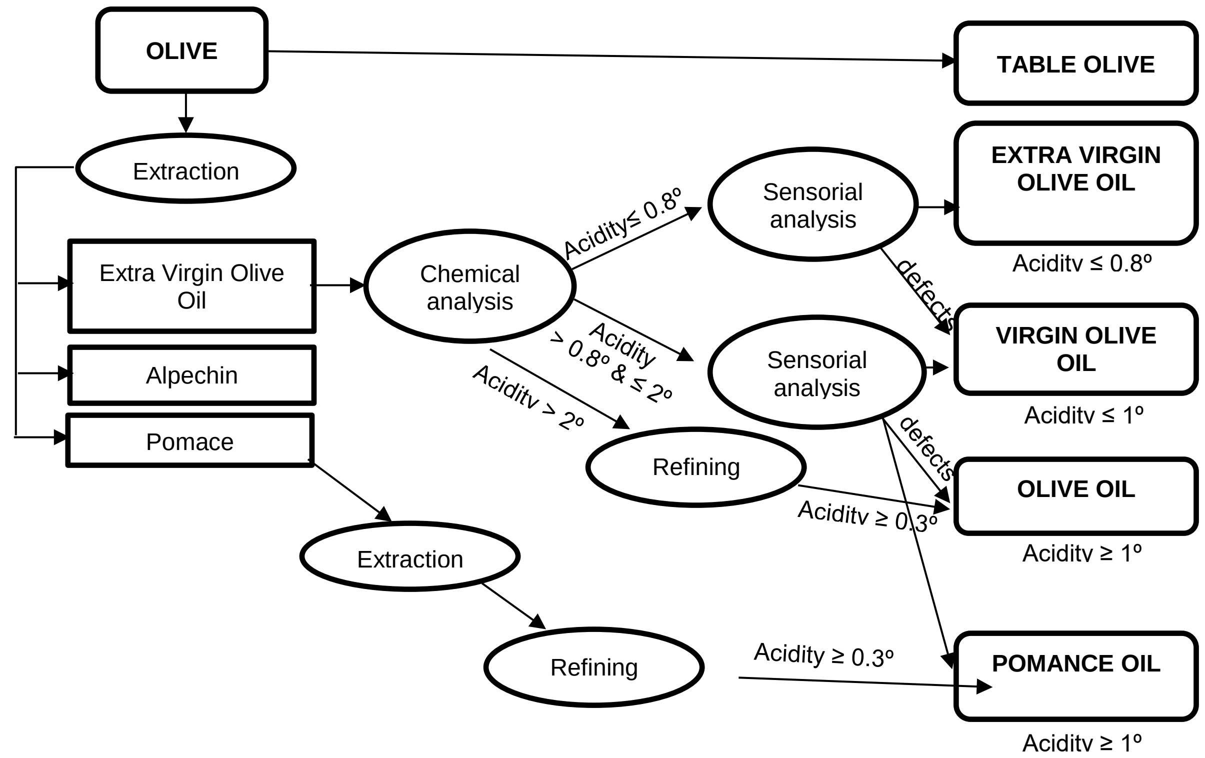


Figure 3-3 Olive-based processing products.

As it can be observed, obtaining a premium quality olive oil is a chain process, which begins with the tree (soil, climate, variety, cultivation and harvesting practices) and ends in the packaging (transport, storage, processing and conservation of the oil).

Any factor that, in any way, produces directly or indirectly an alteration of the natural components of the fruit, negatively influences the quality of the oil obtained. It is fundamental to start from fruits that are perfectly healthy and that have remained on the tree until the time of harvesting.

The olive crop is affected by the climate change, especially the increase in temperature, the decrease in rainfall and the change in the pattern of the temporal distribution, cause variations in the olive crop in many aspects:

- Flowering

The expected climatic conditions would cause an advance the period of the flowering in all the varieties of olive tree and localities. For example, in some areas of Jaen (Andalusia, Spain), an advance of 6 days is expected for the period 2021-2050 and of 17 days in the period 2071-2100.

The increase of the temperature would cause the thermal stress of the olive trees, as a result, a higher frequency of damage in flowering is predicted (in some areas of Andalusia, where currently don´t exist this damage in the next decades the probability of damage will be to 15%). In addition, the development of the phenology of the olive tree requires to cover the needs of cold to obtain a correct flowering, on the contrary, the olive fruit production decreases. In fact, for the period 2021-2050, it is expected that the probability of damage due to lack of cold will reach an occurrence of 10%

Water stress during flowering is especially damaging to the olive tree. It is estimated that the production falls associated with this circumstance will reach up to 25%.

In Spain, for example, oil and table olive production is favoured by high temperatures between April and September, while low temperature are better between July and November. Regarding rainfall, there is positive correlation during March, May and October, but negative effect is the rain is on December. Identification of these aspects can be relevant to monitor the orchard and estimate the production [R.D. 40].

- Quality of olive oil

Some compounds of olive oil such as fatty acids, polyphenols, pigments, waxes, among others, which are analyzed physicochemical and sensorial, could change for a new climatic condition.

It is known that an increase in frost in the early months of autumn produce a decrease in the quality of the olive harvested and the olive oil produced from frozen olives can´t be classified as extra virgin even this olive oil must be refined.

On the other hand, an increase of the temperature during September-December in some varieties of olive produces a decrease of the content in oleic acid.

The decrease of water available for the olive tree can have a beneficial effect in the nutritional quality of the oil, increasing the level of polyphenols, and even of oleic acid of the oil.

In summarize, the current physical-chemical profile of olive oil could change what could reduce the production of extra virgin olive oil if any parameter does not fall within the measuring range of the current legislation.

- Harvesting and pressing:

The drought and the high temperatures cause an advanced on the harvesting moment which produces an increase of the cost of harvest and of the costs in the olive mills because of a low degree of ripeness on olive fruit hinder to collect and to press the olives.

- Soil´s erosion:

Future climate projections show an increase of the frequency of extreme rainfall events such as storms. This kind of rain increases the soil losses.

An example of the effects of drought on the olive crops can be found in 2017, that year, Coordinadora de Organizaciones de Agricultores y Ganaderos de Andalucía (COAG Andalusia) estimated that the drought produced a reduction in production of 25% in the olive crops of Andalusia. This descent of the productivity was quantified around 600 million of euros according to the estimation from Unión de Pequeños Agricultores y Ganaderos Andalusia (UPA).

- Pest of the olive crop:

The increase in temperature may decrease the incidence of the main olive pests such as *Bactrocera oleae* and *Saissetia oleae*. However, other pests considered as secondary currently could increase their impacts such as *Palpita unionalis* and *Euzophera pinguis.*

3.2. GRAPE CROP AND WINE PRODUCTION CHARACTERISTICS

Wine is an agricultural product with high added-value. Its quality depends on several factors such as the characteristics of the production area or the prevailing meteorological conditions occurred during the growing season, farm structure, processing infrastructure, etc. The production volume also varies from year to year mainly due to weather and sanitary conditions. All these factors, together with others during wine processing (Figure 3-4), have their impact on the final result and, therefore, a wide range of wines quality exists on the market.

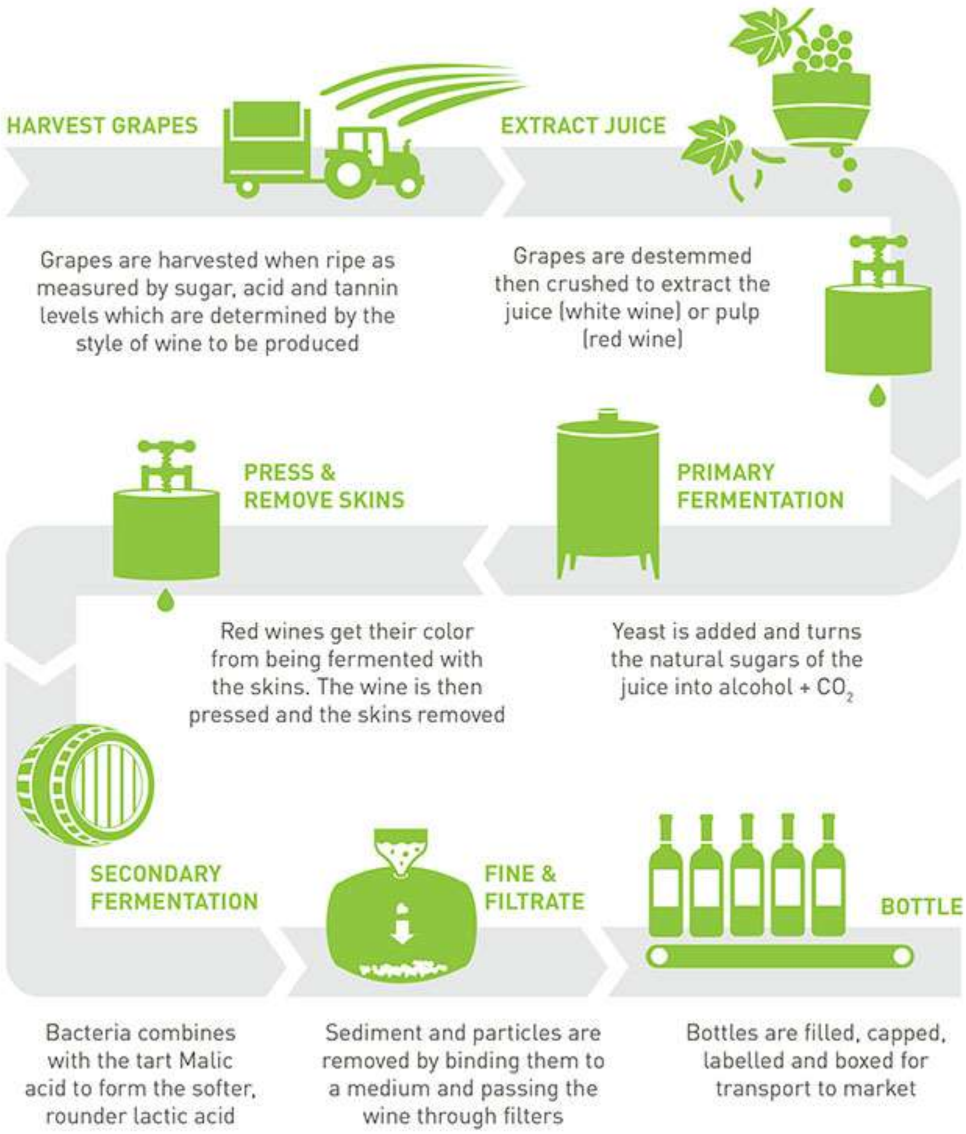


Figure 3-4 Winemaking process [RD.32]

Grapes for wine are grown on 3.362.000ha in 2015 in Europe (Figure 3-5) [RD. 1 and 3]. The top five EU producers are Italy, France, Spain, Germany and Portugal [RD. 12]. In fact, the EU represents around 45% of the world's total vine-growing area and is the world's biggest wine producer, with about 56% of the world production, which in 2017 was 24.7 billion litres [RD.17] corresponding to near 33 billion bottles. EU is not only the wine production leader, but it is also the main market for wine. Nevertheless, while consumption of wine by capita is globally increasing, in Europe it is starting to recover from the decreasing trend owing to changes in the consumption patterns in the Mediterranean countries (entry-level table wines for daily meals are being replaced by premium quality wines for non-daily events). This is a global tendency in which traditional wine producing countries are witnessing a premiumization of consumption patterns, while non-traditional wine producing countries have consumers discovering wine. Nevertheless, European Member States are responsible for 52% of global consumption, followed by North America.

According to Eurostat data, around 2.5 million wine-growers exist in the EU with an average vineyard area of 1.3 ha per holding. In some countries such as Slovakia, France, Czech Republic, Bulgaria, Spain and Germany, 50% of the vine-growing area had more than 10ha by holding; while in contrast, in Romania, Cyprus and Greece holdings with less than 1ha covered more than 40% of the total vine-growing area [RD. 31].

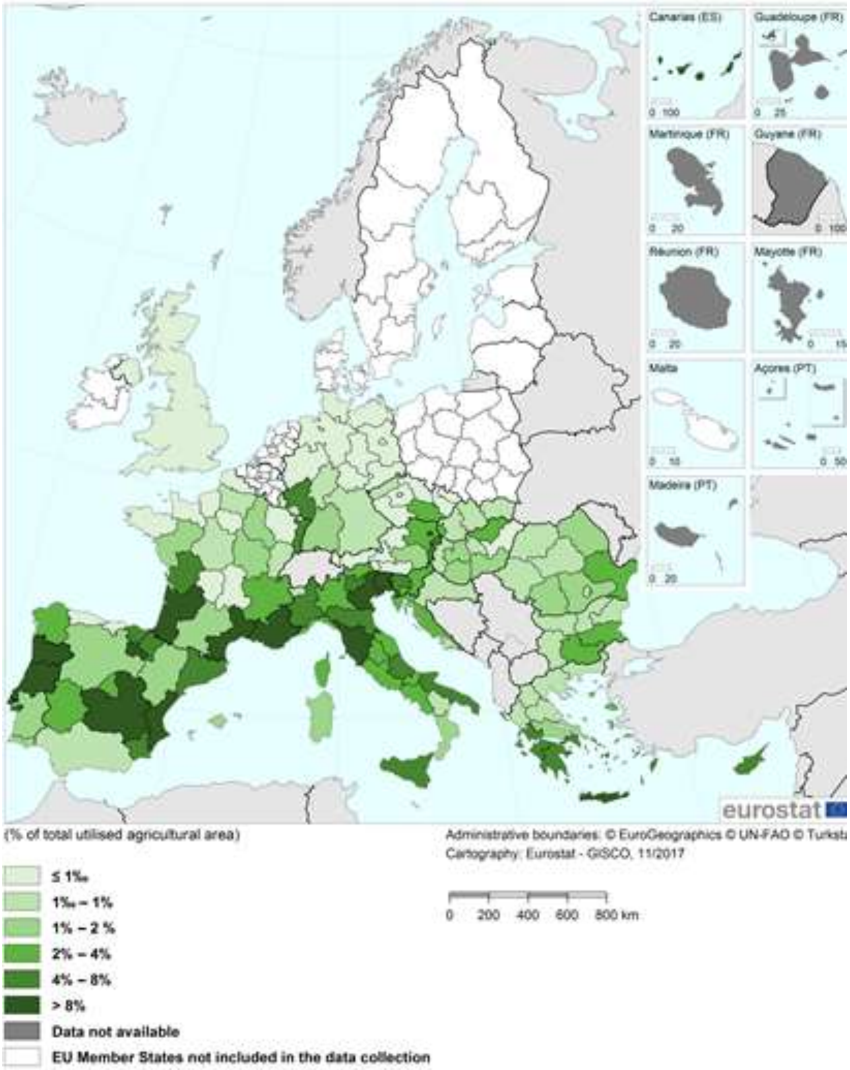


Figure 3-5 EU vineyards are and wine output in 2015 [RD. 31].

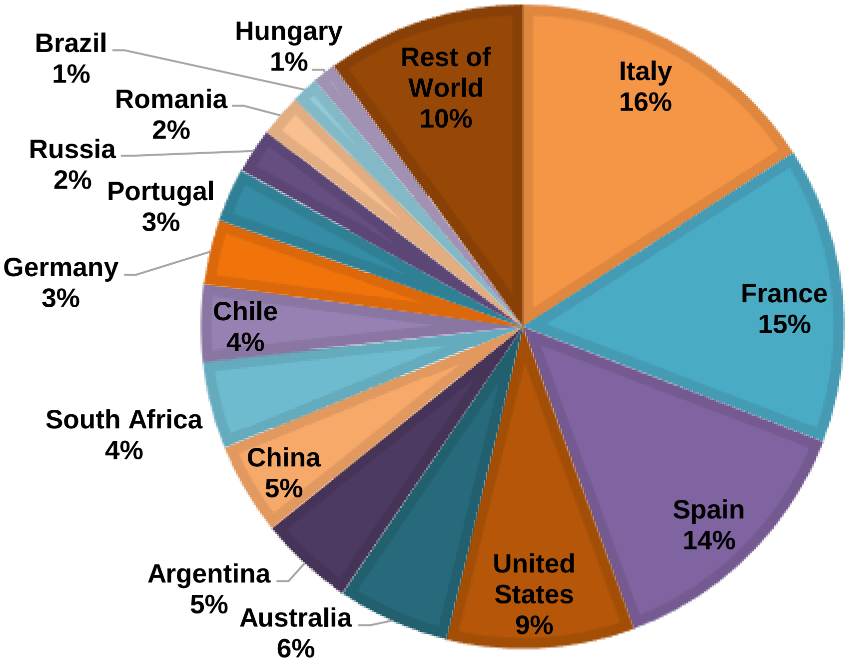


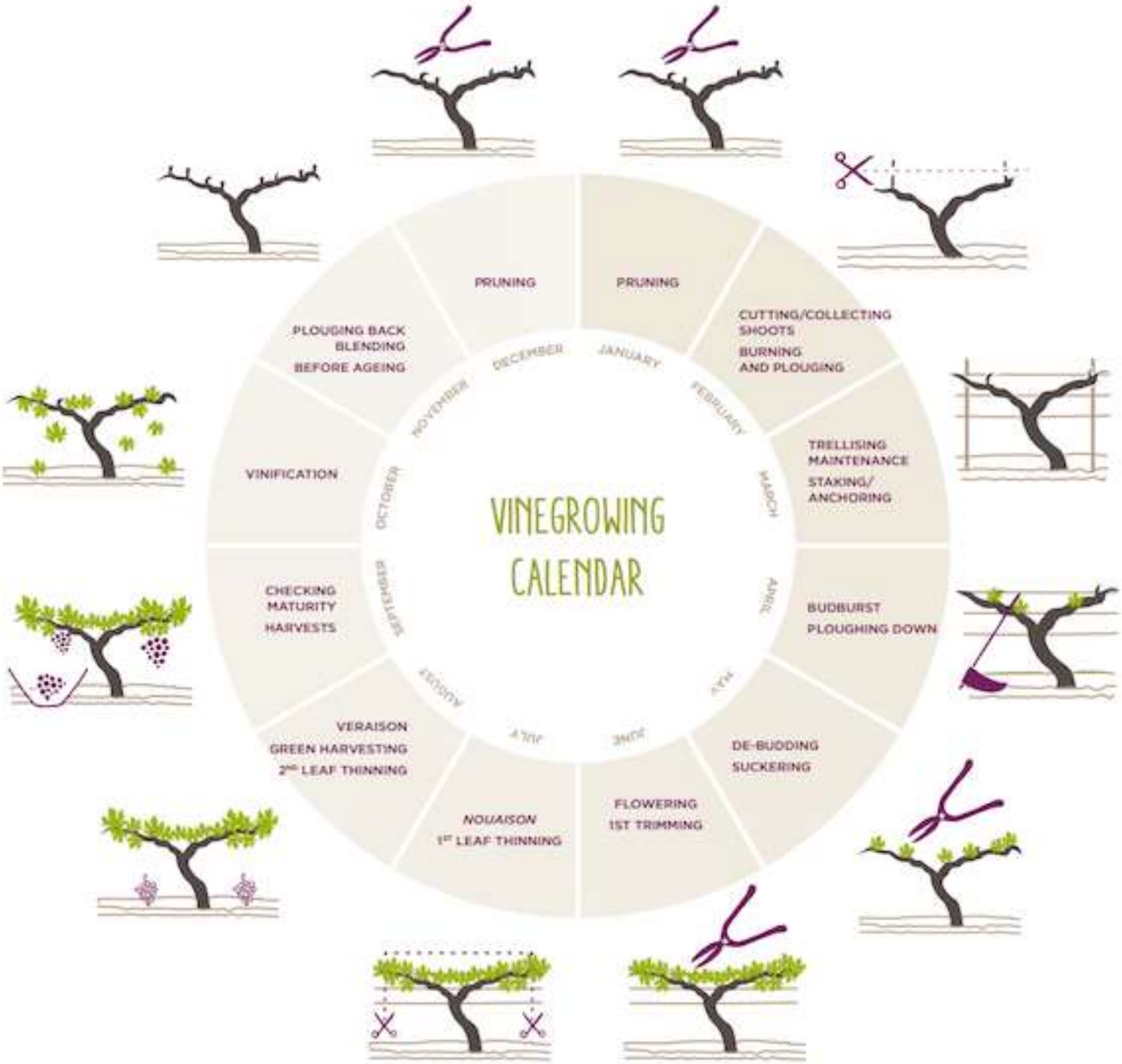
Figure 3-6 Top fifteen wine-producing countries [RD. 17]

Going deeper on the EU-28 characterization of the sector, there are a couple of points that draft the panorama [RD. 31]:

- *Vitis vinifera* is the dominant species for all varieties. Around 500 different varieties are grown in the EU; the largest number of varieties (96) are grown in Italy. Cabernet Sauvignon is the most widely cultivated red variety (6.7% of the total area under red vines) and Airen is the main white variety (16.4% of the all area under white varieties);
- Red varieties cover around 1.6 million ha (mainly Bulgaria, Greece, Portugal, Spain, France and Italy) while white varieties are grown on 1.3 million ha (mainly Czech Republic, Germany, Croatia, Hungary, Austria, Slovenia and Slovakia);
- Around 40% of the vine-growing area is between 10-29 years old and another 37% older than 30 years;
- 82% of the EU vine area was dedicated to the production of quality wines, while 13% was dedicated to table wines.

Grapevine is a perennial crop which grows or blooms during the spring and summer, becomes dormant during autumn and winter months and then repeats the cycle from its rootstock the following spring. With an average lifespan of several decades, this crop requires at least three years to produce adequate fruit for winemaking and five to eight years (depending on the region and type of wine) to achieve full quality potential.

As the vine is adapted to grow in forest environments, several operation should be executed during the growth cycle to prevent the plants growing into a bushy-tree-like mass of leaves and branches (Figure 3-7). Pruning, shoot thinning, basal leaf removal, hedging and pre-harvest crop removal are some of the most relevant. Probably, winter pruning is the most critical as it manages the basic structure of the plant, allowing to balance vigour with production (Figure 3-8), define amount of light interception by the canopy and adaptation to mechanical operations [RD. 21]. Today, many of these practices can be done by machine, although in high quality wine production areas and old vineyards of the EU, several are not yet mechanized.



Source: Vins de Bordeaux

Figure 3-7 Annual cycle of the grapevine and associated operations [RD.33]

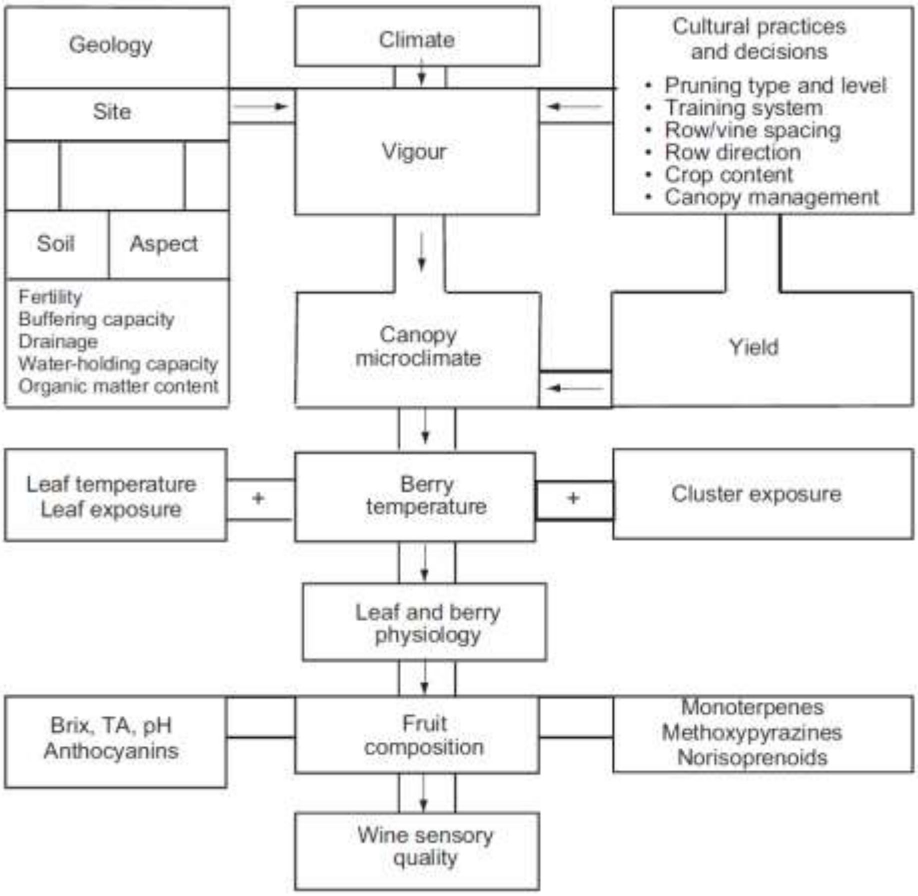


Figure 3-8 A conceptual view of factors contributing to vine balance and wine quality [RD.34]

As it can be easily inferred from Figure 3-8, climate impacts the balance of the grapevine, fruit quantity and quality; therefore, presenting an important impact on wine production and sensory expression, translating directly to its commercial value. The average temperature of the growth cycle, calculated between March and October in north hemisphere, will impact the length of the growing and ripening seasons, ultimately impacting the ideal harvest date: low values of this index will potentially result in later harvest dates, lower quality wines because of deficient grape maturation and higher risk of a rainier harvest, while high values will result in earlier harvest date, better maturation conditions and grape quality but also an increased risk of plant and fruit dehydration, photosynthesis arrest and sunburn events which will cause an unbalanced fruit composition, resulting in lower quality wine. Rainier years will increase the risk of disease outbreaks with downy (*Plasmopara viticola*) and powdery mildews (*Erysiphe necator*) being the most threatening in many European wine regions, the former reducing yields and the latter causing quality losses. If precipitation hits the end phase of the cycle, at maturation, (something fostered by lower temperatures during the growth cycle) the risk of rot (*Botrytis cinerea*) outbreaks increases and with it the risk of grapes becoming unsuitable for any use.

Recent examples of the effect of climate risk variability in wine production were years of 2016 which saw losses in productivity between 15% and 25% in France, Germany and Spain due to fungal disease outbreaks and 2017 in Portugal and Greece with losses of 10% to 15% due to extreme drought and high temperatures [RD.38].

3.3. DURUM WHEAT CROP AND PASTA PRODUCTION CHARACTERISTICS

Mediterranean Basin durum wheat production occurs during winter and therefore, climatic conditions, especially rain, affect significantly the total production that can be achieved. In Northern Africa and Southern Europe, droughts are the main controlling factors. Other main durum wheat cultivated areas globally are the Northern Plains between USA and Canada and the desert area of USA and Northern Mexico, followed by Russia, Kazakhstan, Australia, India and Argentina. Depending on the weather conditions, winter or spring wheat production can be more favourable. Hot and dry conditions in spring/early summer and rainfall in later summer (France, West Germany and Spain) impact on the winter cycle. In fact, wheat quality depends heavily on the weather through the season and this affects the quality of the derived-products. This, in turn, can influence the use that it can subsequently have, mainly as animal feed or for human consumption.

Durum wheat (*Triticum durum*) is known for its protein content, gluten strength, intense yellow colour, butter flavour and excellent cooking quality. Durum wheat is the main raw material for the production of pasta, couscous and bulgur, each of which is obtained via a completely different industrial process. In Europe, durum wheat is used mainly for production of pasta; in North-America, the characteristics related to virtuousness and test weight mean that it is used for couscous and bulgur.

The global cultivation area of durum wheat is estimated to be around 16.7 million hectares with a worldwide production of around 38 million tonnes (MT), which represents 2% of total cereal production [RD. 9]. The EU is the top producer of durum wheat, followed by Canada. In the period 2017/2018, durum wheat production decreased at the EU level, but remained high at around 9,3 MT [RD. 11].

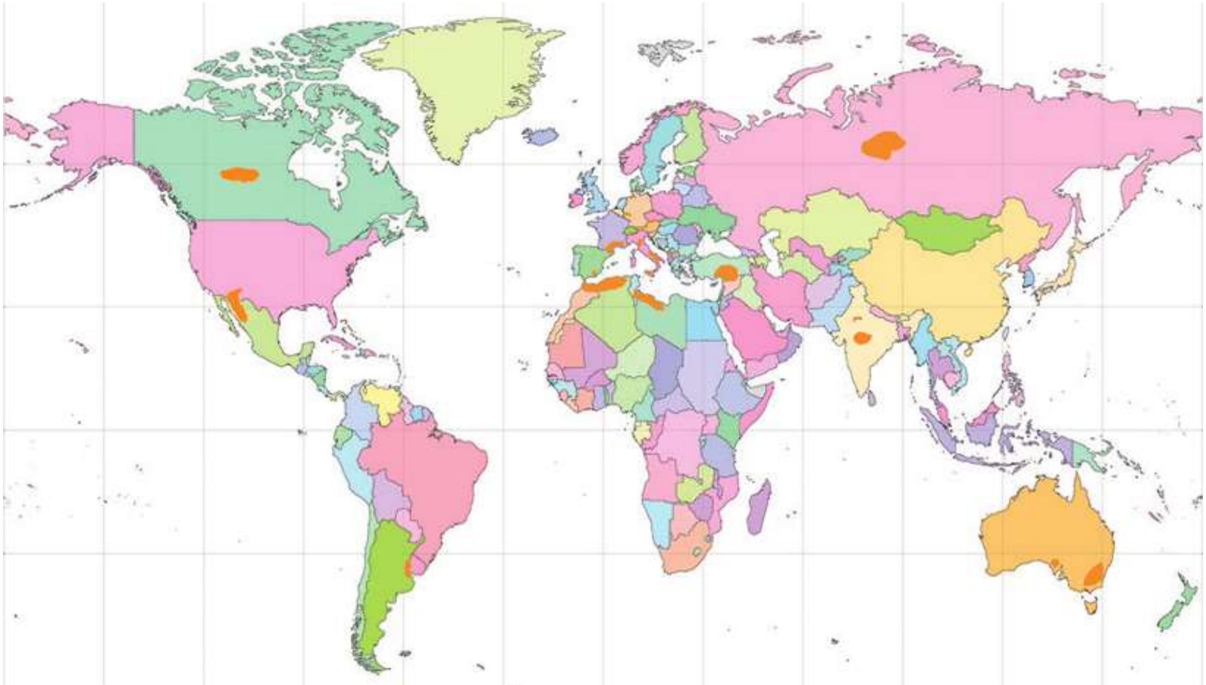


Figure 3-9 World map with the territories where durum wheat is grown highlighted in dark orange [RD. 19]

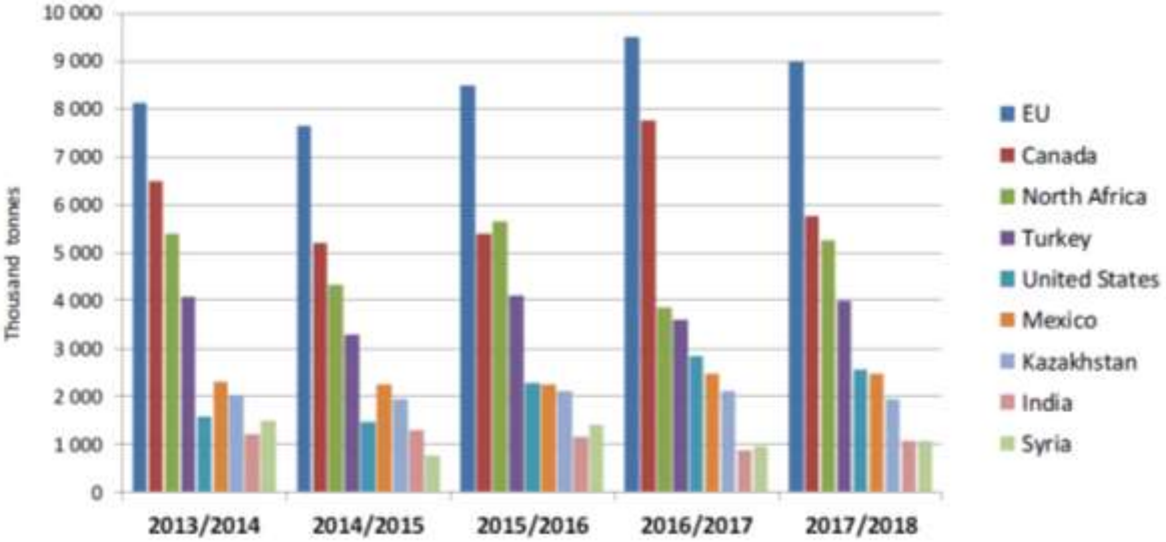


Figure 3-10 Main world producers of durum wheat [RD. 35]

Among all Mediterranean countries, Italy is the European leader in durum wheat production of around 4 MT. France (20%), Greece (13%) and Spain (11%) followed Italy of the total durum wheat European production. Morocco, Algeria and Tunisia are also relevant players in the Mediterranean [RD.35].

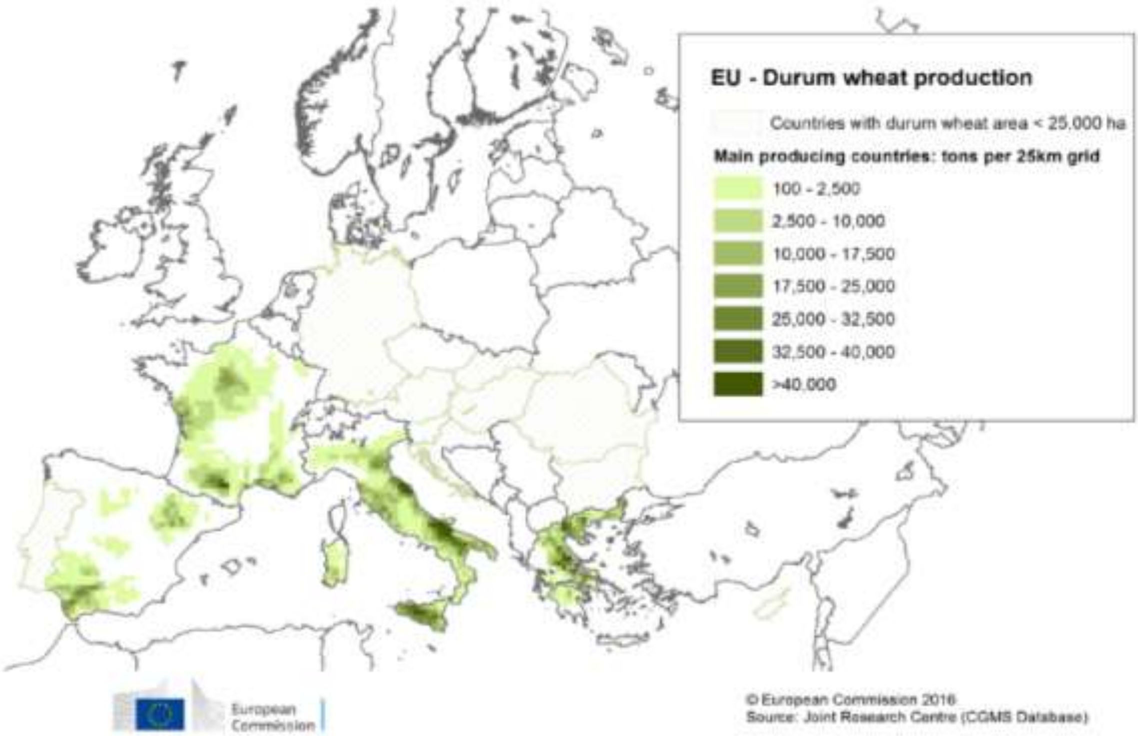


Figure 3-11 EU main durum wheat producing regions [RD. 35]

Durum wheat is an annual crop with a growing cycle of 120-180 days, which is fairly resistant to drought, rust and smut fungi. Less productive than soft or bread wheat, it has a price that is 20% higher. Durum wheat is traditionally grown under rain-fed conditions. So, water stress is one of the main production constraints, together with high temperature during the growing season, since either could lead to reduction in grain quality and/or quantity.

Apart from crop yields, it is also important to consider the raw material quality since pasta production is based on purified midding's of durum wheat called semolina. Protein content and other characteristics such as gluten strength play a major role since pasta manufacturers require semolina with a strong gluten and a high protein content in order to have a good end-product. So, durum wheat variety' characteristics together with climatic conditions have their impact on the pasta production. Italy is the biggest pasta-maker in the world, with companies such as Barilla, Pasta Zara, Divella, De Cecco, Pasta Garofalo, exporting 50% of the pasta produced.

Regarding pasta production, around 14.3 million tons are produced worldwide. Italy and United States are the main pasta producers representing 20% and 13.5% of global production, respectively. At the same time, they are also the greatest pasta consumers, together with Brazil, Russia and Germany [RD.14].

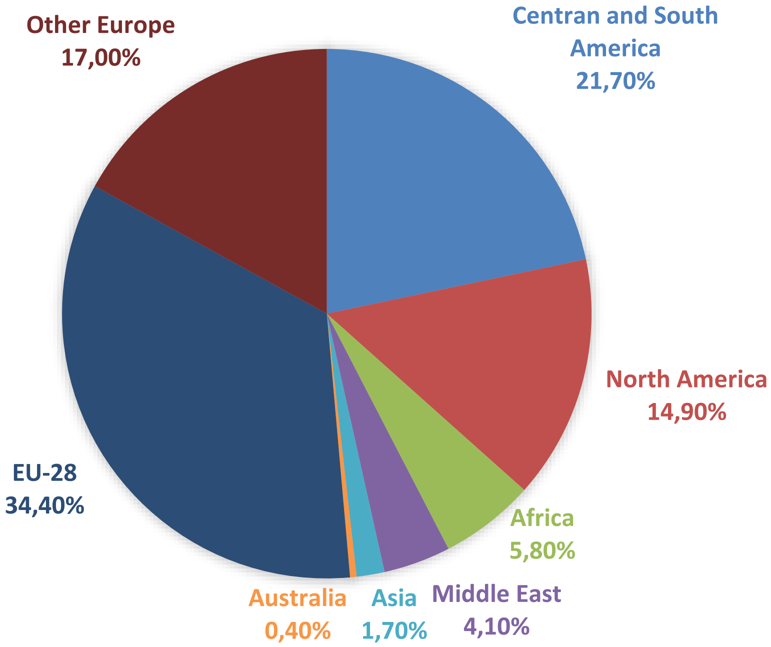


Figure 3-12 Estimate of world pasta production [RD. 14]

Durum wheat is a rainfed crop in which water scarcity can have a major impact on crop yield. Although scenarios in which higher CO_2 concentration can promote grain/straw ratio and general productivity and it is a crop well-adapted to high temperatures, increased uncertainty and fluctuation in rainfall during the fall and early winter periods can limited it.

Quantitative and qualitative parameters are affected by climate-related issues. Drought and heat stress drastically reduced grain yield, but significantly enhanced flour yellowness [RD. 41]. So, CS can have a major impact on supporting decisions related sowing density and moment in order to balance grain yield and quality parameters. In particular, overheating heavily durum wheat in quantity and quality of production.

Almost all countries will undergo a decrease in agricultural production, with the exception of Scandinavia. Most heavily hit will be equatorial areas. On a worldwide level, India, Mexico, Australia and Brasil will be the areas hardest hit. The drop in worldwide agricultural output will be at a level of almost 190 bn USD per year.

Durum wheat phenological phases would be shifted, either shortened or extended and extreme weather phenomena would endanger crop productivity. Also, regarding water availability, which is quite relevant for rainfed durum wheat, climate change appears to lead to two main effects. In the northern Emisphere rivers capacity is expected to increase as well as the overall amount of water availability. On the contrary, tropical and semi-arid areas (like the Mediterranean) will see a significant reduction in their water resources [RD. 42]. As a result, new investments would be needed, especially for irrigation, because of water scarcity in durum wheat production areas.

Last but not least, changes in climate and environmental conditions could lead to the spread of disease and contamination in agricultural products and foodstuffs, as exposed in other sections. In specific, regarding durum wheat, this would translate into the spread of toxic fungi and micotoxin contaminations.

4. EU POLICIES AFFECTING MED-GOLD SECTORS

The Common Agricultural Policy (CAP) establishes the common rules for the different agricultural sectors [RD. 29]. Direct payments in combination with greening and cross-compliance grant a basic income support for farmers but also contribute to providing basic public goods. Therefore, the analysis of the effects of this policy framework for the three MED-GOLD sectors is essential.

4.1. OLIVE REGULATION FRAMEWORK

The Common Agricultural Policy is the most significant policy directly affecting olive farming in the EU. European Agriculture Guidance and Guarantee Fund (EAGGF) structural measurements (i.e. grubbing-up old groves, for investments in replanting and irrigation and for setting up young farms), aid for farmers in Less Favoured Areas, agri-environmental programs have been and are also important for the olive sector. This means that historically the olive sector has been benefited by market-based as well as by structural aid policies:

- A minimum price for producers was supported, and was maintained by a combination of import restrictions and intervention buying;
- Enhancing productivity, via the restructuring of the orchards and infrastructure improvements.

Nevertheless, the policy scenario has changed. To understand this present panorama of the olive sector, it is necessary to analyse the framework that has been regulating the sector in the last few decades.

The first regulation of olive oil production was established in 1966, with the creation of the Common Market Organization (CMO) for oils and fats (Regulation nº 136/1966). Initially, this regulation only affected Italy, which was the only EU country producing olive-based products until the entrance of Portugal and Spain in 1986. The CAP support regime for olive production with a minimum price to pay to farmers has played a powerful role from the 1960s until 1998. Large farmers (those producing more than 500kg of oil per year) received a subsidy based on the oil produced, while small producers received a subsidy per tree, weighted according to the average historical yields of their district. The issue was that the official registers of olive plantation or oil production for subsidies control and tracking were not so adequate and this repeatedly hampered the effective management of the CAP regime.

In 1998, the subsidy system was changed in, passing from tree aid to production subsidy. In fact, this only affected small producers. At that moment with the “interim” olive regime all basic support provided for olive farming was in the form of a subsidy paid in direct proportion to the production of olive oil or table olives. This promoted a rapid expansion in olive groves and a strong incentive for improving production, such as conversion to irrigated production, mechanisation, and increased planting density. Regulation 1638/1998 laid down that a more fundamental reform would be introduced from November 2001. At the end, this regime was extended until the end of 2003/2004 season.

Nevertheless, since 2000, the CAP was undergoing far-reaching changes, decoupling payments from production and giving an increasing emphasis to agro-environmental measures and rural development. This was also the scheme applied to the olive sector in 2004. The olive sector was integrated into the single farm payment scheme and production-based subsidies were abolished. Only Spain decided to support olive groves with specific environmental and socio-economic value through coupled support. Cross compliance with certain environmental and agricultural practices became obligatory, that targeted quality improvement and environmental practices such as erosion control measures (cultivation along contour lines, minimum tillage, cover crops, maintenance of terraces, etc) or biodiversity conservation. Since 2010, coupled support is now totally prohibited, apart from specific circumstances described in article 68 of Regulation n°73/2009 (up to 10% of national ceilings can be used for coupled support to olive production). The decoupling of farm payments from olive production should make the market the main driver of production choices.

Olive oil has a recognised image of a quality product and this has led to the fact that Commission wanted to strengthen the EU olive sector through an action plan presented in 2012. Six areas of action in line with the CAP for 2014-2020 were presented:

- Improve quality and control by methods of analysis and marketing standards;
- Restructure the sector involving rural development measures;
- Reinforce producers’ organisations;
- Promotion of the olive-based products to stimulate its consumption and conquer markets in non-EU countries;
- Support for the International Olive Council (IOC) and international agreements;
- Oppose any measure by third-party that could present a technical barrier to trade.

One important aspect is that the olive oil and table olive markets are covered by Regulation nº 1308/2013, which means the single Common Market Organization (CMO) regulations can apply specifically to this sector:

- Aid for private storage

- Aid for producers' organizations for action in areas such as marketing, traceability and improvement of environmental impact, competitiveness and production quality
- Establish import and export licences that can be issued to applicants by EU Member States and tariff quotas that can be opened by the Commission

The current direct payments related on an income per-hectare linked to cross-compliance and independent of production is established in the EU. Only Italy has still opted for an additional grant voluntary coupled support system linked to production with an overall amount of more than 400 million euros for the years 2015 to 2020.

The CAP and the other EU policies indicated have been and are the main sector drivers. Apart from that, there are very few national and regional measures that can have a significant effect outside the EU policy framework, such as farm advisory services or crop insurance schemes. However, a couple of transversal EU policies can also exert its influence on the sector.

As indicated on regulation nº 1144/2014, olive and olive oil are eligible for promotion initiatives in the EU and non-EU countries. Table olives and olive oil has been part of the annual work programme for promotion through several campaigns.

Regulation nº 1305/2013 on support for rural development can assist the olive sector. This is the case with the thematic sub-programme used in Andalusia (Spain) for supporting the needs of this strategic sector, which have a strong impact on the development of their rural areas, or Puglia (Italy) which includes a plan for supporting investments on the prevention of damage caused to olives trees by *Xylella fastidiosa* (This bacteria collapses the vessels of the xylem which causes symptoms that correspond to lack of water or lack of nutrients on the plant. The containment strategy based on the elimination of positives plants and intensive surveillance of the harmful organism is the one most implemented).

Plant health protection with Union territory is introduced by Council Directive 2000/29/EC. Nevertheless, when a harmful pests and diseases are detected, further ad-hoc legislation can be enacted to control and set emergency measures. This was the case of the Commission Implementing Decision 2015/789 and successive amendments, following the outbreak of *Xylella fastidiosa* in Southern Italy. Later on, the European Parliament resolution 2015/265 requested to compensate farmers for the loss of revenue as a result of the eradication measures, as well as establishing stronger control measures to prevent the spread of the bacteria within the EU and avoid entrance of infected plants.

The implementation of some EU environmental policies, such as the EU Water Framework Directive and the nitrogen directive need also to be taken into consideration. These policies mean that farmers need, for example, to reduce the amount of nitrogen fertilisers applied.

The marketing strategy and profitability for protected designations of origin/protected geographical indication (PDO/PGI) together with measurements related to the development of integrated and organic production have also had their impact on the sector, which was varied across the board, especially in the framework of rural development.

From an international trade policies point of view, there are no relevant trade policies to be considered, especially in the Mediterranean. Olive oil imports from most Mediterranean countries enjoy preferential access under the form of duty free import quotas and preferential tariffs. Moreover, most of the operations take place under the Inward Processing Relief Traffic (IPRT) conditions in which it is possible to import olive oil into the EU duty free provided that the same quantity (and quality) of oil is subsequently re-exported after undergoing processing inside the EU, which could even be only bottling.

It is clear that farmers need to adapt to new risk management strategies, ranging from selecting optimal investment and production targets. The European agricultural policy has begun an ambitious journey to reduce support to farmers, improve environmental conditions, and mitigate climate change. This requires special attention to be paid to the interactions between crops, climate risks and polluting inputs.

4.2. WINE REGULATION FRAMEWORK

Vineyard farmers, among other agricultural sectors, are the least dependent upon payments from the Common Agricultural Policy, since they are producing high added-value products. Nevertheless, as in the case of the olive sector, the origin of the first wine regulation is based on the creation of the sectorial CMO in 1962. This, together with the Regulation (EC) 816/1970, had the objective to obtain adequate information about production and quality. This framework imposed the obligation to register the intention to plant or replant, although any restriction to plant was stabilised. So, instead of being focused on support of producers, it was centred on monitoring the production system. Nevertheless, price and intervention regimes (private storage, distillation), a regime for trade with third countries, rules concerning production and control of planting developments and oenological practices and processes were stabilised.

In 1973 and later in 1975, record harvests were achieved with surpluses of millions of litres of wine. The existing market mechanisms were not sufficient to remedy this situation and in 1976 the Regulation 1162/76 was approved, in which planting of new vineyards was banned. Although there were some exceptions for new plantations for producing premium wines in Member States with low production, this ban was extended until 2015, based on the approval of the CMO reform in 2008.

The following CMO Regulation (EC) nº 337/1979 and Regulation (EC) nº 822/1987 introduced various amendments without changing the intervention logic. In 1999, Regulation (EC) nº 1493/1999 removed the price regime and simplified distillation measures for bringing the opportunity to exploit expanding markets and enable the sector to become more competitive.

Later, the 2008 reform of the wine CMO was introduced as part of the 2003 CAP reform, based on the Single CMO regulation establishment and proposing a national aid programme together with the extending planting rights as indicated above. So, during all of this period, the regime of planting rights was the one regulating the production.

This European planting rights system was an instrument for quantitative and qualitative management of production potential via a system of growing permits, while production volumes per producer were not established. The initial idea of the 2008 reform was a new agreement achieved by the EU Member States to enable competitive producers to respond freely to market conditions, although in 2013 a system based on planting rights managed by MS was agreed to gradually expand production according to world demand from 2016 to 2030. Therefore, the CAP reform adopted in 2013 essentially maintained the measures and approaches agreed in the 2008 wine reform and introduced a new scheme of vine planting authorizations for the period 2016-2030. This new scenario from 2016 is based on authorisations that are free, non-transferable and expire after 3 years if they are not used (Commission Regulation 560/2015 and 561/2015). This new planting rights regime uses criteria about priority and eligibility, where growth is limited to an increase in 1% of the grape surface for wine per year in a MS. They can decide lower % at national level for PDO/PGI protection.

Although the above paragraphs are focused on the planting regimes, other measurements were also developed and implemented during these years, especially for supporting marketing rules, trade with non-EU countries (CR 555/2008), protecting PDO and PGI (CR 607/2009), and to promote and regulate organic wine (CR 203/2012) [RD. 23]. This is quite relevant for the wine sector since they relied on the territory and on the communities living there. The wine creates value for local communities and guarantees the maintenance of population in vulnerable rural areas.

Recently, in 2017, the EU has launched an evaluation of CAP measures applicable to the wine sector, which means an evaluation of the instruments introduced on previous stages. This evaluation should be completed by the end of the second quarter of 2019.

4.3. DURUM WHEAT REGULATION FRAMEWORK

Agricultural policies play an important role on the viability of the farming sector. As it has been described on the previous sections, the CAP is considered as one of the major actors of change. In the last years, CAP has been gradually changing its policy instruments to become more World Trade Organization (WTO) compatible by applying less trade-distorting support measures and this is the case for the cereal sector [RD. 20].

In the previous section it has been highlighted how the CAP has been modified several times, but it is in the case of the cereal sector that all those reforms have had great effect. Table 4-1 summarises the different stages of CAP reform that have affected the cereal sector.

Table 4-1 Stages of CAP reform

Years	Reform	Comments
1962	Creation of the Common Agricultural Policy	The essence was good prices for farmers. High market prices guarantees. Subsidies are linked to production.
1992	MacSharry reform	CAP shifts from market support to producer support. Coupled direct aid payments to farmers are established. Farmers are no longer obliged to produce specific crops. They are encouraged to be more environmentally-friendly.
2000	Agenda 2000	CAP centres on Rural Development and the environmental focus, thus reducing market distortions
2003	Mid-Term review	Link between subsidies and production is cut. Changed almost all coupled to decoupled direct payments. Payments subject to cross-compliance (look after their farmland, meet food-safety and environmental and animal welfare standards.
2008	CAP “Health Check”	Abolishment of the set-aside requirement to promote the recovery from the relatively high increase in the cereal price.
2013	CAP 2020	Link decoupled payments to greening – new policy instrument in Pilar 1 “Green Direct Payment” based on three obligatory agricultural practices: maintenance of permanent grassland, creation of ecological focus areas and diversification of crops.
2018	CAP after 2020	Prioritise small and medium-sized farms Encourage young farmers Direct payments will remain an essential part

All this simplification of regulations and fully decoupling from production means that farmers can switch to different crops or types of production in response to market developments. In Europe, as a consequence of this policy, huge areas of land which had previously been used for growing wheat were left fallow or given over to other crops. This introduced the risk of leading to durum wheat no longer produced in non-traditional areas and of the industry being hit by a shortfall of this staple cereal which is indispensable to the semolina and pasta industry.

The EU durum wheat production has been covered by special arrangements since the introduction of the common organisation of the market in cereals. A supplement to the basic compensatory payment was provided for the production of durum wheat in traditional zones. Also, a special aid for non-traditional areas existed. Moreover, a quality premium supplement was subject to the use of a minimum quantity of eligible certified seed varieties in order to ensure that the quality of production matched industry requirements.

In 2008, in which different arable crop regimes were integrated into the Single Common Market Organization, all EU policy became focused on intervention (buying-in cereals for public storage and protecting the sector from low market prices, which is used only in case of real necessity) and trade measures (zero, variable or fixed tariffs, depending on the cereal). The exceptional CAP interventions in 2008 to 2011 helped mitigate the shortages in the EU cereal market and increased supply to the market and thus reduced prices. The increment on cereal supply was in part due to the abolishment of the requirement of set-aside completely and that the Article 68 of the CAP “Health Check” enabled to have direct payments on the cereal sector, which was applied by a number of MS to the durum wheat.

The new CAP is focused on a green economy, environmental quality and the development of a competitive EU agriculture sector, through the reduction of subsidies while producing high quality products at acceptable prices. All this has to be achieved while managing soil and water resources sustainably, improving air quality, protecting the biodiversity, adjacent landscapes and supporting climate action.

In June 2018, the European Commission presented legislative proposals on the CAP beyond 2020 in order to assure EU sustainability and competitiveness of the agricultural sector but also to be more responsive for future challenges such as biodiversity conservation, circular economy, climate change or generational renewal. The policy will shift from compliance and rules towards results and performance based on the use of modern technologies and innovations and a flexible system in which each Member States, based on their own CAP Strategic Plan, can select and prioritize measures agreed at the EU level to ensure a common set of results indicators.

5. CURRENT CLIMATE SERVICES FOR MED-GOLD SECTORS

As has been shown, the EU policy framework promotes a common approach towards supporting agriculture. It ensures fair conditions for EU farms competing in the single internal European market and expanding into foreign markets linked to population and income growth. Production is currently market-driven since the EU is focused on greening, agro-environmental measures and rural development. So, a safe and high value food production chain which responses to trends in consumer behaviour needs to be considered. In the case of the three sectors studied in MED-GOLD, the EU-28 has a lead position and maintaining this situation must be a priority in the coming years.

Nevertheless, compared to most producers in non-EU countries, farmers face high costs for compliance with legislation compared with competitors in the fields of the environment, animal welfare and food safety. Moreover, although production is growing in all sectors, climate has been highlighted as the main constraint.

Climate is one of the major factors affecting crop production potential, especially since it is unavoidable and unexpected [RD. 37]. Climate model projections indicate an increase on temperature, change on precipitation conditions and increase on CO_2 content in the atmosphere. These will provide uncertainty in crop yields, apart to promote some pests and diseases, since evapotranspiration regimes, photosynthesis activity and soil-crop water balance will be affected [RD. 37]. This scenario substantially damages crop production across the globe, especially in Europe, USA and Australia in which monoculture farming systems are largely present and crops are optimised for existing climate. It has been estimated that drought and heatwaves in the last decades has caused an average loss of 10% in crop yields [RD. 36]. Moreover, in technically developed production systems, likes the ones in which MED-GOLD is focused on, the expected impact on production loss can be large since they are less resilient to weather shocks which are expected to increase in severity and exposure in the future.

This climate variability and change is motivating numerous actions in order to have a response to the potential risks that may affect human security. These actions involve identification, assessment, prioritization, and management of resources to minimize, monitor and control the probability and/or impact of unfortunate events and maximize the realization of opportunities. Climate services (CS), therefore, are fundamental for managing climate-related risks, and increase safety and efficiency of land. Agriculture is a weather-sensitive economic sector and CS can promote improved decision-making processes for dealing with those issues and support sustainable and competitive food production.

5.1. CLIMATE SERVICES MARKET CHARACTERISTICS

The concept behind “climate service” has evolved over time, from a basic definition related to simply climate data to the integration with user needs and customised products. The United States Nuclear Regulatory Commission (USNRC) defined CS as timely production, translation and delivery of useful climate data, information and knowledge (Board on Atmospheric Sciences and Climate, 2001). Later on, in 2009, the Global Framework for Climate Services (GFCS) defined CSs in a way that assists decision making by individuals and organizations which requires appropriate engagement along with an effective access mechanism and must respond to user needs. The High-Level Taskforce for GFCS defined climate services as climate information prepared and delivered to meet users’ needs [RD. 25]. The European Commission defines climate services as the transformation of climate-related data – together with other relevant information – into customised products such as projections, trends, economic analysis, counselling on best practices, development and evaluation of solutions and any other service in relation to climate that may be of use for the society at large [RD. 8].

In 1980, scientific literature referring to climate services began to appear, but until 2009 there was little growth in this scientific field (Figure 5-1). The launch of the GFCS strengthened the production, availability, delivery and application of science-based climate prediction and services. There has been little progress in providing evidence on the added value of tailored climate information for users. English-speaking and Western continental EU institutions are dominant in shaping research on CS.

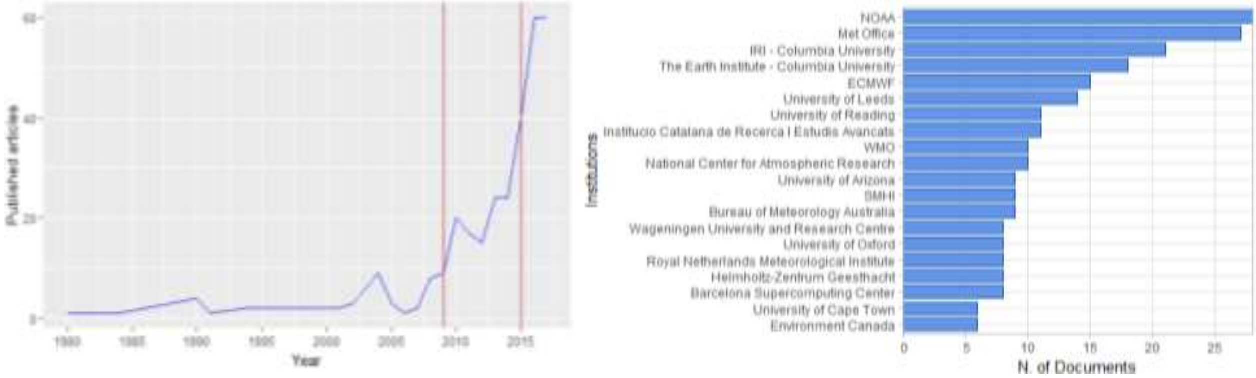


Figure 5-1 Scientific production related to climate services. Annual number of published articles (left) and institutions related (right) [RD.15]

These services include data, information and knowledge that support adaptation, mitigation and disaster risk management. The usefulness of the services lies in availability and timeliness, salience (suitable format, scale and communicated through a medium that respond to users' needs). They must be dependable, usable, credible (accuracy of the forecast), authentic, responsive and flexible [RD. 25]. The value of climate forecasts is determined by its quality as well as its design and implementation. Climate is highly variable, so isolating changes resulting from the delivery and use of climate services from those resulting from natural climate variability is complex,i.e., in order to influence behavioural changes(changes in baseline skills farming practices and resource allocations, such as changes in planting time, crop variety or other farm management decisions).

Spatial and temporal scales have a relevant implication in terms of observability, predictability and service design [RD. 13]. Figure 5-2 shows the space-time characteristics of climate services since it can include from long-term statistics or analysis, information on current conditions to forecast conditions on timescales from minutes to months, year or decades.

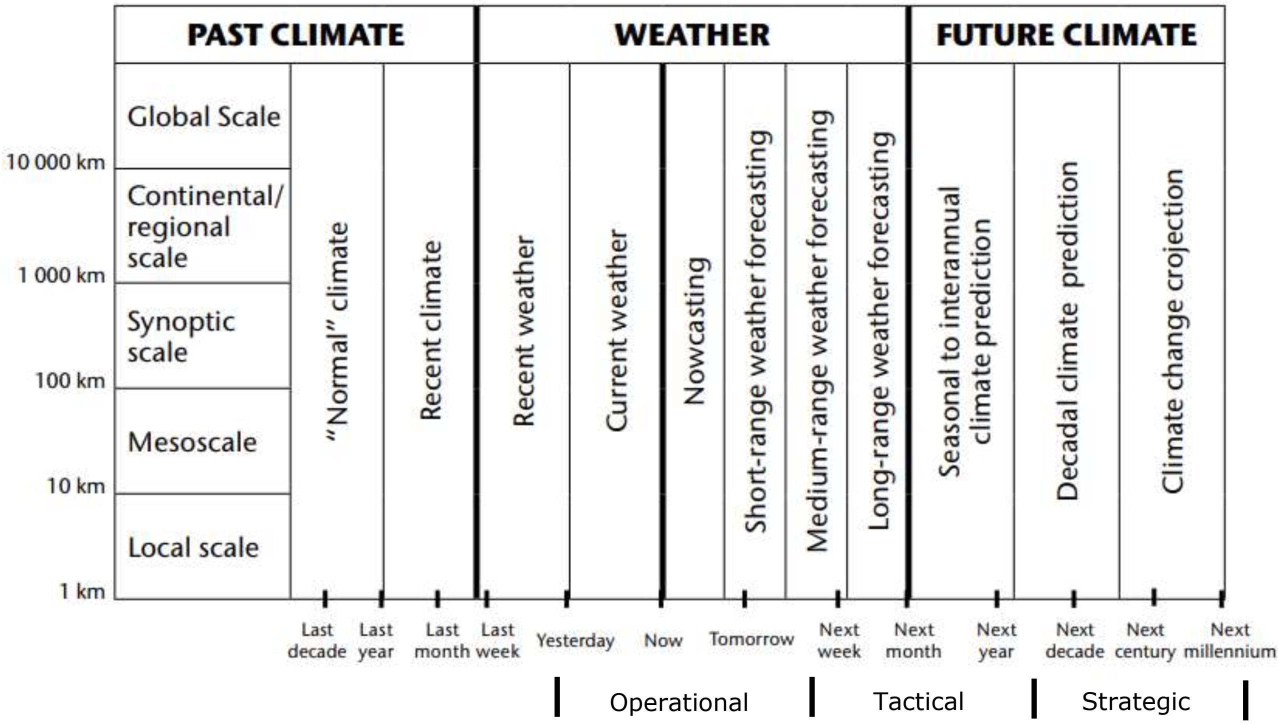


Figure 5-2 Approximate temporal terminology for water and climate description and prediction [RD. 26]

Central players of this global framework for climate services are national meteorological and hydrological services, universities and public-private research centres (Figure 5-1), since they are the responsible for coordinating the collection and exchange of climate data. There are a number of advanced centres providing global-scale climate services, although their operations need further coordination, standardization and downscaling. Medri et al. 2012 [RD. 16] synthesized a list of main international and European Climate Services. Tilche (2014) [RD. 22] also synthesized different European initiatives related to climate services, with Copernicus and Horizon 2020 as the main sources of funding for the operational delivery and the research and innovation. There are calls on market research, barriers and enabling conditions to demonstrate the added value.

Climateurope is an EU project which tries to coordinate, integrate and support Europe's research and innovation activities in the fields of Earth-System modelling and climate services. A network for researchers, suppliers and users of climate information to share best practices, identify gaps make recommendations and discover the state of the art about climate observations, modelling and services. Table 5-1 maps the most relevant projects under the topic "ERA for climate Services" and "Greening the Economy".

Table 5-1 Mapping of Climate Services EU Projects

Projects related to agriculture and forestry		Projects related to other sectors				
AQUACLEW	INDECIS	APPLICATE	ClimApp	ECLISEA	ISIpedia	SECLI-FIRM
CLARA	MEDSCOPE	BLUE-ACTION	ClimINVEST	EU-MACS	MARCO	SENSES
CLIMALERT	SERV_FORFIRE	CIREG	CoCLiME	EUPHEME	PROSNOW	URCLIM
CLISWELN	VISCA	CitiSense	Co-Cli-Serv	EVOKED	PUCS	WATExR
H2020-Insurance	WINDSURFER	CLARITY	CO-MICC	INNOVA	S2S4E	
IMPREX		CLIM2POWER	DustClim	INSeaPTION	SALIENSEAS	

*A link to each project in include on the table.

Independently, MED-GOLD' deliverable 6.1 entitled "Climate related initiatives interactions report nº 1" a larger list of European projects or initiatives in which agriculture and climate are involved, as in the case of this H2020 project.

Climate knowledge hub[1], which is part of a large European project to establish a European Research Area for Climate Services, is a network of climate service providers in which can be seen on the European landscape organizations and researchers working in the field. National Weather Services, public climate service centres, private businesses and private and non-profit organizations are represented. Nevertheless, a real market development including the establishment of small and medium enterprises need still to expand. Most of the services are provided by public organizations and are generally freely available, since only about 10% are provided commercially [RD. 4].

Figure 5-3. Web-GIS presentation of mapped CS providers and funders of the Climate Knowledge Hub.

The conversion of data (agricultural and climatic) into services requires a chain of multiple players (providers and subsequent users/providers) for data assimilation, processing, modelling and communication. This flow should be bidirectional in terms of providers learning users' needs and users understanding how to handle the service with confidence. Figure 5-3 shows the chain of providers and users lying between climate data and climate services. Bidirectional communications are required in all stages in terms of traceability or documentation to provide full transparency, learning from each other. Tailoring refers to recognizing the differing information requirements of users at different points as well as end users' diverse needs.

[1] http://www.climate-knowledge-hub.org/

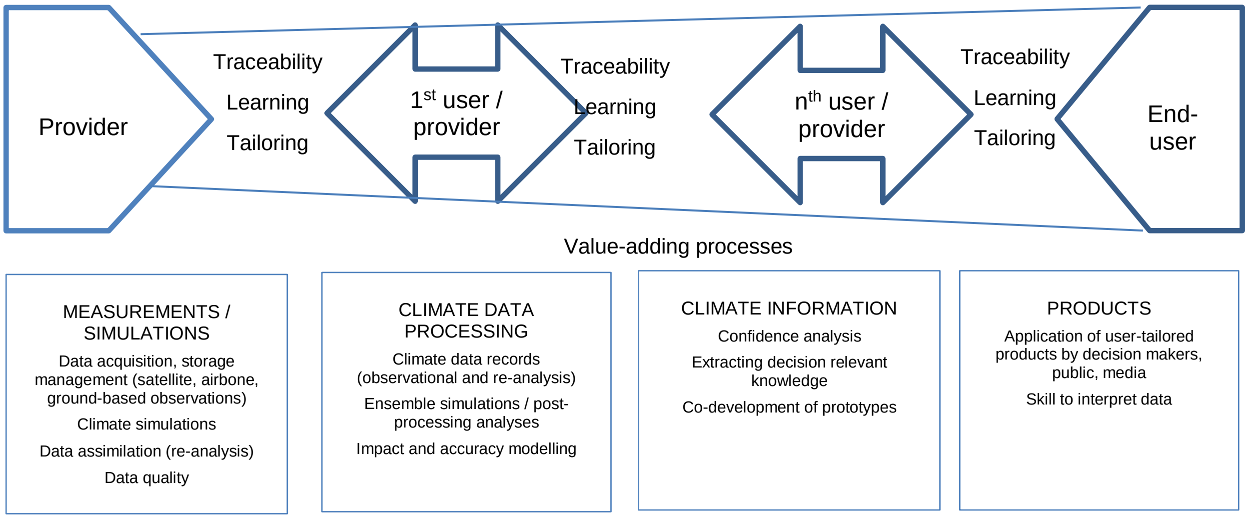


Figure 5-4 Climate service value chain. Adapted from RD.18.

Currently, the most suitable way for CS delivery is public-private partnerships, although special attention needs to be paid to the business development required in order to reach stakeholders. Nevertheless, the capacity of providing trustworthy climate information at resolution and for seasonal to decadal time frames is an issue together with the ability to [RD. 28]:

- Develop protocols and standards for data collection, quality assurance and exchange. Ensure quality and complete with proper documentation and backed through knowledge of up-to-date data availability and characteristics;
- Develop opportunities and reduce vulnerabilities, strengthening the scientific bases and relevance of climate services and creating tailored products based on end users' needs, making the information service simple, accessible and timely;
- Select and demonstrate the added value of right data and information for day to day and long-term planning. Know the user and understand what is needed: relevant climatic elements, how they want to receive the information, how they are likely to interpret the information, purpose and how the information might improve the decision-making process.

Additionally, CS providers need to consider ethical principles to ensure integrity, transparency, humility and collaboration of climate service development and delivery. In this sense, the white paper of the Climate Services Partnership Working Group on Climate Services Ethics [RD. 5] outlines the main ethical principles in which CS should be accountable for the integrity and transparency of their practices and products. No individual or institutions should have a monopoly on climate knowledge or scientific authority, and should be open to scrutiny and comparison. Public data is a public good.

The public-private structure means that most climate services have a first layer service based on free and open access observational data. The business sector, by adding proprietary data and intelligence, may provide customised services. Most current climate services are provided through websites and web-based tools, which transfer information one-way passively. App-based interfaces and social media platforms are also appearing. They are still relatively passive, although there is a greater interactivity compared with websites. A more valuable engagement with users lies in multi-way communication to co-learn and co-develop products and services in an in-depth understanding. This approach can generate data sharing between parts to ensure appropriate tailoring and significant value, which implies intellectual property management requirements [RD. 27].

Climate Services have a great and varied potential in agriculture for the development of sustainable agricultural systems, improved production and quality, reduced losses and risks, decreased costs, increased efficiency in the use of water, conservation of natural resources and decreased pollution. However, further research is still required, especially in quality assurance not only on statistical prediction but also of the data origins. Nevertheless, an increasing demand for customized climate-related products, services and information is appearing since they are suitable for particular purposes, such as:

- Long-term policymaking and private investments: climate projections
- Medium-term decision-making (i.e. consultancy in order to provide alerts and reports to prevent extreme events): inter-annual climate variability projections
- Short-term decision-making: weather and climate forecasts and warnings for up to seasonal timescales.

This involves the translation of temporal and spatial information about the climate into decision-support tools to suit the needs of specific sector applications. Farmers, for example, receive information from different sources via a wide range of channels. They generally do not receive forecast information early enough in formats that they can understand through communications channels that they find relevant.

There is a huge current effort on coordinating and standardizing CS. Users and stakeholders reveal that there is a still poor connection between providers and users to develop adequate CS. Moreover, there are areas more advanced than other in historical time series or long term projections at large spatial scales, since they have been collecting data over many years, which is essential for supporting decision making and take advantage of this innovation in an operational and practical way.

From the above, it can be highlighted that climate services plays a central role for serving in the transition era where knowledge and innovation are essential for a smart, resilient and sustainable agricultural sector. Overall, digitalization of the agricultural sector in which big data and new technologies for monitoring or support decision making processes are another pillar of the agricultural future to help farmers manage their businesses more effectively.

5.2. PERSPECTIVES AND POTENTIAL

Weather services have been developed for more than 40 years in several parts of the world. They are based on information that is both more accurate (shorter lead time) and verifiable (their lifespan is shorter in line with its lead time). Climate services have started to be developed in a consistent way only during the last decade and the product's accuracy still plays a crucial limiting factor in their uptake. These characteristics mean that weather services are well established, both in a commercial sense and in a "public good" way. Climate information is highly uncertain and with relatively low skill; so, there is a strong need to create an environment of trust. The existing gap between how climate information is communicated and how it is perceived and used by stakeholders is an issue. Moreover, weather and climate can be predicted more accurately in some regions of the world than others, owing to data availability and skill of models. The skill also depends on the season and, in particular, the variable of interest.

It can therefore be difficult to convince a prospective user or customer to make use of such forecasts in areas or for variables that traditionally do not display an improvement in skill compared with using a long-term climatology, even if there is increasing evidence that their level of skill is improving. In climate projections, it is essentially impossible to prove their level of accuracy. The best that can be done is to demonstrate the suitability of the climate models at representing features at the country level based on climate model performance over the recent period.

The role of the European Commission appears to be very prominent in the international climate services landscape as it supported a large number of research and innovation programmes in the field. Their focus should be on building valuable and self-sustaining services to grow product confidence. This together with the EU agriculture regulation framework in which the priority lies in strengthening the competitiveness of the agriculture sector, promote sustainable farming and innovation makes, which in turn makes CS play a relevant role.

Climate Services provided by public-private partnerships need to be recognized, promoted and rewarded, creating an environment where doing business with small-holder farmers becomes attractive for the private sector.

As described in the first section, the MED-GOLD sectors are growing in the last years and this tendency is expected to continue in the coming years, owing to market demand and population growth. This implies that better crop performance and new production areas are needed. Therefore, the potential of climate services lies within many different areas:

- Commodity trading: yield estimations based on meteorological forecasts can be of interest for trader forecasters to provide regular market information;
- Strategic investment decisions – strategic planning: viability of different areas for specific purposes. Nevertheless, the economic, political and regulatory environment is likely to have more weight on the overall strategy that is adopted;
- Design and risk assessments: climatological values (intensity and return periods) of extreme events in changing climate;
- Operational management: information about near-future conditions can provide useful insights into the return on investment. It can also support better management decisions in order to identify agricultural zoning;
- Future regulatory constraints. Climate information could be used to improve the understanding of how regulatory frameworks may evolve in the years to come in response to societal pressure.

The results that MED-GOLD will obtain through the specific work packages of each sector (WP2 – olive/olive oil sector, WP3 – grape/wine sector and WP4 – durum wheat/pasta sector) will enable the identification, selection, analysis and evaluation of the ability to translate climate projections at different spatial-temporal scales of meteorological variables into forecasts of crop yields or other farm management aspects that have significant economic, social, environmental impacts.

6. CONCLUSIONS

The agricultural sector is both a major contributor to climate change and is especially vulnerable to its worst impacts. A new paradigm in which there is a need to increase productivity in the agricultural sector while achieving the goals of climate change mitigation and adaptation have given rise to climate-smart agriculture in which climate services plays a major role.

Agricultural production is growing rapidly, driven by population and economic growth. The three farming production systems studied within MED-GOLD are in line with this situation. Moreover, the EU regulation framework of decoupling on farm payments and the introduction of a new scheme of vine planting authorizations should make the market the main driver of production choices. In fact, the CAP is centred on greening and agri-environmental cross-compliance to contribute to providing public goods such as those related to climate regulation. This context implies that agricultural production must be competitive in the global marketplace, but at the same time resilient and sustainable.

Europe has decided to prioritize its strategic positioning in the generation of climate-related knowledge and applied science and to enhance its capacities to deliver climate services in order to meet those global challenges. Climate services enable policy-makers, business and society to better manage the risks and opportunities arising from climate variability and change. Nevertheless, the interface between users of climate information and providers of climate services is complex, multifaceted and particularly challenging in technical terms related to statement, uncertainty and quality and commercial such as communication skills between both sides.

The market landscape of CS providers is still dominated by universities or other research-oriented organizations. Private companies are expected to be more active in the coming years by providing services adapted and close to end-users needs, valuing publicly available and private data.

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