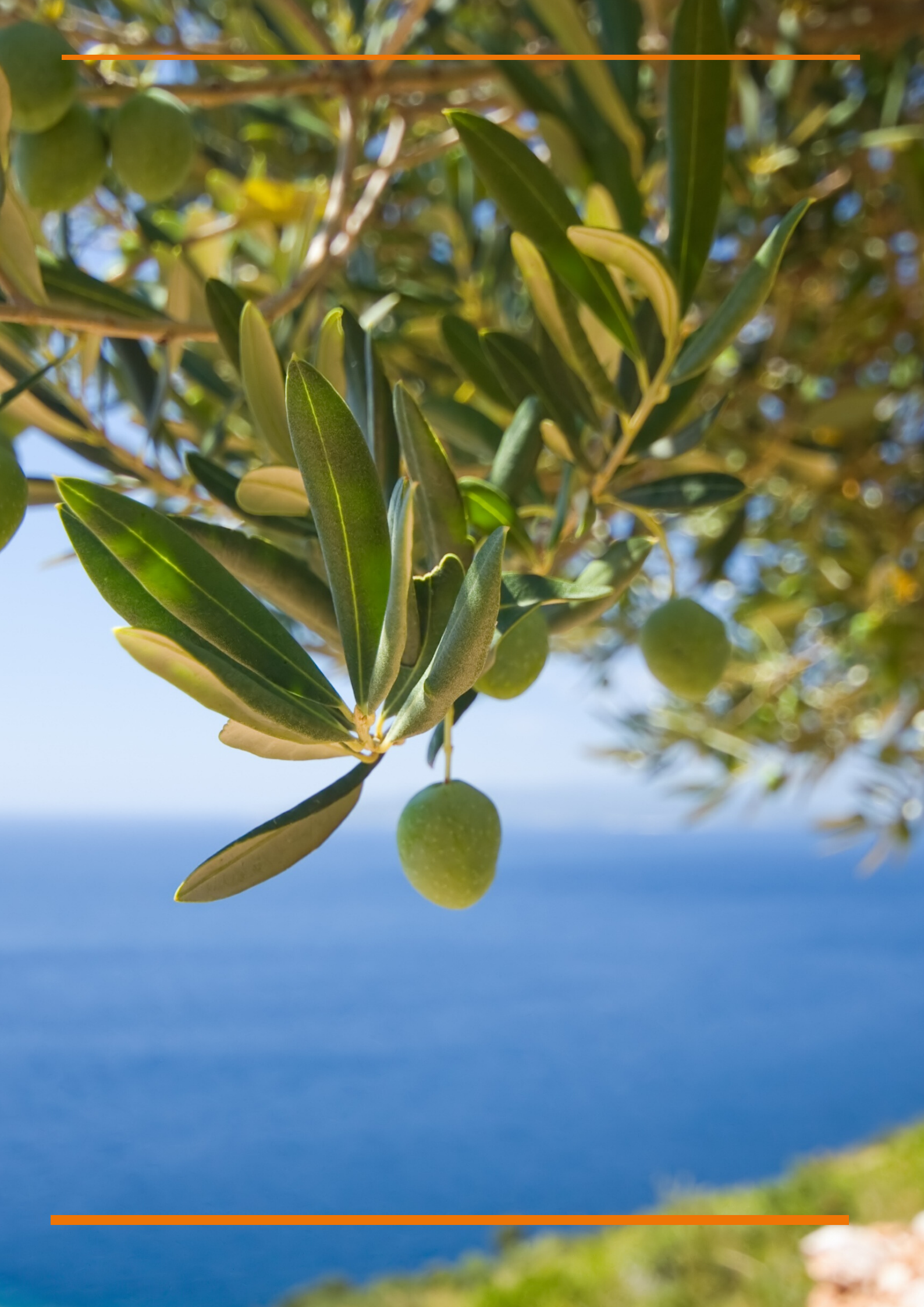
olive4 climate

LAYMAN'S REPORT

OLIVE4CLIMATE

CLIMATE CHANGE MITIGATION THROUGH A SUSTAINABLE SUPPLY CHAIN FOR THE OLIVE OIL SECTOR

Contract Number: LIFE15 CCM/IT/000141
Duration: 01/07/2016 - 31/12/2019
www.OLIVE4CLIMATE.eu



Project Title: OLIVE4CLIMATE LIFE - Climate Change Mitigation Through a Sustainable Supply Chain for the Olive Oil Sector – co-funded by the LIFE Programme of the European Union under contract number LIFE15 CCM/IT/000141

Project acronym: OLIVE4CLIMATE LIFE

Project Location: Italy, Greece and Israel

Project Duration: 01/07/2016 - 31/12/2019

Total budget: 2,397,748 Euro

EU contribution: 1,259,499 Euro

Coordinating beneficiary:
University of Perugia

The associated beneficiaries:
Advanced biomass concepts Gmbh (till 30/06/2018)
National Research Council, Italy (CNR) - Institute of Biosciences and Bioresources (IBBR)
Agricultural Research Organization (ARO) – The Volcani Center
Institute for Agricultural and Co-operative Economy (INASO-PASEGES)
SGS Italia S.p.A.
U.N.A.PR.OL. Italian Olive Growing Consortium
University of Palermo
University of Tuscia

Sector: CCM Land use/forestry/agriculture

Contacts:
Prof. Primo Proietti
via borgo xx giugno, n°74, 06121, Perugia, Italy
Università degli Studi di Perugia
email: primo.proietti@unipg.it
tel. 39-075-5856257

Authors:
Antonio Brunori, Primo Proietti, Nicola Evangelisti, Francesca Dini, Luca Regni, Biancamaria Torquati, Fabio Bianconi, Marco Filippucci, Maria Luisa Carli, Monia Santini, Carlo Trotta, Tommaso La Mantia, Luciana Baldoni

INTRODUCTION

About the project

IN TERMS OF AREA, THE OLIVE TREES OCCUPY 8-9% OF THE TOTAL CULTIVATED LAND IN SPAIN, ITALY AND PORTUGAL AND 20% IN GREECE. ABOUT 5 MILLION HECTARES OF LAND ARE DEVOTED TO OLIVE CULTIVATION IN EUROPE.

Olive tree (*Olea europaea L.*) is one of the most widespread agricultural tree species in the world, reaching 10.65 Mha of cultivated area (data referred to 2016), especially in Europe, even if in recent years olive cultivation has been also successfully introduced in other countries such as California, Australia, Argentina and South Africa.

For the European Union, the olive sector is an essential part of the agricultural sector. In particular, it represents a significant share of the agricultural economy in the southern Europe countries. The EU is also the world eader in the olives production and it is the first exporter in the countries that do not produce olive.

In terms of area, the olive trees occupy 8-9% of the total cultivated land in Spain, Italy and Portugal and 20% in Greece. About 5 million hectares of land are devoted to olive cultivation in Europe. Spain, with 2.5 million hectares, is characterized by the biggest area of olives growing, followed by Italy (1.16 million hectares), Greece (0.88 million), Portugal (0.35 million) (FAO, 2016).

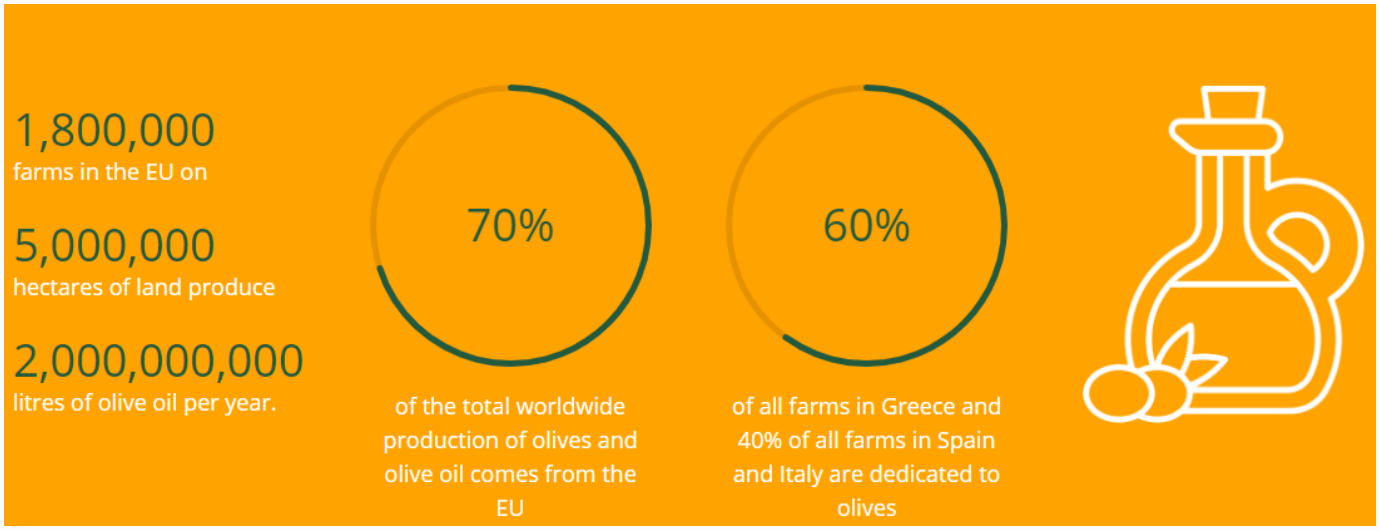
Since the agriculture sector is responsible for 9.9% of the emissions of greenhouse gases. in the EU, it is obvious the relationship between agriculture and climate change.
The agricultural sector is also particularly vulnerable to the climate change effects and, consequently, it has to face the combined challenge of mitigation and adaptation to climate change under the new climate scenarios that are expected to arise as a result of global warming.

One of the challenges of the Common Agricultural Policy 2014-2020 (CAP) is to fully exploit the agriculture potential to mitigate climate change and adapt to its consequences, increasing the positive contribution of the sector to the carbon sequestration.
Most of olive cultivars represent "landraces", that are local varieties empirically selected by farmers over a long periods of time.

Thanks to the very rich varietal patrimony, olive trees are able to survive and produce under different and difficult agro-ecological conditions. In fact, olive germoplasm has not suffered significant genetic erosion, maintaining almost intact its entire variability and its longevity and good capacity to survive without cultivation operations. It represents, therefore, an unusual case among the several horticultural crops and it could constitute an instrument that can be directly used to emphasize carbon sequestration and mitigate the effects associated to the climate change.
Furthermore, some traits such as environment stress tolerance, pest and insect resistance are typically more widely represented in spontaneous populations than in cultivated genotypes.

For this reason the potential value of wild olives and related species can be a source of interesting traits for the development of new genotypes able to tackle climate change and reduce emissions. Even though olive production is widely diffused, there is still little knowledge regarding the fixation capacity of atmospheric carbon dioxide of the olive groves and their greenhouse gases mitigation effect.

In particular, while the quantification of the carbon sequestered by the forestry sector has been object of extensive studies, information about the carbon amount from agricultural systems is extremely limited, because usually is considered only their productive role and not their ecological role.
For the carbon sequestration, another phenomenon that has to be considered, is the desertification. This phenomenon is a direct consequence of climate change and it affects very large areas where the land has lost its productive capacity as a consequence of both to human activities and natural causes.



PROJECT OVERVIEW

The idea and the mission of the project

The idea of the project developed from the **relationship between sustainable agricultural techniques, which have direct impact on climate change mitigation, and the evaluation of the Life Cycle Assessment (LCA)**, in order to propose a systemic vision of the production processes and of products through a quantitative assessment of the Carbon Footprint (CF) associated with the production of extra virgin olive oil.

Thanks to the collaboration with Israel, the researchers also intend to demonstrate how the olive grove can be used not only as a tool to reduce the amount of carbon dioxide in the atmosphere, but also to stem the processes of desertification, thanks to the ability to adapt to arid climates of this species that, if properly managed, allows carbon to be fixed in the wood and reintroduce organic matter into the soil.

This process was tested in the Mediterranean countries with heterogeneous environmental conditions and with significant olive cultivation records, in three heterogeneous geographical contexts: **Italy, Greece and Israel.**
Through demonstration actions, **the goal was to test useful strategies for creating a sustainable olive oil sector and promoting products deriving from integrated and organic cultivation methods that can determine the improvement in the balance between absorbed and emitted carbon dioxide**.

The **LCA** and, therefore CF **evaluation**, as well as the definition of the carbon sequestration realized by the olive groves, provided the **information needed to increase environmental sustainability, identifying a protocol replicable and adaptable to the different production and environmental contexts.**
The project has the mission to increase the sink vs source processes and therefore reduce the climate impact compared to the BAU scenario.

The benefits of the innovative solution

The knowledge generated by the project benefits various public groups:

1) Researchers - they have access to new findings that have been tested on site. The project results are published in scientific journals and at relevant conferences and fairs, so they can reach other researchers working in this field worldwide. Moreover, two land-use calculators, are applied within the project for the optimization of the agricultural solutions for climate change mitigation.

2) The olive sector - the project delivered a handbook with guidelines on sustainable olive oil production techniques for farmers and olive oil producers. Having access to this valuable knowledge help the olive sector to improve and make their production processes more environmentally friendly. This lead to a market advantage of their products. The project consortium had reached out to olive farmers and oil producers throughout the project duration to share the project outcomes with them.

3) Public - the free source knowledge generated by OLIVE4CLIMATE and its partners is a benefit for the general public, raising awareness about the possibilities of sustainable agricultural techniques for climate change mitigation, as well as the current developments and tests in the field.

WHERE WE ARE NOW

Results and goals of the project

1) Carbon Emissions Analysis:

Through the OLIVE4CLIMATE project it was possible **to determine the Carbon Footprint associated with the production of one liter of extra virgin olive oil** in the various types of packaging available on the market (glass bottle and steel can).
The Carbon Footprint is an environmental indicator that measures the impact of human activities on the global climate by quantifying the total greenhouse gas emissions associated directly or indirectly to a product. In particular, it is expressed in kilograms of carbon dioxide equivalent (kgCO2eq) and includes all types of climate-altering gases.

The greenhouse gases different from carbon dioxide, in fact, are converted to kg of carbon dioxide through appropriate conversion factors in order to allow a comparison between the different types of gases and facilitate the communication of the impact on the climate using a single value. Higher is the value, higher is the impact on the climate.

In particular, **21 companies** were analyzed, including **10 Italian, 5 Greek and 7 Israeli** farms. For each company, through specific questionnaires elaborated according to the specifications provided by the sector standards, all the information related to the main phases of the EVO oil life cycle was collected:

- The **olive grove**, i.e. for the olive production process (field phase).
- **Transformation**, i.e. the operations carried out inside the mill up to the storage of the extra virgin olive oil.
- The **bottling and packaging phases**, then the types of packaging used, the quantities and the main sales channels of the product.

Specifically, for each phase, the following data were collected:

1. The inputs flows (quantity, origin, means of transport used, etc.).
2. The output flows (type of materials produced in the process examined, quantities produced, intended destination, etc.).
3. The energy consumption (thermal, electrical, fossil fuels such as diesel and gasoline, etc.).
4. The waste generated and the management methods of the same waste.

The data collected was then processed through the SimaPro software (software dedicated to environmental analysis) in order to determine the value of climate-altering emissions for the 2016 and 2017 production seasons. Since the climate footprint is a partial environmental indicator, i.e. it only considers the product's interactions with the climate, leaving aside other types of environmental impacts (e.g. ozone depletion potential), the models developed were also used to assess the overall environmental impact linked to the life cycle of the liter of extra virgin olive oil, thus expanding the initial objectives of the project.

Through the analysis in the two years of production, it was possible to evaluate the incidence of the cultivation techniques adopted, the type of materials used in the packaging phase, the machines used both in the field phase and in the extraction process and, above all, the incidence of the production level on the final value of the Carbon Footprint.

2) Carbon sequestretion:

The **positive impacts of olive grove on climate change has been defined studying two research topics**. The first one has quantified the carbon dioxide subtracted by plant to the atmosphere and then stocked in plant biomass. The second one has defined olive grow managing actions to reduce carbon dioxide emission.

Carbon dioxide stocked into plant biomass was calculated using plant diameter at 80 cm height. Plant diameter was obtained by measurements done into the field on a significant plant samples. Whole plant biomass (kilograms) was derived using allometric equations. Same evaluation was performed three consecutive years, then medium plant growing was obtaining by subtracting the last total biomass to that of previous ones. Finally, total Carbon stock was derived from kilograms of wood.
Olive grove managing was implemented suggesting some good practices to reduce carbon dioxide emission such as: fertilizers reduction, minimum tillage, natural green cover, alternative use of pruning, new olive plantation.
Best practices applied to a conventional olive grove reduce carbon emission in respect to conventional managing. This no-emitted Carbon can be quantified as tonnes of carbon dioxide equivalent. This amount of carbon dioxide can be sold in the unregulated “Sustainability Market” where sustainability credits are sold to buyer who cannot reduce in a concrete way its emission in-house then it needs to buy them from other.

A sustainability credits market has been set to give wide diffusion to the project results.
Credits market has got an internal standard (available on the project website), a scientific commission and a management office.

3) Monitoring of the olive cultivation efficiency as a tool for the mitigation of desertification caused by climate change

The carbon footprint (CF) and the environmental sustainability of the olive grove are strongly determined by the varieties used, which show a very high variability in response to the agro-environmental inputs and stresses.

Studies conducted within the framework of the OLIVE4CLIMATE project have highlighted a great variation among cultivars originated in arid or temperate regions when cultivated in different environmental conditions or under irrigated or dry cultivation. **The selection of varieties that show high stability in different environments can therefore represent the most efficient strategy for the development of new sustainable cultivation systems.** Among the physiological parameters most subjected to environmental effects are the ability to flower, fruit fertilization, fruit set, fruit ripening, susceptibility to pathogens, the content and composition of the fruit oil. A varietal selection is required to maintain high production performance in the face of scarce water and fertilizer availability.

In addition to the varietal component, other factors that may contribute to determining the response of the olive grove to environmental conditions and agronomic treatments were analyzed within the OLIVE4CLIMATE project. Among these are certainly the microbiome of the root system and the soil, the spontaneous plants that coexist with olive trees and any cover crop used for covering the soil.

4) The developed model:

The **relation between light and geometry of the olive plants is at the centre of agronomic question.** Human intervention, from dwelling to pruning, aims to have a homogeneous distribution of solar radiation on all the canopy leaves; this agricultural practice was developed following an empirical experience, which partly found an analytical verification. The optimization of the absorbing surface that can be designed through digital tools aims to find solutions to increase the photosynthetic activity of the individual tree, due to climate change mitigation.

Through the Identification and survey on typical olive cultivars, and their simulation in parametric models, it was possible to obtain performance analysis tools from which it derives the optimization of the results.

Goal of this task is to estimate and to optimize sustainable agricultural management practices. For this reason, it was created a web application, free of charge, simple to use, providing support for the design of the olive grove. It is possible to compare the impact of certain choices on density, incident irradiation and carbon dioxide production, by entering the information about the types of cultivars to be evaluated (compatible with the territory under consideration), the desired type of farming and the type of processing to be exploited.

The interface shows a first vast catalogue of alternative designs accompanied by a series of data and images. In this phase users are invited to navigate, setting the range of possibilities involved, and then select the most performing solution. In defining the information of the context, the field of solutions in act narrows, guiding the user in the choice, providing the opportunity to evaluate the performance of the olive grove from different points of view. The results were processed in different environmental contexts from Italy (Perugia), Greek (Athens), Spanish (Malaga) and Israel (Tel Aviv). In particular, the developed model takes into consideration one hectare of farming, considering different types of cultivars among which the one for the leccino, using experimental data, to estimate data on biomass production and carbon sequestration by the plant.

The olive trees (Olea europaea L.) are also analized for the long-term carbon storage capacity in soil and woody compartments. In the context of the OLIVE4CLIMATE project, the model 3D-CMCC-OLIVE, extension of the 3D-CMCC-FEM, was applyed to analyze the effects of the human activities (irrigation and pruning) under current and future climate scenarios on olive trees productivity. The olive orchards are located in Italy, Greece and Israel and represent a high variability of management, cultivar and climatic conditions.

The Bayesian calibration approach was adopted to find the best model parameters to be used in the simulations and considering as benchmark the daily Net Primary Production (NPP) simulated by a different model in an olive grove located in Central Italy over three study years (2010-2012). After model calibration, 20 farms among those included in the OLIVE4CLIMATE project and for which necessary data were available, have been used to simulate olive productivity for three time horizons (2000, 2020,2030, each representative of the surrounding 30-year period) and assuming alternative options for two management practices: irrigation vs. not irrigation, pruning each year vs. every two years.

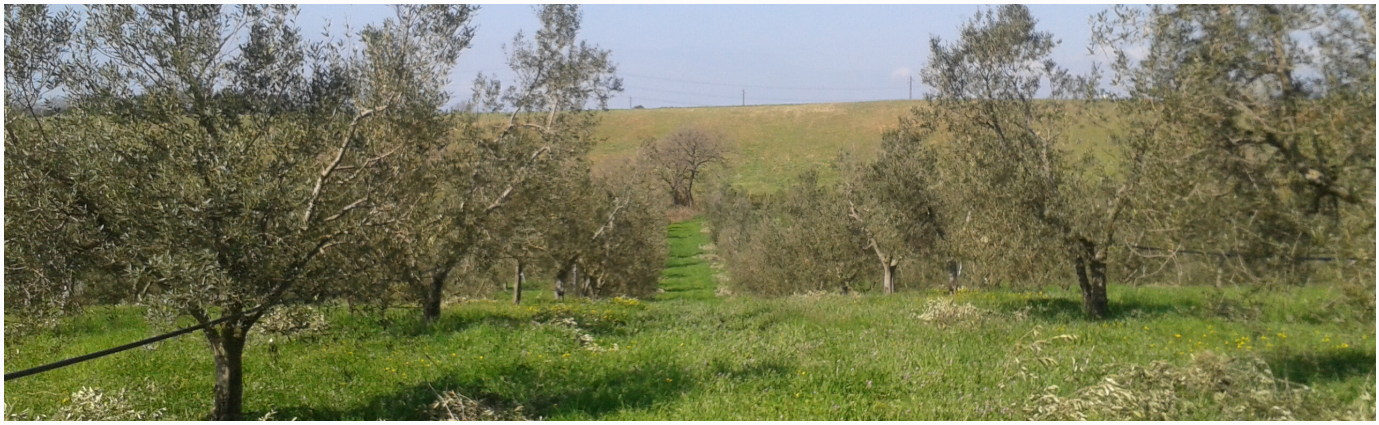
Key message from results is that the choice of the irrigation practice is the main factor, besides the frequency of pruning, to increase the olive trees' climate mitigation role under current and future climate.

5) Economic evaluation:

The working group has estimated how convenient it is for an olive farm to produce and market extra virgin olive oil packaged in 1 liter bottles.
This economic evaluation was carried out following two lines of research. The first one concerned the analysis of costs and revenues related to the production of olives, the transformation of olives into oil, packaging and sale of oil. The second concerned a survey on the effect that the certifications have on the choice of purchasing extra virgin olive oil from the habitual consumers of this product, such as: 1. Organic certification; 2. certification of Protected Designation of Origin (in Italian DOP); 3. Carbon Footprint Environmental certification in terms of carbon dioxide emissions.

Estimation of costs and revenues was carried out in all the companies participating in the project by directly surveying the individual activities carried out in three consecutive years, starting in 2016. In particular, costs were estimated separately for production, extraction and packaging with reference to the individual operations and to the individual types of extra virgin olive oil marketed by the olive farms. In this way it was possible to compare the production costs between the different activities within the same olive farm and between the different olive farms participating in the project, as well as to measure the variations suffered by the production costs as a result of the introduction of good practices in able to reduce carbon dioxide emissions into the atmosphere (see accumulation of carbon).
As regards revenues, on the other hand, it was sufficient to record the sales prices realized for the different types of extra virgin olive oil produced (Conventional, Dop, Organic, Kosher) in the different commercial channels used by the olive farms, as well as to estimate the value of the sustainability introduced in a 1 liter bottle of extra virgin olive oil using the so-called "sustainability credit markets".

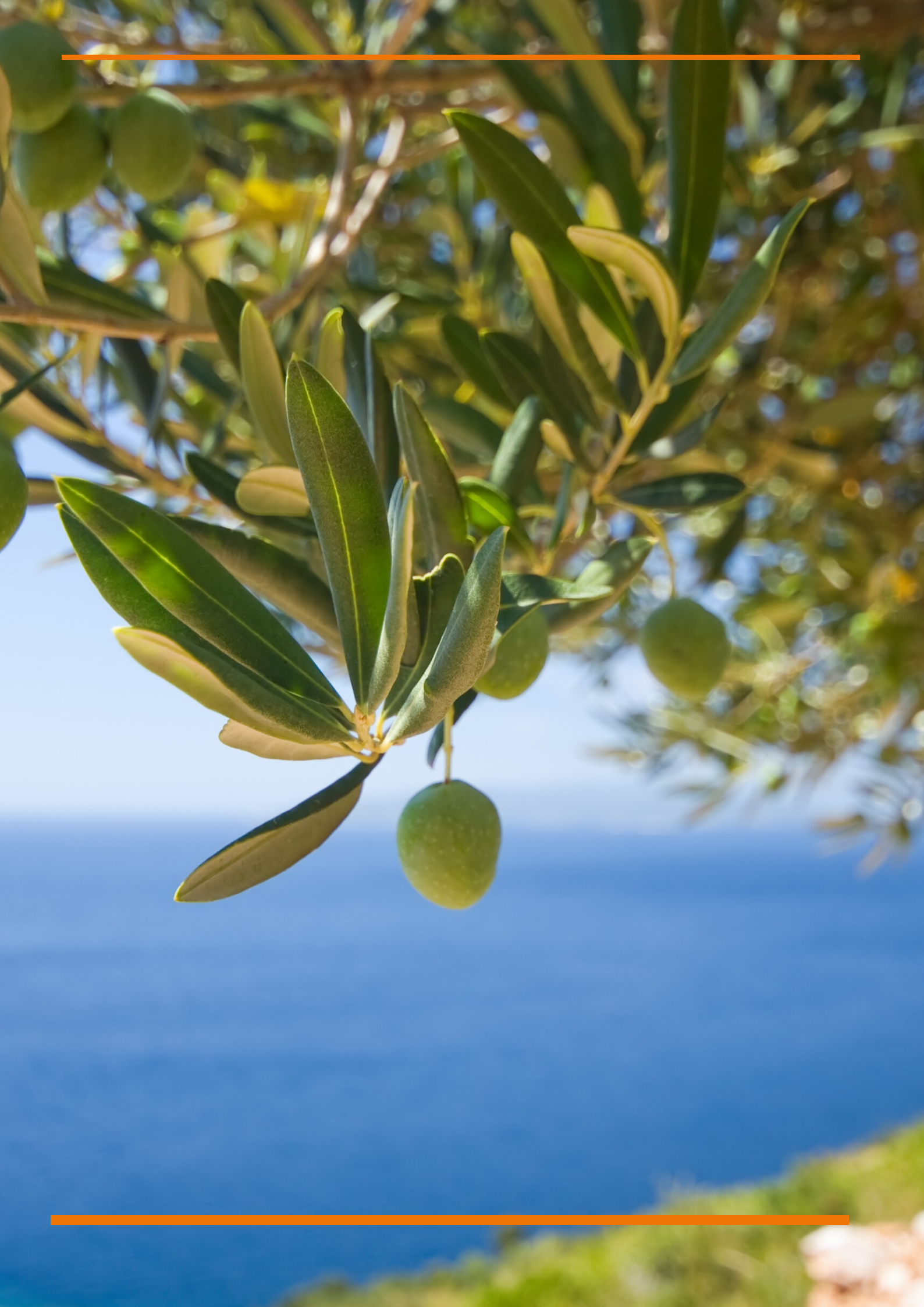
The investigation on the effect that the certifications have on the choice of buying extra virgin olive oil from the habitual consumers of this product was aimed at estimating the willingness of consumers to pay for extra virgin olive oils that in addition to the quality of the product present marks to guarantee particular characteristics, such as: 1) that it has been obtained without the use of synthetic chemical substances and without the use of Genetically Modified Organisms (as in the case of Organic oil); 2) that comes from a specific geographical area, from which it takes its name and on which the characteristics of typicality of the product depend (as in the case of DOP); 3) that it has been produced reducing to the minimum the emissions of greenhouse gases (expressed in carbon dioxide equivalent) which are among the main responsible for climate change (as in the case of Carbon Footprint Environmental certification).
The analysis model used also allowed us to estimate the joint effect, on the same bottle of extra virgin olive oil, of the presence of two or three brands, in order to evaluate for the olive farm the added value obtainable from certain characteristics of its own oil and the commitment to obtain them.



THE FUTURE

Likely future scenarios

The results obtained will be also compared to the possible scenarios for climate change, thus defining tools for stock and sink forecasting and therefore refining or identifying the most appropriate options to mitigate the imbalance between emissions/stock under different combinations of climate and farming/management scenarios.
The project will lead to the carbon footprint of the olive oil in compliance with ISO 14067 verified by an accredited third party certification for the olive oils of the stakeholders' companies involved. In this way it will be possible to enhance the high quality of olive oil according to an evaluated and not estimated procedure.
Moreover, thanks to the new standard "Standard for sustainability credits from sustainable olive grove management" developed during the project, the sustainable management of olive groves can be quantified in term of avoided emission of carbon dioxide equivalent.
This environmental advantages, due to the farmer good behavior, can be translated in an additional farmer gain.
The carbon dioxide avoided emissions can be sold in the form of Sustainability credits in the unregulated market, where high level carbon emitted subject can reduce their environmental impact buying the sustainability credits.
A Olive4climate Credits market will be created to facilitate the credit exchange between farmers and buyers, this market will be also proposed to a wider audicence to increase the number of participants.



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primo.proietti@unipg.it
regni.luca.agr@gmail.com

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