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Deliverable D.2: Assessment of the socioeconomic impact of the project's outputs

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LIFE CLIMATREE (LIFE14 CCM/GR/ 000635)

A novel approach for accounting and monitoring carbon sequestration of tree crops and their potential as carbon sink areas

The **LIFE CLIMATREE** project "A novel approach for accounting and monitoring carbon sequestration of tree crops and their potential as carbon sink areas" (LIFE14 CCM/GR/000635) is co-funded by the EU Environmental Funding Programme **LIFE Climate Change Mitigation**.

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ΓΕΩΠΟΝΙΚΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΘΗΝΩΝ
AGRICULTURAL UNIVERSITY OF ATHENS

UNIVERSITY OF WESTERN MACEDONIA

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1. Introduction

Tree crop cultivations following specific standards (cultivation practices) concerning CO_2 sequestration, apart from their global positive effect on CO2 abatement may also have a positive effect on the local society and national economy. Hence, the overall aim of this report is to shed light on the aggregated added value (social benefits) of tree crop cultivation as a means of avoiding the future impact/costs of climate change. In particular, the WTP for this ecosystem service provided by several tree cultivations, which are of particular importance for the regional and national economies across the EU-Mediterranean area, should be assessed. In order to achieve this objective, it is necessary to elucidate the economic value of CO_2 sequestration by adopting a model/tool that considers a tree crop cultivation as carbon sink area, and specifically, as a positive externality (i.e. non-market benefit).

As already shown, in the Deliverable of action C.5[1], there are many methods to estimate the marginal carbon sequestration values (e.g. cost avoided in other sectors through ETS or through voluntary carbon markets, avoided damage estimates in terms of the social/external cost of carbon – SCC, etc.). Most of these methods are trying to assess the (future) costs induced by not realizing the (carbon) sequestration. A thorough analysis of the monetary values based on different valuation methods is also performed and presented in Section 3 of the Deliverable C.5[2]. Some of these results (i.e. those based on the EU-ETS market value) were then integrated into a GIS environment to map the spatial variation of the carbon sequestration value in each NUT3 region of the study area (Greece, Italy and Spain).

In the present report, the focus is on the design and application of a new method for surveying citizens and exploring their preferences on climate relevant goods. This method should be able to identify the underlying preferences of consumers towards the benefits of carbon sequestration in tree crop cultivations. In this context, we developed

[1] Table 2, in Deliverable C.5 (Economic Module)

[2] In this report, the Life ClimaTree project estimated the potential value added of CO_2 sequestration when using best cultivation practices (in terms of climate change mitigation), and the per hectare sequestration value for a best case (i.e. best practices) scenario.

and applied a technique, which tries to proxy a real (market) decision and exploit the purchasing experience of citizens, while aiming at reducing the uncertainty of conventional stated preference approaches.

Specifically, we tried to estimate the economic benefits of the ES of carbon sequestration in tree-crops cultivations, by using of a representative crop for the case of the Mediterranean region, the olive trees. Then, we investigated consumers' (i.e. society's) WTP to purchase certified (i.e. eco-labeled) olive oil produced with mitigation rich practices. This analysis was supported by the climatic, agronomic and chemical findings of the other actions of the Life ClimaTree project, which offered the necessary knowledge base for performing a well-designed evaluation study that takes into account climatic, biological, an agronomic functions of tree cultivations.

Next, the economic value of CO_2 sequestration will be expressed in term of acreage (€/ha) as a function of olive trees productivity and CO_2 sequestration potential. This function will be transferred (assessed) then to the main tree cultivations in the study area, under the assumption that they will also follow the most efficient cultivation practices (i.e. those practices that maximize CO_2 sequestration). The generated values will be added to the total economic yield (farmers' revenues) of tree crops and, thus, the total benefit of society will be estimated (based on the assumption that these benefits will be passed on to the local/regional farmers through market prices or appropriate economic instruments).

By quantifying and evaluating those benefits, it would be possible to inform the design of relevant "agri-environmental" policies (that address both local farmers and consumers' interests), which will be in line with the principles of sustainable development. In other words, we will try to enrich the armament of climate policies with economic instruments that support the mitigation potentials of the agricultural sector.

2. Capturing the WTP value of CO_2 sequestration from tree corps: WTP for eco-labeled olive oil

Due to the absence of a market, for most ecosystem services the price that a producer can receives for producing them is zero. This case also applies for the ecosystem service of carbon sequestration, which is provided – among others - by tree crops producers. A zero price for this ecosystem service is actually a price that underestimates their true value, which means that fewer resources than is socially optimal will be directed towards its provision (Ribaudo et al., 2010). On the other hand, economist believe that consumers would be willing to pay a premium to obtain this service if a market for CO_2 storage existed. Environmental valuation should contribute to fill the gap before a real market is created, in order to provide a monetary value of CO_2 sequestration, which will allow for more informed agri-environmental policy decisions.

Environmental valuation rests on the idea that costs and benefits can be expressed in terms of money and hence made comparable or commensurable. It is widely recognized that the incommensurability problems facing monetary valuation are particularly noticeable, and particularly acute, in environmental contexts (Pearce 2000). The economic value of agricultural products (e.g. tree-crops yield) can be easily derived from market transactions. However, the question here is how to estimate the added value in these products resulting from an environmentally friendly production process (i.e. when using agricultural practices that may can enhance carbon storage). In order to measure this value, it is necessary to define a monetary valuation *m* of the change in the provision of the ecosystem service from the status quo x_0 to a new level x_1 (in our case *m* represents the environmental positive externality of climate change mitigation).

$$V(x_1, y - m) = V(x_0, y) \qquad [1]$$

where V represents utility (subjective preference satisfaction) and y is consumer's income (Aldrer, 2006). In the above equation *m* represents the consumer's WTP value for a change in the provision of the ecosystem service under consideration[3]. So, the question is "*whether and how much above the current price would the consumer willing*

[3] Based on Lancaster theory (Lancaster, 1966) consumers are supposed to derive utility not from the goods themselves but from the attributes the goods are believed to possess.

to pay for products produced with environmentally sound production and management techniques (Moon et al., 2002), holding all the other products characteristics constant?"

The current action (D.2) of Life ClimaTree project aimed to capture this WTP value with respect to consumers' appreciation and attitudes towards CO_2 sequestration-labeled products. So, we selected to investigate the consumers' behavior towards a potential ecolabel certification mechanism. The rational of using an ecolabel is that consumers who demand this ecosystem service (carbon sequestration) and understand the link with the selected private good could choose labeled/certified goods, even if they are more expensive. Another reason for using the tool of ecolabeling, is because food/nutrition labelling provides an information which may urge people to consume more sustainably (European Commission, 2008) but may also provide market incentives to producers to use environmentally friendly production methods[4]. So, hidden (i.e. zero valued) agricultural (tree-crop) ecosystem services can be transformed to tangible goods offered in the market.

In this context, the proposed eco-labeling program tried to differentiate the agricultural (tree) commodities produced by techniques that maximize CO_2 sequestration from those conventionally produced. Our study focused on the olive tree production. The reason for selecting olive trees is that they are widely cultivated in the Mediterranean region, while they also have a high sequestration potential since the extremely long-life cycle of olive trees (Brilli et al., 2019). The use of specific agricultural practices such as soil-friendly management practices and/or organic fertilization seems to result in significant improvements in carbon sequestration in olive groves (Aguilera et al. 2014). Furthermore, olive tree is a widely known crop, whose product are very familiar to the broad public, making thus possible to delineate a realistic (economic) valuation scenario, with transferability to other tree-crops valuation.

A public survey was conducted planned to reveal the consumers' demand (i.e. value) for the aforementioned ecosystem service. Despite the great number of labeling

[4] For these reasons many sustainability-related food/nutrition information schemes are becoming more and more available in EU. Namely, a survey by the European Commission identified 129 such schemes at the EU or national levels (European Commission, 2012a).

schemes[5]: (a) in farmlands and woodlands, as well as (b) in Measuring, Reducing and Offsetting (MRO) carbon footprints, the theoretical approach followed in this action is quite innovative because there is no yet a licensing scheme that merges these two frameworks into a single one that "recognizes" the effort of farmers to enhance carbon storage through mitigation rich cultivation practices.

3. Survey design and implementation

A questionnaire survey was conducted to explore the consumers' preferences and values concerning the ecosystem service of carbon sequestration and storage provided by tree crops and specifically by olive trees. A web-based technology for survey building and collection was used to emulate a paper survey in an online environment. Namely, we designed a questionnaire for mobile devices such as tablets and smartphones. LimeSurvey, an open-source, online survey application written in PHP and distributed under the GNU General Public License (LimeSurvey.org), was chosen as the web server-based software. The survey was conducted in Greece, as a pilot area/study and then we examined its replication in the other two Life-Climatree countries. Furthermore, we tried to aggregate our findings at the national level and then to use our results in a benefit transfer setting in order to estimate the value of carbon sequestration in Italy and Spain.

As already mentioned, a hypothetical scenario was developed elicitating participants' willingness to pay for eco-certified olive oil (the ecolabel was described as a label which tells consumers that the olive oil was produced by using the most appropriate cultivation practices with respect to CO_2 sequestration and storage). In particular the following question was used:

> *"The production of olive oil according to good agricultural practices (i.e. by using practices that mitigate climate change) is likely to increase*

[5] 463 labeling schemes are currently available in 199 countries and 25 industry sectors (source: http:\\ecolabelindex.com)

production costs and hence its price (per liter). In this case, would you be willing to pay more than today in order to buy a certified olive oil with the same characteristics as the one you use (quality, taste, acidity, etc.)?"

If a positive answer was given, then the WTP for this ecosystem service was elicited in a two-step approach, in which each consumer (participant) was requested:

(a) To select one or more products in a virtual "market store" (from a list of basic or luxury goods) for which she/he is willing to reduce its/their annual consumption in order to save money to buy the certified, with the eco-label olive oil.

(b) (For each product selected): To fill in the maximum amount of money he/she would like to save each year.

This alternative payment vehicle was selected in order to make people aware of the actual sacrifices (i.e. foregone benefits) required for the sake of climate change mitigation. This experimental procedure is based on previous studies trying to investigate the effects of different payment modes in stated preference studies (Gyrd-Hansen and Skjoldborg, 2008; Lee et al, 2015). The English translation of the questionnaire can be found in Appendix B.

The survey was administered in face-to-face interviews of approximately 15minutes that were conducted during the period November 2018-May 2019. The interviews took place in the two metropolitan areas of Greece (Athens and Thessaloniki), while 58 supermarkets (from 9 different supermarket chains) were used as collection points. A spatial (geographical) distribution of these collection points (15 different neighborhoods/municipalities in Athens and 7 different neighborhoods/municipalities in Thessaloniki) served.to ensure the sample representativeness (demographic characteristics, olive consumption characteristics, environmental awareness, etc.). The study received a total of 529 completed surveys for an overall response rate of 27.8% (Fig.1).

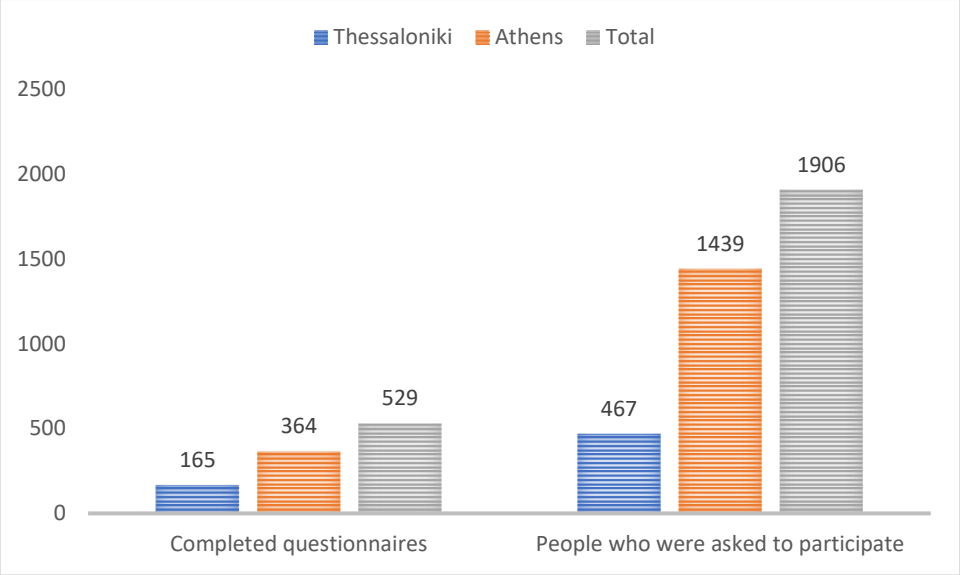


Fig.1 Total number of questionnaires completed

4. Survey results – Quantifying the socio-economic benefits of CO_2 sequestration

The initial sample consisted of 529 respondents, reduced to 456 after excluding those who didn't consume olive oil and self-consumers using their own yields (small producers). The descriptive statistics of the sample are presented in the Appendix (Table A1). Furthermore, Table A2 presents the relative importance of various olive oil characteristics (attributes) in respondents' purchasing decisions. The histograms in Figures A1 and A2 (Appendix) present the frequency and the amount (liters per month) of olive oil consumption per household. It is worth mentioning that the mean per capita olive oil consumption of our sample (i.e. the actual consumption divided by the members of each respondent's household) was found very close to the actual national per capita consumption (NBG, 2015)[6]. Table A3 (Appendix) presents respondents' perception about climate change, climate mitigation actions and their attitudes about environmental/green products. Based on their answers, most respondents are concerned about the impact of climate change and believe that drastic mitigation measures should be taken. Furthermore, respondents are willing to get more information about the environmental impact of the products they buy, while they are positively inclined towards green (environmentally friendly) products.

[6] The sample's olive oil consumption was found equal to 15,5 lt/year while the national estimate is equal to 17lt/year

Concerning carbon sequestration in agricultural production (Table A4 in Appendix), respondents seem to understand the role of agriculture on climate change mitigation. Namely, the need to further promote carbon sequestration practices in agriculture scored very highly. Furthermore, participants have a great interest in being informed and in purchasing eco-labeled agricultural products associated with carbon sequestration practices (benefits). According to these results eco-labeling can be considered as an important tool in consumers' environmental attitudes and their purchasing decisions. Furthermore, a very high correlation (R=0.97) is reported between the importance that respondents' place on ecolabels: (a) in olive oil and (b) in other foods/beverages, allow us to transfer the results of this study, i.e. the WTP for eco-labeled (regarding climate change mitigation) olive oil to WTP for any other eco-labeled agricultural product (e.g. other perennial tree-crops).

4.1 Consumers WTP (value) for CO_2 sequestration through improved (efficient) cultivation practices

Figure 2 presents the percentage of respondents who are willing to pay more than today to buy certified olive oil with the same characteristics as the one that they are currently using. Most respondents are willing to pay the eco-labeled product (41.67%) or are indecisive (39.25%) about their preference.

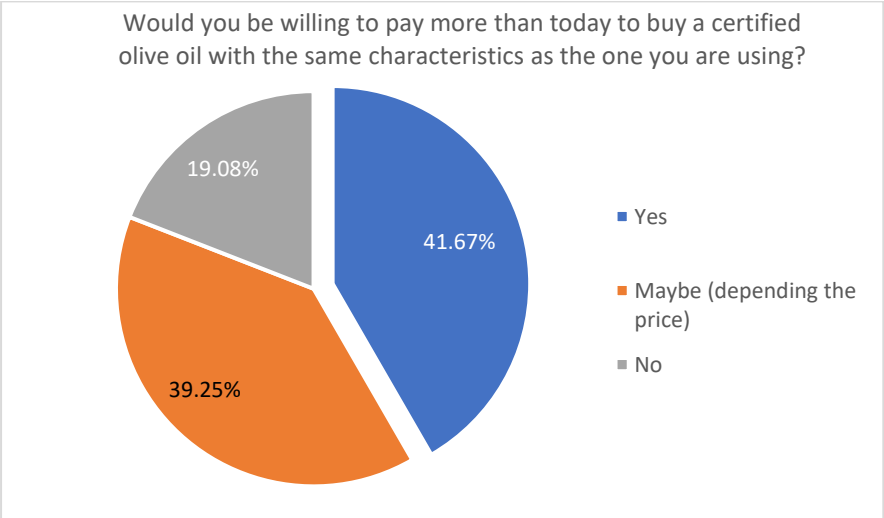
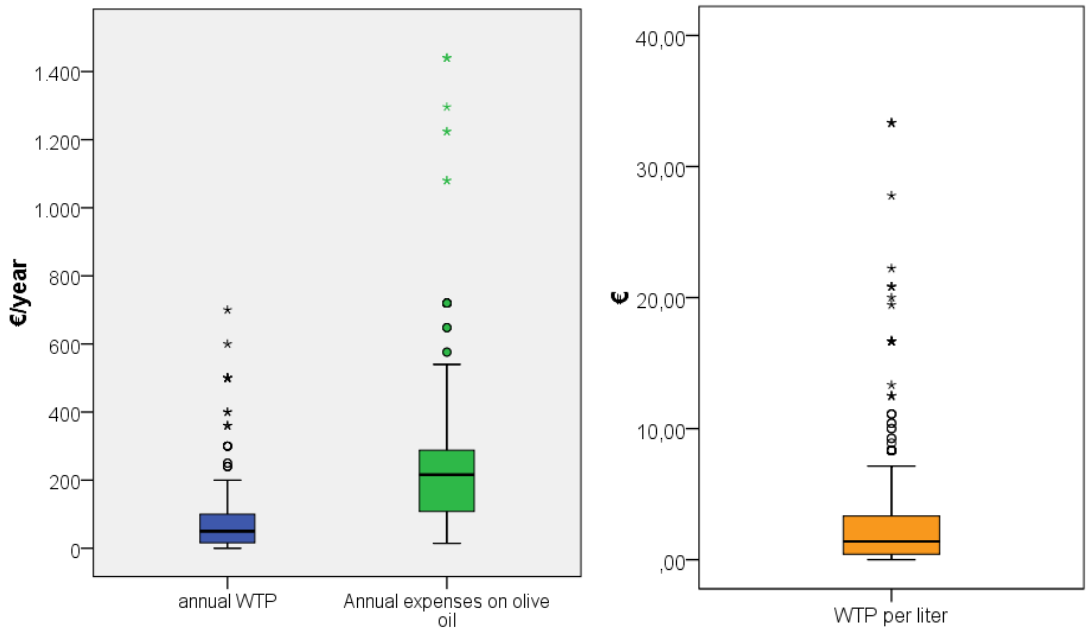


Fig.2 Willingness to pay an extra fee for certified olive oil (in terms of the sequestration farming practices)

After taking into consideration their final choice (i.e. the amount of money they are willing to save each year to buy the certified olive oil), it turns out that 73.3% of the respondents are willing to pay for the proposed mitigation program (i.e. about 80% of the indecisive respondents turned out to be yes-responders). By excluding the protest voters (30 respondents were considered as protesters), it results (see Figure 3a) that the mean annual WTP of the sample is equal to 75.8€, which corresponds to about 30% of the mean (current) expenses for olive oil (246€/year).

Next we used a boxplot-based procedure to exclude all participants that failed to provide a rational/reliable answer (outliers with extremely high WTP). Namely, we first converted the WTP values into "WTP for a liter of eco-labeled olive oil" (by dividing WTP with olive oil consumption) and then we removed all responses that were more than 1.5 times the interquartile range away from the edges of the box (see Figure 3b). The final/reduced sample consisted of 380 respondents. Figure 4 presents the histogram of the WTP/liter values for the final sample (mean value =1.59€/lit).



a. b.

Fig.3 (a) Annual WTP to pay for certified olive oil as compared to the actual annual expenses on olive oil and (b) WTP per liter of actual consumption

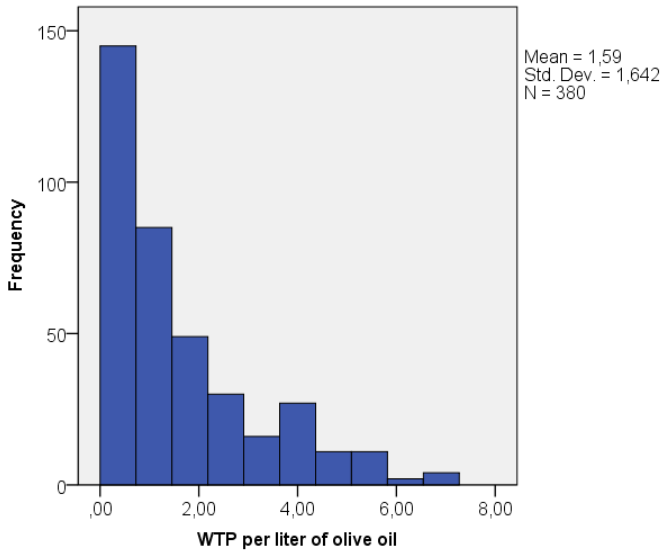


Fig.4 Histogram of willingness to pay for certified olive oil (expressed in €/liter)

A linear OLS regression analysis was then conducted to determine which variables (i.e. consumers' characteristics/perceptions) would affect the WTP for certified olive oil. Results are presented in Table A5 (in Appendix). Apparently, according to the results, the predictive value was rather low (R^2=0.214), which means that the model does not fully explain much of the variance and shouldn't be used to precisely predict WTP values from a sample of consumers. However, its results are still important as several explanatory variables were found significant (six variables were found statistically significant at the 10% level). Namely, a clear relationship was observed between WTP and: (1) olive oil consumption (negative relationship), (2) major concern about climate change (positive relationship) (3) importance of olive oil price in purchasing decisions (negative relationship), (4) education level (positive relationship), (5) importance of eco-labeling in product purchasing decisions (positive relationship), (6) intention to sacrifice luxury goods to pay for olive oil produced following mitigation rich practices.

4.2 Aggregating value-estimates (of CO2 sequestration) at the national level

At this point, it should be stressed that we presume that citizens, when assigning a value to the mitigation potentials of olive orchards, they consider the land use allocated to this mitigation actions (i.e. we assume that the 1.59€/liter is attributed to the cultivated area required to produce one liter of olive oil with mitigation rich practices). Next, according to the EU Farm Accountancy Data Network (EC, 2012b), we assume that the average yield of olive oil in Greece is about 800lt/ha/year. Taking this yield into

account, our study indicates an annual value of [1.59 €/lit] * [800 lt/ha] = 1272€ per hectare of olive orchards following mitigation rich practices[7]. The gross income of olive oil production in Greece (based on data from EC, 2020 and EC, 2012b) is equal to 1600€/ha. Furthermore, the actual mean subsidy per hectare for olive farm owners in Greece, is about 500€/ha (GNB, 2015), although high differentiated among regions. So, the value of using mitigation rich practices in olive orchards it seems to correspond to about 79.5% of the farmers gross margin and more than twice the actual level of the subsidy. By multiplying this value (1272€ per hectare) with the total acreage of olive trees in Greece (782,821 hectares) we can estimate the aggregated annual value of mitigation potential at the country level, which equals approximately 995 million €/year.

It should be noted that these results may overestimate the aggregate (at the national level) consumers' WTP for the selected ecosystem service. In fact, based on our survey results, the mean annual WTP per household for buying eco-labeled olive oil (WTP_i*HC_i)[8] instead of a conventionally produced olive oil (with the same characteristics) was found equal to 75.8€/year/household. So, if we multiply this WTP with the number of households in Greece (4,134,540 households based on the 2011 population census data of the Hellenic Statistical Authority) the estimated total WTP value at the national level is equal to 313million euros (i.e. about 1/3 of the aggregated value estimated in the previous paragraph). Thus, this new aggregate value can initially finance up to 246,069 hectares[9] of olive orchards to change their cultivation practices. Therefore, we can conclude that the original value estimate (1272€/ha) is the value that can be paid by citizens (through eco-label programs), by national governments (through CAP's land subsidies) or by some combination of these two instruments, when less than 246,069 hectares are using these mitigation rich cultivation practices. If in the long-term the national agri-environmental policy aims at giving incentives to more farmers (i.e. to a total area greater than 246,069 hectares) in order to adopt these practices, then

[7] Based on this estimate and taking into account that the maximum carbon absorption per hectare and year in Greece from an olive grove is equal to 4.95 $tCO_2ha^{-1}year^{-1}$, we can estimate the benefit of using the best practices for carbon sequestration to be equal to 256.9€/tCO_2. This value is slightly higher than the value provided in Deliverable C.5/ Table 2 (212.5€/tCO_2) due to the fact that in that time we used a lower per hectare productivity (about 660lt/ha), which was based on some empirical data (estimations).

[8] Where HC is the mean annual consumption of household i

[9] [313million €] / [1272 €/ha] = 246,069 ha

eco-labeling should be replaced by a subsidization policy, which should adjust the maximum possible level of subsidy to the total acreage of olive orchards following mitigation rich practices (see Figure 5). According to Figure 5, the level of the recommended (dynamic) subsidy range from 400€/ha to 1272€/ha.

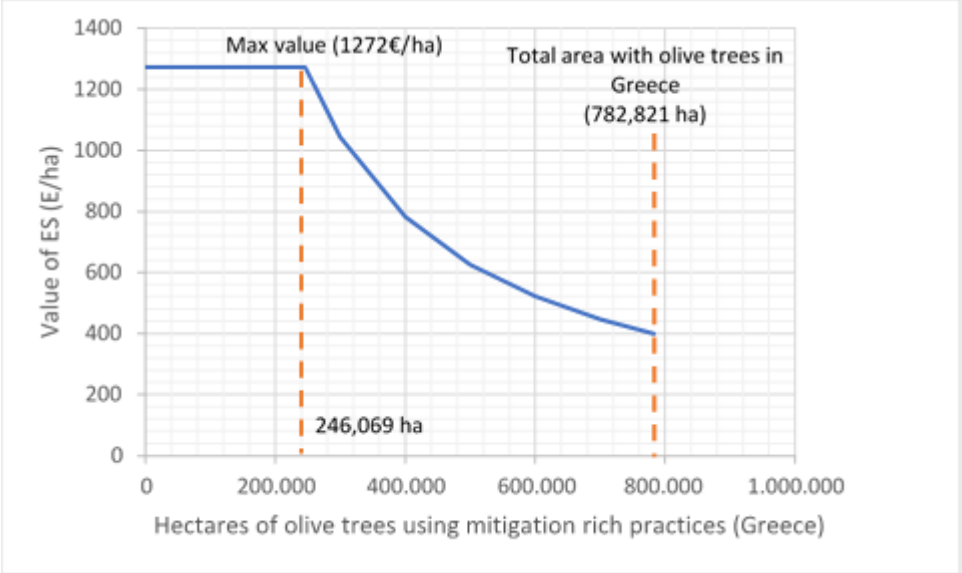


Fig.5: Maximum possible subsidy level depending on the acreage of olive trees using mitigation rich practices

Next we are using a benefit transfer function in order to estimate this ecosystem value for the case of the other two countries of this project (i.e. Italy and Spain). In order to do so, we are using the WTP of Greek households for a litter of eco-labeled olive oil (1.59 €/lt) and we adjust this estimate in order to offset influences concerning different price levels. Specifically, we are using the purchasing power parity index of the three countries to convert the above estimate into an estimate for Spain and Italy (Table 1). By following this procedure, the WTP per litter of olive oil was adjusted to 1.91€ in Italy and to 1.79€ in Spain. Then we multiply this estimate with the average consumption of olive oil in each country to get the annual household WTP for eco-labeled olive oil. Due to the fact that the average consumption is lower in Italy and Spain as compared to Greece (NBG, 2015), the annual WTP estimates were also found to be lower (48.3€/year in Italy and 53.9€/year in Spain). The total WTP value for this ES at the national level is then estimated by multiplying average households' WTP with the number of households in each country. As shown in Table 1, this national-level estimate amounts to 1.248 billion euros in Italy and in about 1 billion euros in Spain. In order to find the maximum area of olive trees in each country, where mitigation rich

practices can be financially supported by an eco-labeling scheme, it is necessary to estimate the per hectare value of this ES and then to divide the aggregate (national) WTP by this value (i.e. following the same steps as previously described for the case of Greece). Then, we can also design a subsidization policy for each country, by adjusting the level of subsidy to the total acreage of olive orchards following mitigation rich practices (see Figure 6).

Table 1: Benefit transfer for the case of Spain and Italy (using the 2020 PPPI)[10]

	Greece	**Italy**	**Spain**
PPPI	0.557	0.671	0.627
WTP (€/lt)	1.59	1.91	1.79
Annual household consumption	47.6[11]	25.31[13]	30.11[12]
Annual household WTP (€/year/household)	75.8	48.3	53.9
Number of households	4,134,540	25,816,311	18,535,900
Aggregate (total) WTP	313 million €	1248 million €	999 million €
Mean productivity (lt/ha)[13]	800	1000	650
Per hectare value (€/ha)	1272	1910	1163

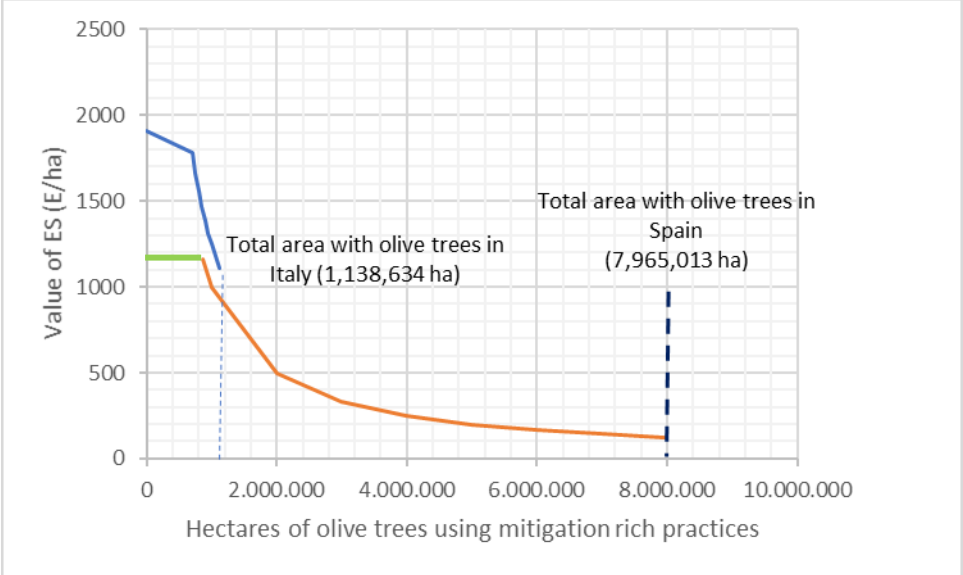


Fig.6: Subsidy level depending on the acreage of olive trees using mitigation rich practices

[10] **Total, National currency units/US dollar, 2000 – 2019** (https://data.oecd.org/conversion/purchasing-power-parities-ppp.htm)
[11] Sample estimate
[12] GNB (2015)
[13] Based on average estimates of EU (EC, 2012b)

5. Policy implications and conclusions

Up until now, there is a notable lack of knowledge about the role of tree crops as carbon sink areas both between producers and consumers. This lack of knowledge underestimates the ecosystem service value of carbon sequestration, and thus is likely to lead to (market) failure in supplying the desired level of this environmental attribute stemming from the tree crops' products. This action contributes to the assessment/evaluation of this positive externality (CO_2 sequestration) at the societal level (in terms of both consumers and producers). In particular, a survey was conducted to explicitly describe (through an eco-labeling approach) the role of tree crops in mitigating climate change, aiming at informing the consumers about this service and then to reveal their preferences concerning this ecosystem value.

The price of eco-labeled agricultural commodities produced with environmentally sound production techniques are likely to be higher than commodities conventionally produced (Moon et al., 2002), and therefore, the demand for these commodities may theoretically correct the market failure. This tool facilitates farmers to capture the rewards of their environmentally superior performance and consumers to increase their utility by consuming an environmentally friendly product (i.e. a product that contributes to climate mitigation).

In our application, eco-labeling seems to be a viable option as consumers are willing to pay a large enough premium for tree crops' products that maximize carbon storage. So, it could be a policy measure to support relevant investments to tree crops. While eco-labels require compliance with standards, they are still considered market-oriented, because they do not involve direct government regulation (McCluskey and Loureiro, 2003).

Based on our results, the mean willingness to pay of our sample (in Greece) was found equal to 1.59 €/liter. This value was also converted into €/tCO_2 and €/ha estimates. So, the economic benefit from adopting the best practices for carbon sequestration was

found equal to 256.9€/tCO2. This value is quite close to the value of carbon estimate in the Stern Review (242€/ tCO2 in 2020 and 298.3€/tCO2 in 2030) (Stern, 2006). On the other hand, the per-hectare estimate was found equal to 1272€/ha, a value which is comparable to actual subsidies on organic in tree-cultivations. These WTP estimates reveal that the carbon storage of tree crops is an ecosystem service with a significant economic value. So, governments could subsidize farmers to adopt the most efficient CO_2 storage practices. A total subsidy of 313million euros/year was found as a reasonable payment for Greek farmers that would adopt mitigation rich practices (corresponding values were calculated for the case of Italy and Spain by applying the benefit transfer method). Such a subsidy (or other similar direct/indirect payments) is thus expected to have quite significant (positive) impact on farmers' income and agricultural employment, as well as on rural societies.

Consequently, based on the outcome of this action, tree crops, apart from their obvious environmental benefits (i.e. their contribution to CO_2 sequestration), they can also have a positive effect on the local society and the national economy. The evaluation of those benefits may result to rational and effective policy proposals, which will be in line with the principles of sustainable development (providing thus further specialization into the policy instruments suggested in Action C.5).

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APPENDIX A

Table A1: Descriptive statistics for the sample

Variable name	Description	Statistics
SEX	Gender: 1=male, 0=female	31% male / 69% female
AGE	Age of respondents	49.38 (15.65) *
N_H_MEM	Number of household members	2.64 (1.2)
INCOME	Annual household income (€)	18,464 (10,773)
EDUC	Education level:	
	1 =primary education,	5.9%
	2 =lower level secondary education,	5.5%
	3 =upper secondary education,	23.0%
	4 =university education,	53.9%
	5 =post-graduate studies	11.7%

*Mean with standard deviation in parentheses

Table A2: Importance of olive oil characteristics according to the sample of consumers

When buying olive oil, how important is: (on a scale of 1 to 5, where 1 not important 5 = very important	Mean	Std. Deviation
Taste, Odor, and Color?	4.58	0.758
Packaging design	2.52	1.290
Price	4.27	1.022
Quality	4.80	0.521
Prestige and Reputation of company	3.63	1.314
Region of origin (e.g. protected area)	3.64	1.306
Organic farming product	3.04	1.479
Valid N	456	

Table A3: Consumers' perceptions about environmental/climate change issues

How much you agree or disagree with the following statements: (On a scale of 1 to 5, where 1 = I totally disagree and 5 = I totally agree)	Mean	Std. Deviation
I have a major concern about climate change and its (possible) impacts	4.38	0.959
I believe that drastic measures should be taken in order to mitigate climate change	4.62	0.786
I think it is too late for mitigation measures. So, it's better to invest in adaptation measures	2.80	1.604
I think that, currently, priority actions/policies should be directed on socio-economic issues rather than on environmental ones	2.70	1.423
I would like to know the environmental impact (or environmental benefit) of every product I buy	4.01	0.957
I would buy a product on the basis of being environmentally friendly	4.16	0.936
Valid N	456	

Table A4: Consumers' perceptions about sustainable production and certification of agricultural products/olive oil

On a scale from 1 to 5, where 1 = not at all and 5 = very much, how important do you consider the following	Mean	Std. Deviation
Agricultural production should be based on agricultural carbon sequestration practices	4.73	0.593
Agricultural products resulting from the application of good agricultural practices should be certified and labeled accordingly	4.74	0.610
Importance of certification when choosing and buying food and beverages	3.70	1.375
Importance of certification when selecting and purchasing olive oil	3.69	1.450
Valid N (listwise)	456	

Fig. A1: How often do you consume olive oil?

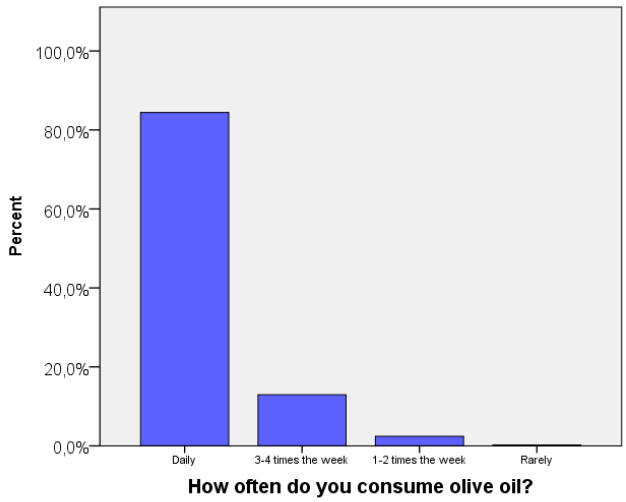

Fig. A2: How many liters of olive oil do you consume per month (approximately)?

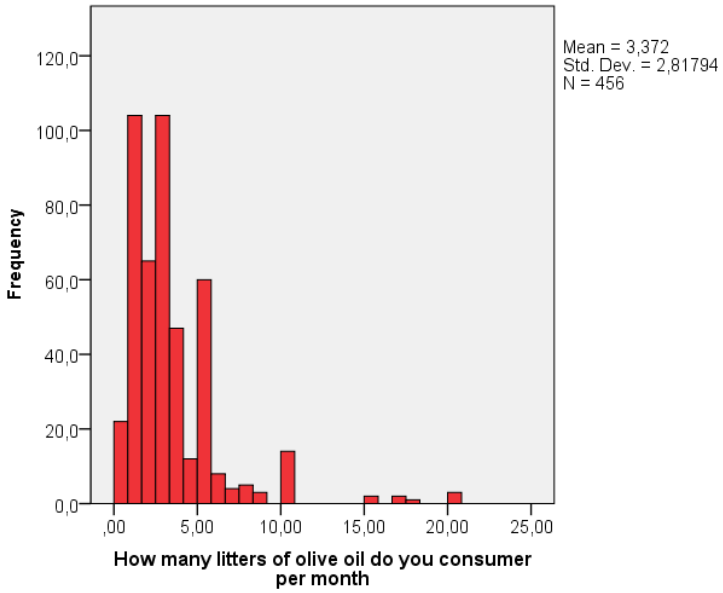

Table A5: Regression analysis results (Determinants of consumers' WTP)

Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	0.438	0.613		0.713	0.476
I would sacrifice luxury goods to pay more for olive oil	1.088	0.154	0.327	7.047	0.000
Olive oil consumption (per month)	-0.123	0.026	-0.219	-4.756	0.000
Major concern about climate change and its impacts	0.210	0.080	0.124	2.627	0.009
Price of olive oil is an important factor in their olive oil purchase	-0.160	0.075	-0.099	-2.134	0.034
Education level	0.160	0.080	0.095	2.000	0.046
Importance of eco-labels when selecting and purchasing olive oil	0.090	0.053	0.079	1.676	0.095
R^2	0.214				
Adjusted R^2	0.222				
F	17.005				0.000
Durbin-Watson	2.041				

a. Dependent Variable: WTP per liter of olive oil

APPENDIX B

Climatree LIFE Project survey research – (UEHR, AUTh)

This questionnaire is part of the LIFE CLIMATREE project, which aims to develop an innovative carbon capture quantification tool for permanent tree plantations. The main objective of the program is to study the possibilities of implementing measures and actions to mitigate climate change (carbon capture) in the agricultural sector and to assess the respective benefits that can be gained in society.

You have been randomly selected along with a large number of residents of the country who also participated in this survey. The purpose of the survey is to investigate your consumer preferences with regard to the purchase of agricultural products by certifying good practices to mitigate climate change. Responses are confidential and will be used exclusively for research purposes.

[A1] Are you buying olive oil?

Please choose **only one** of the following:

○ YES ○ NO

[IF YES→ go to question A2, If NO→ go to question G1]

[A2] How often do you consume olive oil?

Please choose **only one** of the following answers:

○ Daily
○ 3-4 times the week
○ 1-2 times the week
○ Rarely

[A3] How many liters of olive oil do you consume per month (approximately)?

Only numbers may be entered in this field.

Please write your answer here:

_____

[A4] Where do you usually buy olive oil?

Please choose **all** that apply:

☐ Super Market
☐ Mini market and/or convenience store

☐ Cooperatives and/or co-op grocery stores

☐ Producers and/or street markets

☐ Other:

[A5] On a scale of 1 to 5, where 1 = none and 5 = too much, how important are the following factors/characteristics when buying olive oil?

Please choose the appropriate response for each item:

	1	2	3	4	5
Taste-Odor-Color	○	○	○	○	○
Packaging design	○	○	○	○	○
Price	○	○	○	○	○
Quality (e.g. extra virgin, virgin, olive oil)	○	○	○	○	○
Prestige and reputation of production company	○	○	○	○	○
Region of origin (e.g. protected area of origin)	○	○	○	○	○
Organic farming product	○	○	○	○	○

[B1] Distribution of household expenditure

Please write your answer(s) here:

Only integer values may be entered in these fields. Each answer must be between 0 and 100. The sum must be equal to 100.

- What percentage of your monthly income do you spend on basic consumer goods such as food, clothes, rent, bread, water, etc.? ___%
- What percentage of your monthly income do you spend on luxury goods like: expensive clothing, leisure travel, jewelry, private education, private health, etc.? ___%
- What percentage of your income do you spend on actions, policies or measures for climate change mitigation/adaptation? ____%

[B2] On a price scale between 1 and 100 (where 1 = very cheap and 100 = very expensive):

Please write your answer(s) here:

Only integer values may be entered in these fields. Each answer must be between 1 and 100.

- What is the average price of the basic consumer goods that you buy? ____
- What is the average price of the luxury goods that you buy? _____

[C1] On a scale of 1 to 5, where 1 = I totally disagree and 5 = I totally agree, how much you agree or disagree with the following statements:

Please choose the appropriate response for each item:

	1	2	3	4	5
I have a major concern about climate change and its (possible) impacts	○	○	○	○	○
I believe that drastic measures should be taken in order to mitigate climate change	○	○	○	○	○
I think it is too late for mitigation measures. So, it's better to invest in adaptation measures (i.e. measures addressing the risks of floods, droughts, etc.)	○	○	○	○	○
I think that, currently, priority actions/policies should be directed on socio-economic issues rather than on environmental ones	○	○	○	○	○
I would like to know the environmental impact (or environmental benefit) of every product I buy	○	○	○	○	○
I would buy a product on the basis of being environmentally friendly	○	○	○	○	○

[C2] On a scale from 1 to 5, where 1 = not at all and 5 = very much, how important do you consider the following:

Please choose the appropriate response for each item:

	1	2	3	4	5
Agricultural production should be based on agricultural carbon sequestration practices (i.e. climate change mitigation practices)	○	○	○	○	○
Agricultural products resulting from the application of good agricultural practices should be certified and labeled accordingly	○	○	○	○	○

[C3] On a scale of 1 to 5, where 1 = not at all and 5 = very much, how important would such certification be (certification of agricultural products adopting climate change mitigation practices):

Please choose the appropriate response for each item:

	1	2	3	4	5
When choosing and buying food and beverages	○	○	○	○	○
Particularly, when selecting and purchasing olive oil	○	○	○	○	○

[D1] The production of olive oil according to good agricultural practices (i.e. by using practices that mitigate climate change) is likely to increase production costs and hence its price (per liter). In this case, would you be willing to pay more than today in order to buy a certified olive oil with the same characteristics as the one you use (quality, taste, acidity, etc.)?

Please choose **only one** of the following answers:

- ○ YES
- ○ MAYBE (depending the price)
- ○ NO

IF YES or MAYBE → Go to question D2

IF No → Go to question E1

[D2] To cover the higher cost of (certified) olive oil, you need to save money in your household's annual budget. Consider the following two types of goods and choose from which one you would prefer to save money to cover the higher cost of olive oil.

Please choose **only one** of the following answers:

- ○ Reducing spending on basic consumer goods
- ○ Reducing spending on luxury goods

First choice (consumer goods) → Go to question D3

Second choice (luxury goods) → Go to question D4

[D3] Reducing spending on basic consumer goods

From this type of goods, you can choose one or more products for which you are willing to reduce its/their annual consumption in order to save money for the purchase of certified olive oil (for good agricultural practices that mitigate climate change). For each product that you choose, fill in the maximum amount of money you are willing to save each year (by reducing its consumption). An indicative price is listed for each product in order to help you estimate the corresponding reduction in consumption.

Please write your answer(s) here:

Only numbers may be entered in these fields.

Flour	___€	Apples	___€
Milk	___€	Potatoes	___€
Dishwashing liquid	___€	Toilet paper	___€
Coffee	___€	Spaghetti	___€
Vegetable oil (other than olive oil)	___€	Rice	___€
Clothes (basic clothing)	___€		

According to your answers, you are willing to reduce your total spending on basic consumer products by: X €/year [where X is the sum of the above table generated by the survey program]

For comparison purposes, we would like to inform you that based on your stated consumption of olive oil, you spend about: Y €/year on your olive oil. [where Y is equal to: (Answer at question [A3] x12(months) x indicative price of olive oil in each country[14]):

If you agree you may proceed to the next question, otherwise you can correct your answers.

	product	Indicative price
	Flour	0.95€/kg
	Milk	1.2€/lt
	Dishwashing liquid (500ml)	1.3€
	Coffee (instant coffee, 200gr)	6€
	Other (than olive) vegetable oil	2€/lt
	Apples	1.5€/kg
	Potatoes	0.7€/kg
	Toilet paper (8 rolls)	3.1€
	Spaghetti (500gr)	0.8€
	Rice (500gr)	1.5€
	Clothes (basic clothing)	No indicative price

[Prices of the above table are also indicative, describing the average price of these products in Greece. Different prices could be used for other countries]

[14] in Greece a price of 5€/liter was chosen but this could be different in other countries]

[D4] Reducing spending on luxury goods

From this type of goods, you can choose one or more products for which you are willing to reduce its/their annual consumption in order to save money for the purchase of certified olive oil (for good agricultural practices that mitigate climate change). For each product that you choose, fill in the maximum amount of money you are willing to save each year (by reducing its consumption).

Please write your answer(s) here:

Only numbers may be entered in these fields.

	Expensive clothes	___€
	Leisure travel	___€
	Jewelry	___€
	Alcoholic beverages	___€
	Electronics	___€

According to your answers, you are willing to reduce your total spending on basic consumer products by: X €/year [where X is the sum of the above table generated by the survey program]

For comparison purposes, we would like to inform you that based on your stated consumption of olive oil, you spend about: Y €/year on your olive oil. [where Y is equal to: (Answer at question [A3] x12(months) x indicative price of olive oil in each country[15]):

If you agree you may proceed to the next question, otherwise you can correct your answers.

GO TO QUESTION F1

[15] in Greece a price of 5€/liter was chosen but this could be different in other countries]

[E1] Why aren't you interested in purchasing this product?

Only answer this question if the following conditions are met: Answer was 'NO' at question [D1]

Please choose **all** that apply:

- ☐ I already consider the price of olive oil high as compared to other vegetable oils
- ☐ I cannot afford to increase my spending
- ☐ I do not consider that impacts of climate change are important
- ☐ I believe that agricultural practices have a negligible impact on mitigating climate change
- ☐ The government and/or the European Union should subsidize farmers to adopt (climate change) mitigation practices
- ☐ I believe that the money raised will not be used to finance the mitigation actions against climate change
- ☐ Other:

[F1] Gender

Please choose **only one** of the following:

- ○ Female
- ○ Male

[F2] Age

Only an integer value may be entered in this field.

Please write your answer here: ____

[F3] Postal address

- Municipality: _____
- Postal Code: _____

[F4] Education level

Please choose **only one** of the following:

- ○ Primary School
- ○ Lower secondary
- ○ Upper secondary
- ○ Tertiary (Polytechnic/College/University)
- ○ Master (MSc)/PhD level

[F5] Occupation

Please choose **only one** of the following:

- ○ Private employee
- ○ Civil servant
- ○ Self-employed
- ○ Retired
- ○ Unemployed
- ○ Homeworker
- ○ Other

[F6] Household members

- Number of household members: _____
- Number of household members over 18 years old: _____

[F7] Annual household income

Please choose **only one** of the following:

- ○ up to €5.000
- ○ €5.000 - €10.000
- ○ €10.000 - €15.000
- ○ €15.000 - €20.000
- ○ €20.000 - €25.000
- ○ €25.000 - €30.000
- ○ €30.000 - €40.000
- ○ More than €40.000

[F8] Please provide any comments you may have about this survey (e.g., length, ease of completion, suggestions for future questions, etc.):

Please write your answer here: _____

Thank you for your participation

Thank you for completing this survey.

END OF SURVEY

[G1] Reason(s) for not buying olive oil

Only answer this question if the following conditions are met: Answer was 'NO' at question [A1]

Please choose **all** that apply:

- ☐ I don't like the taste of olive oil

☐ I think it is too expensive as compared to the other vegetable oils

☐ I am an olive oil producer / I get olive oil from relatives and friends

☐ Other:

Thank you for your participation

Thank you for completing this survey.

END OF SURVEY