Climate change effect mitigation through cultivation practices in olive trees

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Abstract

Olive cultivation is considered as one of the most significant agricultural activities in Greece, from a financial, social and ecological point of view. Agriculture is widely considered as a major part of the climate problem.

The environmental friendly agricultural practices, suggested by oLIVE-CLIMA LIFE project, implemented for 5 years, to 3 different areas, in 120 olive groves and thousands of olive trees from 52 farmers, disseminated to numerous other farmers through the five workshops, organized in 2017, 4 in Northern, Central and Southern Greece, as well as 1 in Italy and through the 5 demonstration videos for farmers available in the website of the project www.oliveclima.eu.

The project LIFE 11 ENV/GR/942 oLIVE CLIMA succeeded in its target to introduce farming practices that enhance carbon sequestration and permanent storage, as part of CO_2 is removed for more than 100 years from the atmosphere. Thus, olive products may be the only food deserving carbon credits, a benefit that may be commercially useful to producers for promotion of olive oil.

The practices introduced by oLIVE CLIMA proved to be economically more sustainable than their traditional counterparts, allowing a strong anticipation for yields increase and reduction of production cost. In parallel, yield increase without additional inputs, lowers the carbon - environmental footprint of the product with regard to several environmental impact categories.

Keywords: climate change, olive, agriculture, circular economy

1. Purpose

The FAO predicts that the world's population will reach 9.1 billion people by 2050. Food production will have to increase by some 70% above today's levels to keep pace with demand. This increase in food production could be achieved by developing more land for agriculture. However, the negative impact on climate change and global bio-diversity of converting natural forests or other wild habitats is well documented. Land use changes account for some 12% of all the greenhouse gas emissions that lead to global warming. Today, there are still many farmers that don't use environmental friendly cultivation methods with effect to the Climate change.

The project oLIVE-CLIMA introduced farming practices selected so as to have two-fold objective, i.e. A) to ensure enhanced carbon dioxide (CO_2) uptake from the atmosphere and its storage in soil as Soil Organic Matter (SOM) increasing thus soil fertility. At the same time, B) to train olive growers to minimize biennial bearing, increase yields and decrease costs, mainly by a smart approach for pruning, improved waste management (e.g. instead of burning the pruned wood), and by minimizing tillage, up to zero tillage. The overall objective has been to use CO_2 as a tool for more economically viable olive crop.

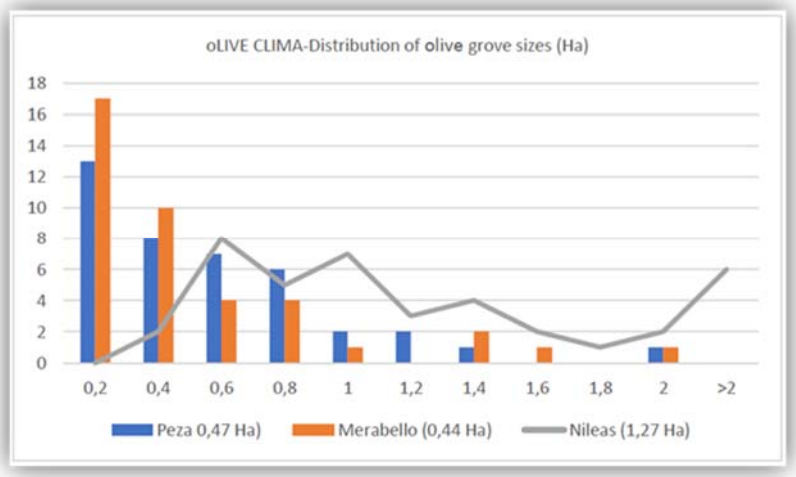
One more potential benefit for the olive growers is that by implementing oLIVE-CLIMA practices they can reliably demonstrate in a quantitative way the improvements of the product's environmental performance by using Product Environmental Footprint "PEF" to potentially promote their olive oil in the market.

2. Methods

The project LIFE 11 ENV/GR/942 oLIVE CLIMA was developed as follows, 40 olive groves in SW Peloponnese (NILEAS group of farmers), 40 in NE Crete (Merabello group) and the last 40 in central north Crete (Peza group). Olive groves differ significantly in size (Has/olive grove) between Crete and Peloponnese, as shown in the figure 1

below. This figure should not mislead with regard to farmer's property size. One family may be the owner of as many as c. 20 small sized olive groves dispersed in their area, especially in Crete.

Figure 1. Size of olive groves in the three selected areas.



The interventions consisted of the following practices, as compared to the traditional ones in each area:

1. Pruned wood shredding, instead of burning it in bonfires in the olive groves.
2. Small scale composting of organic material (leaves from the olive oil mills, potentially also oil mill waste water and pruned wood). Composting had not practiced so far, at all.
3. Introduction of a specific pruning pattern focused primarily to enhance exposure to light (photosynthesis oriented) and aeration of the foliage, and to achieve equal yearly production. The practices established before, focused mainly on the facilitation of harvesting and considered as inescapable both, the low yield/Ha and the bienniality of bearing.
4. Enrichment of the flora (new practice) on the floor of the olive groves with winter vegetation, by broadcasting a seed mix based on legumes and cereals. Before that, it was common to see olive groves with floor weed cover in winter, less than 40%. 5.
5. Zero cultivation, instead of mechanical cultivation with tine harrows or rotavators.

Pruned wood shredding and spreading was applied 204 times, adding up to 172 Ha, whilst it was also used 21 times (11 Has) on control parcels. Pruned wood was burnt 76 times (29 Ha) on control parcels, and 17 times (21 Ha) on the implementation parcels, especially in Crete in the first year of the project. At the same time primary wood was removed to be used as fuel in houses, from 22 control parcels (18 Ha) and from 69 intervention parcels (108 Ha). The lower number for the control is justified because of the habit of not pruning every year, especially in Crete. Out of the 228 times (222 Ha) that pruned wood was processed in any way, 45 times (67 Ha) it was (partially) removed from the olive grove as shredded, to be used as fuel, in a pellet sense, and 38 times (62 Ha) to be part of the compost mix. The first option (pellet type fuel) was also tested one time in a control parcel (2 Ha). The olive growers had a chance to realize the versatility of this intervention.

3. Results

Among the practices introduced, the most important seems to be pruning. It has become obvious to olive growers that oLIVE CLIMA pruning can smoothen the year-to-year alternate bearing of olive trees, a situation that exhausts the trees in the "on" years, rendering them susceptible to adverse conditions in the "off" years, with detrimental effect on yields and production cost. Sustainability of olive growing is possible, and the threat of abandonment can be deterred. Olive growers, especially the most experienced among them believe that oLIVE CLIMA pruning and other practices will help them in the long run.

Compared to wood burning, wood shredding exposes the citizens less to nasty gases created by the bonfires (mainly due to incomplete burning). When shredded wood is spread on the ground or composted, it can reduce fertilizers use by the olive grower, as 1000Kg of dry wood can replace 6.5, 9.0 and 3.0 Kg/Ha of N, P and K respectively, according to the analyses performed on shredded wood by IOTSP. At the same time, it adds 0.55T of C/Ha to enrich soil organic matter (SOM), but the environmental benefit of avoiding the extraction of 300-400 kg of heating fuel (per 1000 Kg of dry wood) is still debatable in the context of the PEFCR development, for the fear of possible double counting, as it happens sometimes with biofuels.

This has been by far the most important contribution of the project towards sustainable management of olive trees. It has to result in a well-balanced ratio between vegetation and fruit (balanced, every year, in order to eradicate biennial bearing). This means that the efficacy of olive groves can be greatly improved by pruning (combined with equally efficacious plant protection), irrespectively to some extent from factors like soil quality affecting water and nutrient

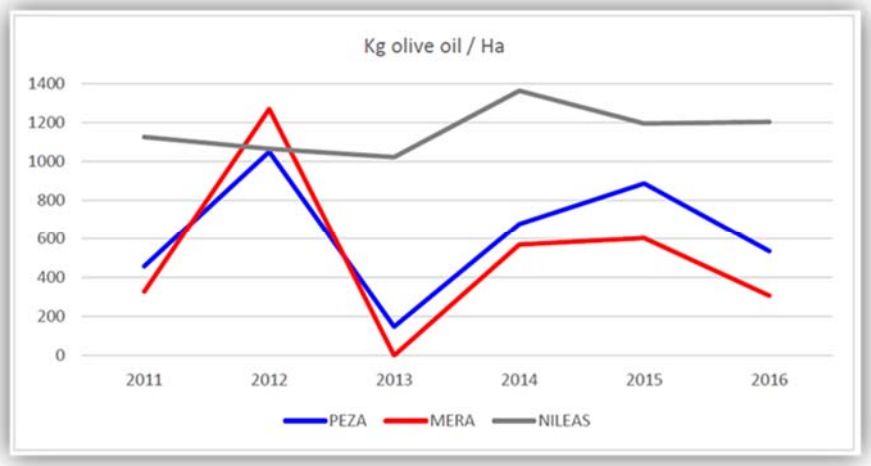
availability. Good quality pruning has to adjust for these factors, which means that an operator needs adequate understanding of environmental (soil, meteorological) conditions as well as olive tree physiology.

The pruning method proposed by the project focuses on two results, a) to increase as much as possible the soil cover with olive tree foliage, so as to increase photosynthesis and carbon dioxide assimilation, and b) to increase yield in Kg of fruit/Ha and olive oil content % of fruit (mostly affected by exposure to sun), i.e. finally the yield in Kg olive oil per hectare. Both results are products of the same process, good quality pruning.

During the initial phase of the project, serious differences were recorded between the approaches that the three farmers' groups had against pruning, as follows:

- Merabello: Occasional / empirical pruning, rarely every year, often every 3-5 years.
- Peza: Early spring pruning, mostly every year, professionally trained operators.
- Nileas: Winter pruning every year by professionally trained operators. Almost 3 out of the four olive groves in this area are additionally subject to detailed summer pruning.

Figure 2: Yield differences between locations and years



A collateral problem to increase production cost is the adverse effect of low yields on the environmental footprint of olive oil, since yield in Kg /Ha is the denominator of the entire environmental burden due to the olive grove management.

In addition to yield in olive fruit and olive oil, pruning produces also vegetative growth (wood, stem, leaves) ideally in balance with the reproductive part. So, the higher the yield in fruit / olive oil, the higher the produced wood, or else, the higher the amount of CO_2 removed from the atmosphere. Wood, in its turn can be separated in the part that will be annually removed by pruning and the wood that will become part of the permanent structure of the trees, i.e. roots and trunk. As it is well established that the trunk of olive trees expands in diameter by age, it is certain that in spite of any carbon losses due to autotrophic respiration, the bottom-line is that a large part of carbon trapped in the wood will be permanently stored in it, justifying for carbon credits for olive oil. This has been agreed in the PEFCR context, but calculation details remain to be agreed too.

The pruned wood also offers two options if shredded. To replace part of the fertilizer used and furnish carbon for SOM increase, if spread on the ground, or to replace heating fuel, if collected and sold in the market.

The project succeeded to demonstrate to farmers and their consultants working practices alternative to the traditional ones, which enhance CO_2 absorption from the atmosphere, increase carbon sequestration in biomass and carbon storage in soil and wood. The practices introduced by the project are economically sustainable and can assist local olive grower communities to reduce the olive production cost, favouring labour of both the farmers themselves as well as of the local work force, while reducing in parallel dependence and spending for material inputs at times of economic constrain.The potential benefit for the olive growers is that by implementing oLIVE-CLIMA practices they can reliably demonstrate in a quantitative way the improvements of the environmental performance by using Product Environmental Footprint «PEF» to promote their olive oil in the market. Olive oil can capitalize the effort invested by EC in developing the PEFCR for olive oil, and offer to producers Product Environmental Footprint «PEF» to aim to a better position in the market. The LIFE oLIVE CLIMA project was designed to show the potential of olive trees to mitigate climate change with a series of measures aimed at increasing the absorption of carbon from the atmosphere and the storage of a significant part of it in the soil and trunk of the olive trees. The latter is mostly important, as by exceeding 100 years of storage in the permanent structure of the trees, it counts for carbon credits, rendering olive oil as unique among food products to justify for an inherently reduced carbon footprint.Thus, olive products may be the only food deserving carbon credits, a benefit that may be commercially useful to producers for promotion of olive oil. Project partners had been active in the Product Environmental Footprint Category Rules determination for olive oil. They had been involved in the development of the 'Olive Oil Protocol by the International Olive Council' and the EU's Technical Secretariat for PEFCR [1] for Olive Oil. On 18 November 2016, the Technical Advisory Committee of the

PEF unit recognized olive trees as one of the two largest ever-living trees in European agriculture on long-term carbon storage.

4. Conclusions

The project opened some new avenues of work needed to further support sustainability of olive crop. They are presented below, by reference to the performed interventions, and according to their importance:

- Pruning: It is proposed to the authorities to incorporate into the CAP measures, specific training of olive growers for pruning, with the objective to ensure the sustainability of the crop, deterring its abandonment, for socio-environmental reasons.
- Pruned wood as lingo-fuel: An economic study would help olive growers in an area to decide if building a peletting facility would be a viable enterprise. Especially, taking in account the prospective of pruning under the regime of climate change. Second, on how is pruned wood modelled in Life Cycle Analysis terms. Could it be also used for carbon credits, i.e. as heating fuel replacement?
- Pruned wood as fertilizer: Under zero tillage, there is a question mark on the rate of wood dissipation, as compared to its incorporation within the soil by top soil fauna, especially by earthworms. A proper carbon balance has to be investigated in LCA terms, in order to compare this option for treating the shredded wood vs. using it as lignofuel.
- Carbon storage in the permanent structure of the olive trees: This parameter is utterly important for the carbon credits of olive oil, but very uncertain as well. Research would be needed for a method to provide an estimate of permanent wood mass, with limited uncertainty, in order to be suitable for robust PEF calculations.
- Risks for disease spreading by pruned wood shredding: Care should be given to avoid anything but burning, in cases that trees are under attack by Verticillium dahliae. It is important to carry out monitoring, if in doubt. This affects also the established pruned wood smashing which is established without precautions, in some areas.

5. References

[1] Product Environmental Footprint Category 2 Rules Guidance 3 Version 6.3 – May 2018, European Commission