CLIMED-FRUIT

Adaptation to climate change and mitigation for perennial crops in Mediterranean Area

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Deliverable D2.5: Simplified Cost/Benefit Assessment (CBA) for selected practices from the core OG group

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Nature of the deliverable		
R	Document, report (excluding the periodic and final reports	x
DEM	Demonstrator, pilot, prototype, plan designs,	
DEC	Websites, patents filing, press & media actions, videos, etc.	
OTHER	Software, technical diagram, etc.	
Dissemination Level		
PU	Public, fully open, e.g., web	x
SEN	Sensitive, limited under the conditions of the Grant Agreement	
CO	Confidential, restricted under conditions set our in Model Grant Agreement	
CI	Classified, information as referred to in Commission Decision 2001/844/EC	

Quality procedure				
Date of delivery	Version	Date of review	Reviewers	Comments
	V1	30/05/24		

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More information on the project can be found at project website.

Project summary

CLIMED-FRUIT aims to share knowledge ready for practice, collected from different Operational Groups (OG) across Europe, for a better adaptation to climate change and mitigation, in perennial crops in the Mediterranean Area (grape vine, olive, fruits). The project builds on the results of a core group of 9 OG coordinated by a multi-actor consortium members (advisors, farmer organisations, research and education institutes, standardisation organisation), covering several Mediterranean crops in 7 different countries (France, Spain, Portugal, Greece, Italy, Croatia, Serbia). Best practices collected and shared range from (i) soil conservation and carbon storage, (ii) improving resilience of crops facing climatic hazards (frost, hail), (iii) innovative practices for adapting water stress management, (iv) adaption of food chain processes to climate change and diversification, and (v) preserving biodiversity for a better resilience to climate change issues and pests. These groups will share their experience through a combination of innovative digital formats, cross-visits and interactive local dissemination events. In addition, new knowledge and practices will be gathered more widely by organising an open contest. Participants from other European projects, other EIP OGs or even international projects from the Mediterranean area will be invited to propose abstracts. The most applicable solutions will be selected and pitched in a broad online conference. Participants will be invited to rank the best presentations according to cost/benefit ratio, which will then be widely disseminated and shared. Social media channels, videos, podcasts, crowd writing contests will be used to spread the knowledge. Specific editorial partnerships will be established with most popular technical reviews. The network will host a forum to capitalise on existing OG experiences and aims to foster new OGs to spread and explore new practical knowledge in relation to adaptation to climate change.

Objective and executive summary

Deliverable 2.5 is the product of the activities done in task 2.4, whose text is here entirely reported:

Task 2.4. Implementing cost/benefit simplified assessment method for practical solutions from OG core group *(Task Leader: UNE, Participants: all partners): The 9 different best practical solutions selected in task 2.3. will be assessed according to the method developed in D1.6. The objective is to provide practical feedback on the advantages and drawbacks (also in economic terms) of each solution. A specific workshop will be organized in order to exchange between partners and produce the final simplified cost/benefit assessment for the 9 selected solutions, easily understandable by farmers and advisors (D2.4). As a result, the Extended Practice Abstracts will be updated with the cost/benefit assessment (Milestone 4, M20).*

Regarding the total number of cost/benefit assessment, according to task 2.3, 10 practices were selected so 10 simplified Cost/benefit analysis were conducted, based on the methodology developed in task 1.4 (see deliverable D1.6). A specific workshop was organised by IFV and UNE on 27th March 2024 to exchange between partners on the difficulties encountered and the key points to be taken into account when finalising the simplified CBAs.

Here are the main points of focus from the workshop to guide the partners in the implementation of the CBA:

- ***Global aim of the simplified CBA**: provide the essential information and all the useful links and sources so that practitioners can easily find additional information*
- ***Context:** costs can vary greatly depending on the region in question. It would be impossible and would make little sense to average costs across the whole of the Mediterranean region. Consider the costs applied in your region and specify the geographical area and context in the introduction. If you are aware of major cost discrepancies in certain areas or if certain partners have precise data on the practice in their region, this could be the subject of a note/comment.*
- ***Economical part (table):***
  - *the lines of the table with the costs in the template are flexible and can be adapted to your practice to highlight items where there are significant changes (or not, eventually if relevant) in costs between the ex-ante and ex-post situations*
  - *sometimes there are different levels of implementation of the practice, that means different costs, how to deal with that? Probably better to consider the simplest situation or at least the most cost-effective compromise, remember that two of our criteria for the practice selection were "Replicability of the solution (in terms of ease of implementation by the grower)" and "Economic cost-effectiveness in the application of the solution, considering implementation costs and associated savings or benefit". This can be discussed on a case-by-case basis of course.*
  - *Benefits: the benefits can often be difficult to calculate in cost terms. The simplest thing would probably be to add a "benefits box" below the table of costs only if you have a precise estimate/information on the subject.*
- ***Environmental part:***
  - *Remember that the CBA will be included in 3 pages extended practice abstract: do not repeat the information of part 1 or 2 but refer to it if needed (limited number of words due to translation)*
  - *use all the information/estimates you feel are legitimate, but do so transparently: cite the sources (bibliography to be included at the end of the cba)*
  - *no need for long explanations: just the main information and then refer the reader to additional useful links*

Cost-benefit analysis for the selected practices from core OG group

Extended Practice Abstract Nº 1

Simplified cost/benefit analysis

Subsurface irrigation

Introduction – presentation of ex-ante and ex-post situation

Aerial drip irrigation (DI) system (ex-ante situation) is compared with a subsurface drip irrigation (SDI) system (ex-post) in the case of a Mediterranean vineyard with a density of 4,500 vines/ha located in the South of France.

Aerial drip irrigation is the most widely used type of irrigation in winegrowing today. The main advantage of the buried version is that it uses water more efficiently, particularly by limiting losses through evaporation. However, it is a very demanding system in terms of maintenance and monitoring to ensure its durability over time. The question of the system's end-of-life remains, and recovering the equipment can prove costly. This aspect must be considered at the time of planting. A line in the middle of the row will be easier to remove/replace than a line close to the vine.

Economical impact

The main differences between aerial and subsurface drip irrigation lie in the way the system is installed: subsurface irrigation requires more stringent installation, specific more resistant equipment, and more monitoring to ensure the system lasts. On the other hand, a subsurface system is less exposed to surface damage (equipment, animals). The extra cost of installation can be offset by the savings made later: water, fertilisers and herbicides (if fertigation), labour, etc. Investment for both irrigation systems is made for around 15 years.

Legend

Estimated indicator

Measured indicator

	Ex-ante: Aerial Drip Irrigation	Ex-post: Subsurface Drip Irrigation
Variable costs		
Installation (earthworks, connections, burying…)	1000 €/ha	1400 €/ha
Equipment (drippers, valves, combs…)	2000 €/ha	2800 €/ha
Maintenance	78 €/ha/an[7]	78 €/ha/an
	The maintenance costs can be considered equivalent, because although there are fewer interventions in SDI (less damage caused by animals, equipment, etc.), they are nevertheless more expensive. For easier maintenance with SDI, it is advisable to add volumeters for more accurate monitoring of potential leaks in the system and faster repairs.	
TOTAL for lifetime of the system	4170€	5370€
COMPARISON	Global increase of 30% of the cost:	

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Environmental impact

Energy

No significant change estimated:

There is no appreciable difference in terms of energy consumption, as the pumping systems are similar between underground and overhead drip irrigation.

Water

Indicator approximate improvement of over 20%:

- Subsurface irrigation (40 cm depth) in the middle of the row generated larger volumes of wet bulb than aerial drip irrigation system. Subsurface irrigation in the inter-row did not modify the vines water status neither the yields comparing to aerial irrigation under the vine row [(1)]
- Irrigation water productivity (yield produced per unit of irrigation water use) improved by around 25% in comparison with surface drip irrigation [(2)]
- Greater water savings for SDI compared with DI (up to 20% can be achieved) [(3) (5)]

Soil

Unmeasured impact:

No measurement of soil characteristics was taken in the framework of OFIVO. However, certain references based on tomato crops, rockmelons and onions (higher water consumption) indicate an impact of long-term SDI on the chemistry and physical properties of the soil, such as changes in clay content, cation levels and on pore space around emitters [(4) (5)]

Air

Unmeasured impact:

No direct relationship between the practice and the indicator in question

Biodiversity

Indicator approximate improvement between 1 to 24%:

It has been identified recently that the proximity of SDI emitters modifies the abundance of specific bacterial and fungal genera involved in plant and soil health, providing new information for improving the management of SDI systems [(6)]. In the framework of OFIVO, it was observed that the water from the subsurface irrigation reached the ground surface by capillarity. Therefore, SDI could be a lever in dry areas to promote the establishment of plant cover in the inter-row, which is known for providing a set of sustainable services.

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Extended Practice Abstract Nº 2

Simplified cost/benefit analysis

Spontaneous plant cover on almond trees

Introduction – presentation of ex-ante and ex-post situation
Maintaining a spontaneous plant cover on almond plantations year-round has proven to be highly effective in sequestering carbon. It is a key tool for both climate change mitigation and adaptation. In this analysis, the ex-ante situation involves conventional tillage with harrowing, which is the main soil management practice among farmers in the Mediterranean region, where mechanical soil management is conducted three times per year, typically after significant rainfall events. The ex-post situation involves managing a spontaneous plant cover by cutting weeds in May, mainly using cutting implements (e.g. mowers) or very superficial tillage, and by leaving residues on the soil surface.

Economical costs and benefits

This analysis uses data from a 2020 study by Martin-Gorriza et al. (1) that examines two organic rainfed almond orchards located in the Region of Murcia, Southeastern Spain. Production costs do not include fertilizers or pesticides since none were applied (organic almonds). Variable costs include costs related to machinery (fuel and depreciation) and labour.

Legend

Estimated indicator

Measured indicator

	Ex-ante	Ex-post
Variable costs (€/ha)		
Harrowing (3 times per year)	85.01	-
Mowing	-	21.14
TOTAL	85.01	21.14
COMPARISON	Global reduction of 75% of the cost:	
Sale of almond (€/ha)	2,541.17	614.95
Economic Benefits	There is a 75% reduction in short-term revenue, resulting from a 73% yield decrease of almond kernel: 321 kg/ha (ex-ante) vs 87 kg/ha (ex-post). However, production costs are equally decreased. Long-term benefits include improved soil health, increased future productivity, and significant environment advantages that can translate into economic benefits.	

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Environmental costs and benefits

Energy	Fuel consumption decrease of 37%: 
Fuel consumption is based on the annual diesel consumption using a 73-kW tractor, which was 35 L/ha-year (ex-ante) and 22 L/ha-year (ex-post). Accordingly, ex-post strategy saved around 37% of diesel fuel. (1)	
Water	Water infiltration improvement of 45%: 
Plant cover boosts water infiltration by up to 45% compared to conventional tillage and reduces evaporation during hot periods. Without vegetation, soil is exposed to sunlight, increasing temperature and water loss, causing desiccation and soil hardening. Plant cover is an effective soil management for maintaining soil moisture, providing better rainwater infiltration, and minimizing surface water loss. (2)	
Soil	OC and N improvement of 56% and 25%, respectively: 
No direct relationship between the practice and the indicator in question	
Air	GHG decrease of 60%: 
Greenhouse gas emissions were 62 kg CO2 eq/ha (ex-ante) and 25 kg CO2 eq/ha (ex-post), which represents a 60% emission reduction with the use of spontaneous plant cover compared to conventional tillage. In both scenarios, soil management was carried out mechanically using diesel tractors and their implements. (1)	
Biodiversity	Organisms' improvement of 76%: 
Though uncommon in Spanish almond plantations, spontaneous plant covers have been shown to enhance biodiversity in crops like vineyards. These covers support natural enemies, and specifically increase the population of Hymenoptera (86%), minute pirate bugs (80%), spiders (40%), mites and thrips (100%). Additionally, cover crops positively influenced the diversity and density of pollinator insects, birds, and small mammals; and have a beneficial effect on bee populations. (6), (7)	

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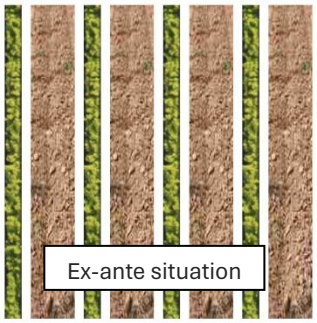
Extended Practice Abstract Nº 3

Simplified cost/benefit analysis

Green manure in mediterranean viticulture

Introduction – presentation of ex-ante and ex-post situation

For the purposes of this analysis, we have taken the case of a 15 ha Mediterranean vineyard with a density of 4,500 vines/ha located in the South of France. The ex-ante situation considered is based on inter-rows with 100% tillage. The ex-post situation considers one inter-row out of two tilled and one inter-row out of two with the implementation of a green manure sown at the end of the summer, then rolled at the beginning of spring to be used as mulch during the season. In the ex-post situation, we could also consider mowing the inter-row with the mulch before the harvest in the event of a major resurgence of weeds. Note that this ex-post strategy can be alternated every year (the tilled row becomes the sown row). In both situations, we consider natural weed cover in winter and mechanical work under the row during the season.



Economical impact

Sources of economic data: IFV Viticout calculator and "Les engrais verts en viticulture", Chambre d'Agriculture de l'Hérault

Legend
Estimated indicator
Measured indicator

	Ex-ante:	Ex-post:
Costs (including fuel, labour, inputs, depreciation)		
Tillage	200 €/ha *Tillage every row (4 passes/year, 50* €/ha/pass*)*	100 €/ha *Tillage one row in two (4 passes/year, 25* €/ha/pass*)*
Green manure seeds	0 €/ha	130 €/ha
Green manure operations	0 €/ha	Seedling one row in two (1 pass/year): 48 €/ha
		Rolling (1 pass/year): 14 €/ha
		Mowing (1 pass/year): 19 €/ha
TOTAL	200 €/ha	311 €/ha
COMPARISON	Global increase of 50% of the cost:	

Economical benefits: In the ex-post situation, less time is needed for tillage between the rows, and all the operations linked to the green manure are spread over time, which means that the daily workload can be spread out. Depending on the itinerary chosen, planting green manures can also help reduce inputs (less chemical N fertilizer). Note: under-row and inter-row tillage can be combined in the ex-ante situation, which is not necessarily the case in the ex-post situation. Also, the itinerary described in the ex-post situation should not have an impact on yield, which is why it is not taken into account in this analysis.

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Environmental impact

Energy

Indicator improvement of 25%:

Fuel consumption is higher in the ex-ante situation. If we take the case of a diesel tractor, average fuel consumption linked to inter-row management decrease from around 52 L/ha/year for the ex-ante situation to 40 L/ha/year for the ex-post situation (*source: GES&VIT, IFV tool for carbon footprint calculation*). Indicator for fuel consumption improve from 25%. On the other hand, the use of green manure in the ex-post situation enables between 10 and 20 units of nitrogen /ha/year [5] to be returned, depending on the legumes composition of the green manure. This saves on external nitrogen inputs and the associated energy costs.

Fuel Consumption	Ex-ante	Ex-post
Rotary arrow (soil labour)	13L/ha/pass all rows: total 52L	6 L/ha/pass one row in two: total 25L
Seeding	-	5L/ha
Mulching	-	6,5 L/ha
Mowing	-	3L/ha
Total	52L	40L

Water

Indicator approximate improvement between 1 to 24%:

By reduction of nitrate leaching by direct uptake of the residual N of the soil and by decreasing runoff [4], green manures allow mitigation of water pollution.

Soil

Indicator approximate improvement from 50% and up:

Impact of green manure on soil:

- Protect soil from erosion[0] and prevent soil crusting and sealing[6]
- Maintain favourable soil structure and porosity: improve water infiltration and reserve refilling[7]. Particularly interesting in areas where precipitations occur during winter over a short period of time in a series of heavy rainfall events (case of “Cévenol episodes” in some French mediterranean vineyards)
- Improve soil fertility: nitrogen supply [8] (amount of N available for associated crop depends on C/N ratio of the green manure[9]), leaching reduction
- More biomass returned compared to spontaneous soil cover, increased organic matter content in the medium to long term

Air

12% increase in emissions but offset by carbon storage:

The carbon footprint of the ex-ante and ex-post situations was calculated using the GES&VIT tool developed by IFV. In the ex-ante situation, the impact of the management of the inter-rows with 100% tillage implies a carbon footprint of 170 kg CO2eq/ha/year (including 4 passes/year). In comparison, inter-row management in the ex-post situation has a footprint of 190 kg CO2eq/ha/year (taking into account 4 passes of tillage every other row, green manure sowing, mulching and mowing every other row). Although emissions increase very slightly (+12%), the establishment of a green manure and its return to the soil increase storage, which explains why the net carbon footprint of the ex-ante situation is lower than the ex-post situation.

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Biodiversity Indicator approximate improvement between 25 to 49%:

Impact of green manure on biodiversity:

- Green manure and reduced soil perturbation provide resources that maintain higher trophic levels in soils
- Positive impact on earthworm abundance and activity (1)
- Positive impact on microbial biomass and soil biological activity (1, 2)
- Mulching could favor arthropod and micro-arthropod abundance compared with a plant cover without impacting microbial biomass (1)
- In some cases, service crops can favour inorganic N immobilization because of microorganism demand (3)

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Extended Practice Abstract № 4

Cost/benefit analysis – BLOWDEVICE

Introduction – presentation of ex-ante and post-ante situation

Table grapes grown in the south of Italy, and in Puglia region as well, belong to multiple varieties, both white and black, with or without seeds. The geographical context at stake is characterised by ideal pedo-climatic conditions to obtain a high-quality product, in particular with a high level of sugars and rich aromas, highly appreciated by national and international consumers.

Organic table grapes are a vulnerable fruit due to their perishability, especially in the south of Italy, which is prone to fungal infections. Traditional methods like sulphur dioxide (ex-ante) have drawbacks and are not allowed under organic agriculture. Alternative GRAS (Generally Recognised As Safe) treatments were explored but presented several limits of effectiveness and application. In this context, it is important to foster the use of a specific "intelligent" packaging, based on a label able to control the exchange of gasses in a bidirectional way, i.e. accumulation of carbon dioxide inside the packaging and avoiding the "fog" effect caused by the water vapor. The innovative device (ex-post situation), placed directly on the packaging, plays the role of a barrier to fruit respiration, able to improve the shelf-life of different fresh fruits after harvesting. *(Simplified CBA was conducted on organic table grapes)*

Economical costs and benefits		
	Ex-ante (total amount €/ha)	**Ex-post (total amount €/ha)**
Variable costs		
Seedings/plants	**None**	**None**
Fertilizers	**None**	**None**
Pesticides	**1000 €/ha**	**300 €/ha** *Use of blowdevice induce an earlier harvest, then less pesticides used*
Water	**None**	**None**
Labour	**2000 €/ha**	**1000 €/ha**
Machine costs	**None**	**3000 €/ha** *Machine costs refer to the machinery needed for application of the blowdevice (packaging)*
Interest on previous cost	**None**	**???**
Revenues	**25000 €/ha (as a standard)**	**30000 €/ha**
Gross margin	**22000 €/ha**	**26700 €/ha**
COMPARISON	Global reduction of 21% of the cost: 	

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Environmental costs and benefits

Energy

Indicator deterioration between 1% and 24%:

The indicator refers to fuel consumption (necessary to produce the breathable label), and gas (necessary to keep the packaging at low temperature). The unit of measurement is the amount of Kw saved.

Water

Indicator improvement between 25 and 49%:

Water saving (intended as water saved for the extended shelf life of the product) is considered as important in the practice considered with reference to the unit of measurement, i.e. litre per hectares saved of irrigation.

Soil

Indicator improvement between 25 and 49%:

As to soil, the indicator refers to soil saved form further cultivation, and the unit of measurement to hectare saved form new cultivation.

Air

Unmeasured impact:

No direct relationship between the practice and the indicator in question

Biodiversity

Unmeasured impact:

No direct relationship between the practice and the indicator in question

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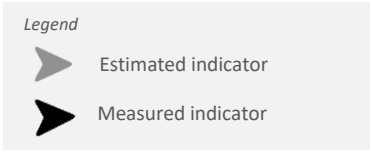
Extended Practice Abstract Nº 5

Cost/benefit analysis

Tea compost

Introduction – presentation of ex-ante and post-ante situation

In Mediterranean regions, organic farmers usually maintain soil fertility using on-farm compost (ex-ante). However, there is another possibility to obtain the same achievement using a derivate known as Compost Tea (CT) (ex-post). The use of CT has several added values:



- **Environmental:** CT production comes from on-farm by-products through an aerobic process of recovering carbon and nitrogen present in green residues or animal ones (such as manure),
- **Economic:** by-products are not waste anymore, but if reused in the farm, they are useful for a medium programming time of fertilisation, representing a good substitution for the external fertilisers,
- **Social**: in view of the implementation of circular economy strategies, the goals of sustainability can be better pursued,
- **Agronomic:** the application improves soil structure and permeability, as well as the soil microbiome.

Specifically in short term cycle crops (tomatoes, zucchini, and similar other crops), compost tea can be considered as a fertiliser, with local application concentrated in the crop lifecycle.

The analysis is conducted in the context of the south of Italy, particularly in the Puglia region. The geographical area is strongly dedicated to organic agriculture and, consequently, to the production of fruits with excellent organoleptic and nutritional characteristics. The described approach has allowed the development of sustainable technologies from an economic and environmental perspective, which satisfy the needs of producers and consumers.

Economical costs and benefits		
	Ex-ante (total amount €/ha)	**Ex-post (total amount €/ha)**
Variable costs		
Seedings/plants	**500 €/Ha**	**500 €/ha**
Fertilizers	**2000 €/Ha** *Buying market fertilizer*	**1000 €/ha** *Production of compost tea*
Pesticides	**1000 €/ha**	**1000 €/ha**
Water	**1000 €/ha**	**700 €/ha**
Labour	**1000 €/ha**	**1500 €/ha** *Brewing machine*
Machine costs	**1000 €/ha**	**1000 €/ha**
Revenues	**None**	**1000 €/ha** *as saved cost of fertilisers*
TOTAL	**6500 €/ha**	**5700 €/ha**
COMPARISON	Global decrease of 12% of the cost: 	

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Environnemental costs and benefits

Energy Indicator approximate deterioration between 1 and 24%:

The indicator used is relative to fuel (intended as fuel amount necessary to produce CT) and, in particular, to gasoline as unit of measurement (0,5L of Gasoline to produce 10 kg of compost tea).

Water Indicator approximate improvement around 10%:

The use of CT proves to increase soil permeability thus fostering water savings (intended as water saved from further irrigation turns : around 10%).

Soil Indicator approximate improvement from 75% and up:

Soil quality (increase/maintenance of soil permeability and porosity) proves to be consistently increased, together with the unit of measurement, i.e. level of nutrients in soil analysis.

Air Unmeasured impact:

No direct relationship between the practice and the indicator in question

Biodiversity Indicator approximate deterioration between 1 and 24%:

Biodiversity (intended as the reuse of farm by-products as fertilisers) is slightly decreased.

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Extended Practice Abstract Nº 6

Simplified cost/benefit analysis

Irrigation 4.0 in the Vineyard

Introduction – presentation of ex-ante and ex-post situation

The practice aims to optimize the management of the multiple summer stresses while maintain the set production and quality standards even in the most difficult years, optimising the use of water, through precision irrigation.
Ex-ante is a standard drip irrigation system.
Ex-post is a precision drip irrigation system, where vineyard portions with different vigor are subjected to different weather-dependent watering regimes.

Economical costs and benefits

The practice by better managing the summers stresses aims to increasing the competitiveness of wineries. Moreover, water is a limited resource in the considered area of Northern Italy (Franciacorta) where the irrigation system was tested, as well as in many viticulture regions.

Legend
Estimated indicator
Measured indicator

	Ex-ante	Ex-post
Variable costs		
Input		
Water	**100%**	**85%**
Installation (material + labour) Services	Standard Drip Irrigation System*:* **100 %**	*Standard Drip Irrigation System* *Pitch Dripper used to modulate the water income.* *Mapping of the conductivity and hydric needs of the vineyard: cost / ha* *Decision-support system* Total costs (installation + services): **115%**
Other equipment	-	*Meteorological station:* **2000€**
Benefits	**-**	**-**
Yield in the low vigor area	**100%**	**119%**
Acidity in the low vigor area	**100%**	**124%**
COMPARISON	*The 15% increase of initial costs is balanced by the increase of yearly yield and grape quality obtained in the low vigour area receiving the exact amount of water needed, and by the reduction of variable cost for water consumption.*	

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Environmental costs and benefits

Energy

No significant change estimated:

There is no appreciable difference in terms of energy consumption.

Water

Indicator improved by 15%:

In the experimental vineyard in Franciacorta, water consumption per hectare was reduced by 15% with the precision irrigation system vs the standard irrigation system (from 722 to 600 m^3/ha in 2022, from 300 to 250 m^3/ha in 2021).

Soil

Unmeasured impact:

No direct relationship between the practice and the indicator in question

Air

Unmeasured impact:

No direct relationship between the practice and the indicator in question

Biodiversity

Unmeasured impact:

No direct relationship between the practice and the indicator in question

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Extended Practice Abstract Nº 7

Simplified cost/benefit analysis

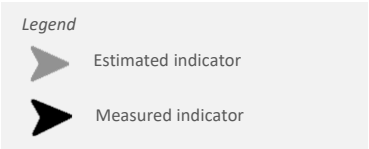
LATE WINTER PRUNING to prevent spring frost damage and maintain the freshness of the grapes/delay ripening.

Introduction – presentation of ex-ante and ex-post situation

As a consequence of climate change, late spring frost events are increasing in frequency and in locations, with up to 100% damage in the affected lots. Moreover, the high summer temperatures decouple the maturity trends leading to grapes with unbalanced low acidity. The proposed practice delays the time of susceptibility to frost and delays ripening to maintain the freshness thus having a potential negative effect on overall wine quality/typicity.
Ex-ante is a standard winter pruning practice.
Ex-post is a late winter pruning practice that is performed when the apical shoots have reached the "2 unfolded leaves" phenological stage (in Italian climate, indicatively late March - early April).

Economical costs and benefits

When the practice is applied with a pre-pruning in January-February, and a second finishing step at "2 unfolded leaves", it entails a slightly increase the hours of workforce (+15%), although it does not require extra machine operation.
On the other hand, the practice reduces the risk of harvest losses due to late spring frosts that cause turnover reduction in the following year, commercial problems with clients, and lower productivity of the damaged grapevine plants in the following years.



	Ex-ante	Ex-post
Variable costs		
Labour (excluding installation)	Labour for pruning 100%	Labour for pre-pruning + pruning 115%
Machine costs (fuel + depreciation)	-	-
COMPARISON	*The slight increase of labour costs is abundantly balanced by the lower incidence of late spring frost damages. The overall economical comparison is in favour of the late pruning practice*: 	

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Environnemental costs and benefits

Energy No significant change:

No variation on mechanical operation.

Water Unmeasured impact:

No direct relationship between the practice and the indicator in question

Soil Unmeasured impact:

No direct relationship between the practice and the indicator in question

Air Unmeasured impact:

No direct relationship between the practice and the indicator in question

Biodiversity Unmeasured impact:

No direct relationship between the practice and the indicator in question

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Extended Practice Abstract Nº 8

Simplified cost/benefit analysis

The sustainability of avocado crop in Europe

Introduction – presentation of ex-ante and ex-post situation

The consumption of avocado in Europe, as it is considered a superfood, has increased drastically in recent years, with the majority of these fruits coming from South America, with the consequent impact of CO2 on the atmosphere through its transportation.

Likewise, the general increase in temperatures in some European regions has made these areas suitable for growing avocados, which is why new plantations of this fruit have been started in recent decades. At the same time, the scarcity of water resources in some areas shows the need to optimize water management in this area.

The ex-ante situation of the study considers an avocado plantation in which the new knowledge and agronomic techniques on the crop are not applied and the ex-post situation contemplates the implementation of the knowledge studied during the OG Avocado project, in terms of increase productivity and reduction of water use, among others.

Economical costs and benefits

The data refers to the area of Valencia, a province located in the Mediterranean region of Spain.

Legend

Estimated indicator

Measured indicator

	Ex-ante	Ex-post
Variable costs		
Input		
Fertilizers	952,20	952,20
Phytosanitary products	516,60	516,60
Water	2.683,53	1.736,40
Labour (excluding installation)	1.392,96	1.392,96
Machine costs (fuel + depreciation)	320,64	320,64
TOTAL	**5.865,93 €**	**4.918,80 €**
COMPARISON	Global reduction of 16% of the cost: 	

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Environmental costs and benefits

Energy

Indicator improvement of 35%:

The energy used to obtain irrigation water has been measured, which is reduced as a result of the optimization of the latter. In addition to this improvement, with the implementation of the agronomic techniques studied, an improvement in the productivity of the crop is achieved, therefore, the energy consumed for each kilo of avocado produced is also reduced, and not only the global energy at the plot level.

Water

Indicator improvement of 35%:

The amount of irrigation water used in the ex-ante and ex-post situation has been measured, which is reduced in response to an increase in water efficiency: a smaller amount of water is used, since it is added more times, avoiding percolation.
In addition to this improvement, an improvement in crop productivity is achieved, also reducing the water used for each kilo of avocado produced.

Soil

No change:

No specific measurements were taken during the project for this indicator, but it is not supposed to be impacted.

Air

No change:

Although the soil and air parameters are not directly affected by the implementation of the practice, due to the increase in productivity in the field, consuming the same resources we achieve a greater quantity of avocados. Therefore, with this increase in productivity, the use of phytosanitary products is reduced with the consequent carbon footprint of their production and transportation, the use of agricultural machinery, among others.

Biodiversity

No change:

No specific measurements were taken during the project for this indicator, but it is not supposed to be impacted.

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Extended Practice Abstract Nº 9

Simplified cost/benefit analysis

Rice straw mulching to increase water efficiency in citrus production

Introduction – presentation of ex-ante and ex-post situation

Climate change, through the drastic decrease in precipitation in some regions of the Mediterranean, causes a decrease in water contributions, as well as the availability of water, and an increase in dependence on irrigation systems. This is more evident in the case of irrigated crops such as citrus.

Therefore, it is necessary to continue researching new systems and solutions that allow optimal management of water resources in agriculture, such as mulching, in the case of this practice, with rice straw, a waste that is difficult to manage. that is currently burned in the study area, with the consequent impact on CO2 emissions into the atmosphere.

The ex-ante situation considered for this analysis involves a citrus farm with the usual fertigation system, and without vegetation cover, being the most frequent situation in the study region. The ex-post situation considers the implementation of mulching with rice straw.

The calculations have been made for a typical plot of 1 hectare.

Economical costs and benefits

The data refers to the area of Valencia, a province located in the Mediterranean region of Spain. As for the rice straw implemented as mulching, it comes from the Albufera Natural Park in Valencia. Due to the above characteristics, in the case of Valencia, rice straw is free for interested parties, while this situation may not occur in the case of other European regions or in the case of straw from other crops.

	Ex-ante	Ex-post
Variable costs		
Input		
Fertilizers	828,00 €	745,20 €
Phytosanitary products (mainly herbicides)	1.033,20 €	929,88 €
Water	1.736,40 €	1.389,12 €
Installation (material + labour)	-	850,58 €
Labour (excluding installation)	1.741,20 €	1.392,96 €
Machine costs (fuel + depreciation)	400,80 €	380,76 €
TOTAL	**5.739,60 €**	**5.688,50 €**
COMPARISON	Global reduction of 0,90% of the cost: 	

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Environmental costs and benefits

Energy

Indicator improvement of 20%:

In order to obtain this indicator, the energy used has been measured both for the extraction of irrigation water and the energy related to the machinery used, with savings recorded in the latter through savings in herbicide treatments. Likewise, the transportation and installation of the mulch on the plot has been considered in the ex-post analysis.

Water

Indicator improvement of 20%:

In this case, the amount of water used to irrigate the plot has been measured in the ex-ante and ex-post situation. This data has been obtained through measurements made with the capacitance probes installed in the pilot plots, in parallel with other technologies such as drone flights and the interpretation of satellite information.

Soil

Indicator improvement of 15%:

It is widely known that the application of mulching on plots, in addition to water savings that responds to the decrease in evapotranspiration, improves the structure and fertility of the soil thanks to the decomposition of organic matter.
To obtain this indicator, the data collected in the referenced bibliography has been taken into account, in addition to consulting the soil department of the Polytechnic University of Valencia, which has previously studied these values. [(1), (2), (3)]

Air

No change (but a positive impact can be considered):

Although this indicator remains neutral at the plot level, by applying rice straw mulching on one hectare of citrus, the burning of between 75,000 and 90,000 tons of rice straw is avoided. Studies carried out to date do not reflect improvements in air quality with the alternative use of rice straw. [(4)]

Biodiversity

Indicator improvement of 15%:

In the same way as the analysis carried out for the parameter related to the soil, it is known that mulching increases biodiversity, fundamentally that related to the soil (microorganisms and worms).
The estimate has been obtained based on existing bibliography. [(5)]

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Extended Practice Abstract Nº 10

Simplified cost/benefit analysis

Cover management in raifed olive groves

Introduction – presentation of ex-ante and ex-post situation

The resilience of olive groves in the current climate change context demands immediate action from farmers. The ex-ante widespread adoption of traditional soil management practices, such as tillage for weed control, leaves an unprotected and bare soil during rainfall, wind and heat waves. In the Portuguese northeast region, there has been severe weather changes from softer winters to extreme heat waves during the summer causing a biological change in the olive trees cycle and consequent loss of productivity. It is a common practice to till 2-3 time a year leading to the worsening of the effects, on soil health (erosion, water holding capacity and biodiversity), of extreme weather conditions. A need for a change in the farmers' mindset is urgent. The ex-post situation (natural cover in row/inter-row, seeded inter-row, refers to a change in the cover management practice leading to a change in the soil's nutrition and thus a change in the fertilizer cost.

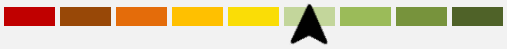
Economical costs and benefits

The values presented in the column ex-post refer to installation of the practice. The investment in seeds may not occur if the choice is spontaneous vegetation or, occur once at the year of installation. Costs tend to reduce in a long-term period and refer to machine and man work. The comparison in the last line of the table, is estimated after the first couple of year.

Legend

Estimated indicator

Measured indicator

	Ex-ante (€/ha)	Ex-post (€/ha)
Variable costs		
Inputs:		
Seeding/seeds	--	150
Fertilizers	150	100
Machine costs (fuel+depreciation+Manwork)	140	140
TOTAL	290	390
COMPARISON	Global improvement between 1 to 24% of the cost (explanations below): 	
Economical benefits: It will be more evident after the first couple of years. The need for nitrogen rich fertilizers will be lower. As for soil interventions, there is no change in the ex-ante and ex-post situation because the tilling hours will be mowing hours. In a long term period the mulching efect of the grass (spontaneous cover) might diminish the mowing hours. If herding the cover is an option, the mowing cost is eliminated.		

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Environmental costs and benefits

Energy	Indicator approximate improvement of 15%: 
The indicator is estimated in a long-term period of time (3-4 years) and based on empirical knowledge of fuel consumption as after 3-4 years, the need for cover interventions will be less.	
Water	Indicator improvement of 50%: 
The type of crops considered is rainfed. A 50% improvement of soil moisture during the summer has been reported by Carlos M. Correia *et al* (1) at 10-20 cm depth.	
Soil	Indicator improvement of 15%: 
The indicator is estimated based on improvement in soil properties measured by Carlos M. Correa *et al* (1) at 10-20 cm depth.	
Air	Indicator approximate improvement of 15%: 
The indicator is estimated based on empirical knowledge. The presence of vegetation favours carbon sequestration and consequently increases air quality.	
Biodiversity	Indicator approximate improvement of 45% 
The indicator is estimated based on empirical knowledge of auxiliary fauna and flora preservation. A study by José Alberto Pereira *et al* (2) refers the benefits of biodiversity in spontaneous ground covers.	

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