FIRE-RES

Innovative technologies & socio-ecological-economic solutions for fire resilient territories in Europe

D3.2 IA 3.1 brief: Development and demonstration of a "fire wine" label

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Abstract: To mitigate wildfire risk, fire-smart landscapes present a promising strategy, integrating fuel discontinuities through a mosaic of agricultural and forested areas. The role of those farmers has been mostly neglected so far. Moreover, farmland managers' perceptions on wildfire risks, their agricultural practices that mitigate the risk, and their factors affecting their expansion of abandonment of parcels were underexplored.

This Innovation Action has investigated how the bioeconomy in rural areas can contribute to mitigate wildfire risk, this is, which practices can be applied to maintain fuel discontinuities, which are the particularities of each territory in terms of fire regimes and farmland activities, and the behavioural and interest patterns of farmers. The focus was on the wine sector but can be mostly extended to other agrarian productions. To this end, anthropological approach has been applied to field visits and in-depth interviews with local experts in LL Catalonia, LL Galicia, LL Aquitaine, LL Portugal and other Spanish, Italian, and French regions. A survey was additionally launched, which resulted in a scientific article published on its findings.

Based on that pool of knowledge, the requirements for a brand that acknowledges the wildfire risk mitigation ecosystem service were developed, after expert consultation. The first contract for the usage of the label was achieved, with several requests under analysis by the publication of this deliverable. Strong efforts have been done in dissemination and local meetings to establish sound relationships with farmers and their associations.

Keywords: agriculture, wine, landscape, brand, fire risk mitigation

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0.Acronyms

AECM: Agri-Environmental and Climate Measures

AOC & AOP: French designation of controlled origin

CAP: Common Agricultural Policy

ADF: Association of Forest Defense (Spain)

CALG: Compagnie d'Aménagement des Landes de Gascogne (Entity of land management of the South West of France in the 1950's – disappeared)

CERPAM: Centre d'Etudes et de Réalisations Pastorales Alpes Méditerranée (Main service dedicated to pastoralism in Provence Region, France)

CTFC: Forest Science and Technology Center of Catalonia (Spain)

DDAF: Direction Départementale de l'Agriculture et de la Forêt (French administration for Agriculture and Forestry – 'Département' delegation)

DDTM: Direction Départementale des Territoires et de la Mer (French administration for Land and Sea Territories – 'Département' delegation)

DFCI: Forestry Defense against Wildfire (France)

DOQ Qualified Designation of Origin

EU: European Union

EC: European Commission

ES: Ecosystem Services

FAO Food and Agriculture Foundation

Ha: hectares

IGP: French indication of geographical protection

IPLA Istituto per le Piante da Legno e l'Ambiente (Institute of Environment and Forestry, Italy)

IRTA: Research and Technology Institute of Agriculture (Catalonia, Spain)

MAEC: Mesures AgroEnvironnementales – funded agriculture and environment measures

MVMC: Monte Veciñal en Man Común, collective ownership in galician mountains, Spain

OIV: international organization of Wine and Vine

OLD: Obligations Légales de Débroussaillement (French Legal Brush Clearing Requirements)

ONF: National Office of Forests (France)

OUV: Outstanding Universal Value (UNESCO heritage)

PACA: Provence Alpes Côtes d'Azur (Administrative Region of Provence in France)

PDO: Protected Designation of Origin

PFIT Forest Territorial Plan (Italy)

PNR: Regional Natural Park (France)

PN: Natural Park

PPR: Regional Landscape Plan (Italy)

SAS: Simplified joint-stock Company (France)

SCOT: Territorial Coherence Scheme (France).

SDIS: Fire and Rescue Service – 'Département' delegation

UNESCO: United Nation Educational Scientific and Cultural Organization

USA: United States of America

1. Introduction

This Innovation Action aims at operationalising the concept of fire-smart landscapes (Leone et al. 2020; Ascoli et al. 2023; Pulido et al. 2023) through and indirect, bioeconomy pathway to increase landscape resilience to wildfires -following the conceptualisation by Wunder et al. (2021). We developed inter-sectoral bioeconomic linkages for wildfire risk mitigation, insofar as the agricultural sector, and related to it the agrotourism sector, could implement measures that align with a holistic strategy at a larger landscape-scale level.

The agriculture actors (farmers or landowners, but also shepherds or stockbreeders), however, may not have intrinsic incentives to implement effective fire-reduction measures -due to unawareness of the risk or mitigation practices, insufficient budget, detachment from the primary sector, or alternative priorities. Yet, there is a great potential for risk mitigation strategies, whose maintenance has been typically overlooked by risk management bodies as taking for granted the biomass discontinuity in those parcels. Current active farmers in the agriculture-forest interface provide a highly relevant risk mitigation ecosystem service. Nevertheless, there is an increasing trend on farmland abandonment, whose encroachment creates more homogeneous and high fuel-loaded territories. By contrasting wildfire risk maps (Figure 1) with areas where land abandonment is more acute (Figure 2), we find important correlations, particularly in Mediterranean Europe. For wildfire risk management it is therefore crucial that current farmlands are maintained actively managed. Besides, some strategic zones for fire spread modulation could be more efficiently maintained through the so-called productive firebreaks (Bertomeu et al. 2022) (or "fuelbreaks" (Ascoli et al. 2018)), this is, through agricultural of grazing use of the open, low fuel areas.

Figure 1 - Map of prevalence of high forest fire risk in Europe, as composite index. Source: EFFIS (2025).

Figure 2 – Shares of agricultural land abandonment with regard to the total agricultural land aggregated at NUTS3 level in 2030. Source: Perpiña Castillo et al. (2021)

While farmland abandonment responds to multidimensional factors, economic incentives and differentiation mechanisms offer opportunities for encouraging those farmers with monetary and/or social recognition motives. In this frame, product labels represent a signalling Market-based Instrument to boost consumers' financial involvement in wildfire-mitigation land management (Fraccaroli et al. in review; Wunder et al. 2023).

This Innovation Action (IA3.1) therefore investigated the state of the art in terms of relation between farmers -particularly winemakers- and the wildfire risk in the agriculture-forest interface. We have analysed their contextual and productive factors, degree of awareness on wildfire risk and knowledge about mitigation measures. This information, jointly with expert consultation has allowed the development of a set of requirements for ensuring that farmlands contribute to wildfire risk mitigation. This entails a first approach to a potential "prescribed farming".

To recognise the farmers that follow these requirements, two labels were registered at the EU level: Fire Wine Resilient landscape © and Fire Product Resilient Landscape ©. A procedure for engaging in the use of this trademark was developed, and the initial steps in their implementation have been given within the FIRE-RES project.

In the following chapters, the entire process has been reported. The fieldwork comprised mainly the FIRE-RES LL in Catalonia (Spain) due to proximity of the responsible partner, but it was complemented with fieldwork in other LL (Aquitaine, Galicia, Portugal) and other European regions (Piedmont, Provence). While CTFC has taken the responsibility of

this development, it is necessary to acknowledge the key contributions of other FIRE-RES partners, such as BOMBERS (conceptually), XUNTA (Galicia), ISA (Portugal), INRAE and IEFC (France) and TIEMS (Piedmont). Interaction with INESCTEC has allowed improving the brand business model development. Moreover, the FIRE-RES Advisory Board has been crucial to envision the territorial potential of the brand beyond the EU.

This Innovation Action during the FIRE-RES project has focused on the provision side of the wildfire risk mitigation ecosystem service. Strong efforts have been done to rise awareness on the initiative among producers, particularly within the winemaking value chain, and within LL Catalonia. Yet, for upscaling the potential the international perspective has been also worked, both within the wildfire risk practice and academic community, the Mediterranean forestry sector, and the wine sector.

We thus invite the reader to navigate the process along the next sections.

2. State of the Art: vineyards, farmlands and wildfires

2.1 What is particular of wine production with regard to wildfire risk management?

Our research focused on wine productive areas, although scientific works dedicated to fire-smart landscapes and territories do not usually distinguish any specificity of wine production compared to other farming. Nevertheless, there are declarations, comments and analysis shared in public media and some politic debates which lead us to think that vineyard had a particular role in the management of the rural and suburban territories concerned by wildfire risk.

Wine production is important for Europe: it represents a strong economy within the agricultural sector, and it covers large areas in temperate regions, but particularly in the Mediterranean (Figure 3) where fire risk is high (Figure 4).

Figure 3 - Areas under vines, by NUTS 2 regions (% of total utilised agricultural area, 2020). This map has evident overlaps with European land abandonment and forest fire hazard maps that shows how strategic seems to be wine production. Source: EUROSTAT (2022).

Figure 4 - Share of EU area under vines (%, 2020). Source: EUROSTAT (2022).

Moreover, wine production is often the last economic dynamic that permits social and rural life to be maintained. Then, wine producers and wine growers have a central role in landscape management. The report of Price Waterhouse Coopers (2024) highlights this social contribution: "*Rural regions with expanding vineyards have nearly maintained their population, experiencing only a slight decrease of 0.4%. In contrast, areas with shrinking vineyards have seen a significantly higher decline in their population growth rate, which is 6.5 times greater at -2.6*". In this historical period when Western Europe is experiencing increasing land abandonment, viticulture can thus be understood a tool for land use planning.

Price Waterhouse Coopers (2024) report remarks the low inflammability of the vineyard: "*In some wine-producing regions, vineyards can serve as firebreaks or barriers, helping to protect against wildfires. The bare ground between vine rows can create a firebreak, preventing the rapid spread of wildfires. Some vineyard managers may also engage in controlled burning or other fire prevention practices to reduce the risk of fires spreading in the area".* Low flammability of crops has been tested by Pagadala et al. (2024), which reminds that farmland also burns and accounts for 8–11 % of the total number of fires that occur globally. Vineyards can be irrigated, which increases its capacity of wildfire risk mitigation, but the situation regarding access to water varies greatly from one region to another. Anyway, one main advantage of vineyards considering the fire risk is the permanence of the plantation over time, as we still can find crops that were planted one hundred years ago. This characteristic designs a more stable landscape that facilitates the planification of fire risk management. That is why the abandonment of these fields is such an important topic.

The main countries producing wine in the world are Italy, France and Spain. In 2024, Italy produced 44.1 million of hectoliters (hl) in 728,000 ha while France produced 37 million hl in 783,000ha and Spain 31 million hl in 930,000 ha of land (data of OIV). It represents hundreds of thousands of jobs in each country. Portugal is a smaller country (10th of the world in terms of surface of vineyard) but its production is socially linked to its history and heritage. Still, many surfaces of vineyards are not registered officially but are present

in the landscape as small familiar production in self-sufficiency or out of Protected Denomination of Origin (PDO) registration. This occurs, for example, in the hinterland of Galicia or in Portugal In PDO Ribeira Sacra, there are about 2,000ha inscribed but some estimations report about 8,000 ha of planted vineyard in their territory[1].

The wine trade dates back to the Mesolithic period and is closely linked to societal and historical developments. Following the *Phylloxera* crisis of the late 19th century, during which a large proportion of Europe's vineyards were uprooted, the production of wine became concentrated in regions that still able to produce it. This led to pioneering approaches to traceability and transparency in production. It encouraged the structuring of the professional sector and the formation of territories of PDO. Meanwhile, economic crises in the late 19th and early 20th centuries prompted winegrowers in certain regions to form cooperatives in order to counterbalance the power of merchants. Nowadays wine cooperatives are more prevalent in wine-producing regions with small estates and low selling prices (Garrido Herrero 2022). In France, for example, cooperative wineries account for more than half of production. In the early 1990s, there were more than a thousand of such cooperatives in France. Cooperatives are particularly widespread in the southern French regions. In Italy (1,000), Spain (1,000) and Portugal (300), cooperatives also account for a significant share of production, with at least 50%.

However, Spain and Portugal, southern France and southern Italy are regularly suffering from wildfires. These four countries are represented in FIRE-RES, hosting Living Labs, reason for having decided to compare their approaches to agriculture and wildfire risk management, but also to understand the different positions and contexts linked to the landscape, historical and socio-economic realities of each territory. The strong development of the wine sector over centuries guarantees an abundance of available examples and the future capacity of the Fire Wine brand to grow.

Figure 5 - Photo of Nappa Valley, 2017, Los Angeles Times

[1] https://www.elprogreso.es/articulo/ribeira-sacra/viticultores-dedicados-autoconsumo-deben-llevar-carne-fitosanitarios/20200330142227143086 5.html

These last years, media (both through online articles and in newspapers), worldwide, have commented on the resistance of the vineyards to wildfire, using photographs taken form the air that show an impressive contrast between the green of the fields and the black of the burned forest. For example, in Los Angeles Times in 2017, where the journalist declared that "*vineyard may have kept wine country fire for getting worse*"[2].

The role of vineyards has been also highlighted in sister projects, such as ResAlliance with regard to a Cyprus case (Ghosn and Ilektra Remoundou 2024), as a good practice and a natural solution to manage fire risk.

Figure 6 - Vineyards intact five days after the Paphos Fire (2024). Source: Haris Nicolaou © Educational use, non-commercial.

Globally, the region of the southwest of France accrues most articles of local, national and professional newspapers published on this thematic. After the fire of 2019, L'Independant[3], a local newspaper, highlighted the positive role of the vineyard, which was used as "support and fallback areas for firefighters".

Figure 7 - "Healthy vineyard is protective". Source: L'Indépendant, 2019- Michel Clementz

[2] https://www.latimes.com/business/la-fi-vineyards-firebreak-20171012-story.html
[3] https://www.lindependant.fr/2019/09/28/p-o-quand-les-vignes-jouent-le-role-de-coupe-feu-zones-dappui-et-de-repli-pour-les-pompiers,8445049.php

Then a local debate emerged[4], questioning the future effectiveness of vineyards as valid tool tackling fire spread because of the growing weeds in the vineyard, as e.g. in PDO Costières de Nîmes. About 10% of the vineyard worldwide is organic, and politicies in favour of sustainability and biodiversity encourage to maintain vegetation in the borders and in the interlines of the plantations -see e.g. the agroenvironmental measures of the Common Agriculture Policy. In parallel, in 2021, the need of watering the vineyard to be fire-effective[5] appeared to be a condition to maintain it, a reality that has been confirmed during the drought 2022-2024 that suffered part of the southwestern Europe.

Additionally, winemakers are concerned about the risk of the wildfire for the vineyard itself. In Australia, USA, Spain, Portugal and France, more vineyards are getting hardly burned as the wildfires are become stronger. For the French *Départements* of Aude and Pyrénées Orientales this concern was echoed by several media, such as *L'Independant* (18/04/2023)[6], La Tribune (10/07/2025)[7], or on *La Dépêche* (23/08/2023)[8]: "*Vineyards can prevent the spread of fire. This unique property of vines means they act as a natural barrier, having already slowed down several fires in the region. Winegrowers, firefighters, and politicians are therefore calling more than ever for the preservation of vineyards, as they are an irreplaceable part of the landscape and environment.*"

Figure 8 – Corbières' vineyard after the fire of July 2021. Source: L'Indépendant 18/07/2021

[4] https://www.vitisphere.com/actualite-90892-le-desherbage-des-vignobles-facilite-t-il-les-incendies-.html
[5] https://www.pleinchamp.com/actualite/la-vigne-un-pare-feu-qui-reclame-aussi-sa-part-d-eau
[6] https://www.lindependant.fr/2023/04/18/incendie-de-cerbere-la-vigne-a-fait-son-oeuvre-de-coupe-feu-mais-jusqua-quand-11142519.php
[7] https://objectif-languedoc-roussillon.latribune.fr/entreprises/agroalimentaire/2025-07-10/aude-les-incendies-vont-obliger-a-repenser-les-paysages-agricoles-1029348.html
[8] https://www.ladepeche.fr/2023/08/23/vignes-et-vignerons-en-rempart-contre-les-incendies-11409986.php

The debate became official with the growing number of political voices calling for the recognition of firebreak vineyards and, to a lesser extent, olive groves, particularly within the French Senate, as in 2022[9].

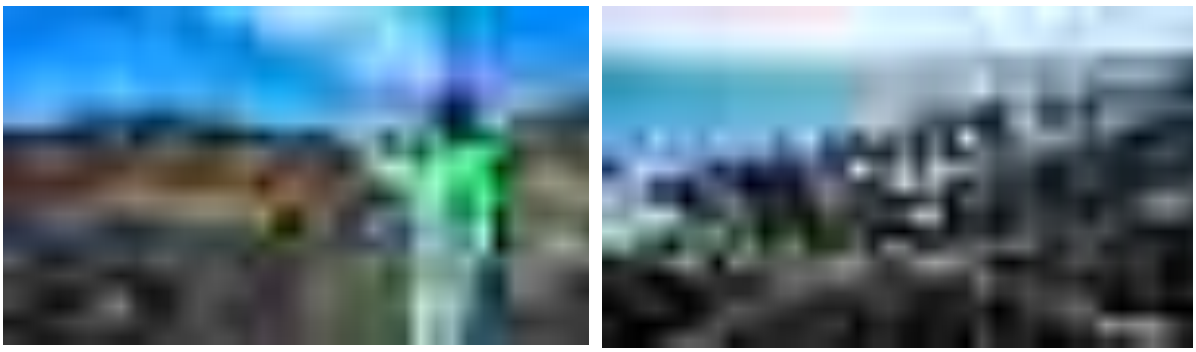

Figure 9 – Left: R. Peronne, president of PDO Collioure Banyuls. Right: Cerbère, WUI of vineyards, in the border of Spain and France. Source: M. Clementz, Vitisphere, August 2022. The pictures focus on vineyards planted as firebreak in the 1990's.

Last summer 2025 has been particularly hard in Spain, Portugal, and southern France. The wildfires spread in L'Aude wine areas just before the harvest, causing damages to the grape production. This losses raise questions about the resilience of vineyards to wildfire, which also shows the change in forest fire regimes, which are becoming more violent.

In the period of 1988-1995 financial support and planning from the French administration permitted to create firebreaks in the south of France, inviting grape growers and shepherd to collaborate. This financial support was a reaction to the concatenation of wildfires in 1985-1986. It worked well in the PDO of Banyuls Collioure, as the vineyard was in the process of renewal. From 1995 the only financial support has been the MAEC (Agri-environment-climate measures from CAP) in part of the areas. Consequently, a few "firebreak" vineyards disappeared.

Figure 10 - Vineyard of Chateau La Baronne, in PDO Corbières after the wildfire of July 2021.

[9] https://www.vitisphere.com/actualite-97337-des-senateurs-veulent-elargir-les-aides-coupures-de-combustible-aux-vignes-jouant-les-pares-feux-.html

The fragility of that system, which proved its value and effectiveness, as it can be derived from the local newspaper references after the several fires this touristic area suffered. Nevertheless, criticism was also voiced, and this feedback has helped Fire Wine design. This past experience in Occitanie meant that this region is a priority region to be visited during the FIRE-RES project, even though this was not part of the project Living Labs.

In 2013, a new project highlighted the use of vines as firebreaks, in Narbonne. The cooperative winery did agree with the city hall to cultivate 18 ha in PDO La Clape, creating the entity "SAS Alta Vinha" to manage the wildfire risk. This area is included in the PNR La Narbonnaise and is close to Narbonne beaches. It is a mosaic landscape that corresponds to the FireWine principles (section 3.3) that demonstrated too the capacity of wine structures to participate actively to fire risk prevention. Some vineyards in the surrounds of Narbonne had already participated to the previous works in 1990's.

Figure 11 - New vineyard planted in 1992 as "fire break" near Narbonne. Source: Challot (1993).

2.2. Methodology

To determine the state of the art of the wine sector with regard to the wildfire risk, and the farmland practices that would mitigate wildfire risk, we adopted a four data collection streams, as follows:

1) Review of secondary sources, related to i) wildfire risk management in different wine producing regions, ii) economic incentives and similar labelling initiatives, and iii) policy initiatives. This has been reported mainly in 2.1.

2) An ethnographic approach through field visits to producers, processors, and other territorial management experts. This entailed a qualitative, in-depth data collection.

3) A survey to gather quantitative data on variables that emerged as relevant during the qualitative phase.

4) Several bilateral meetings and workshops with wildfire risk management experts and winemakers, targeting mainly the construction of the requirements.

The details are developed in the following sections.

2.2.1 Field visits

From 2021 to 2024 we made field visits in four countries. We selected territories that are famous for their wine and that have suffered fires or that are closed to an existing risk, and eventually where FIRE-RES was already developing activities (because there is a partner or Living Labs).

The visits included an observational part of the fields, and interviews with key actors to understand the realities and the challenges expressed by the local stakeholders, as to observe and to compare the features of the different landscapes. We observed visually and globally the landscape geomorphology, the type of vegetation (global vigour, representative species), type of agriculture-forest interface, proportion of the vineyard in the landscape and its location, the visual state of abandonment. Whenever possible we organized meetings with several stakeholders as well as interviews. We selected different kinds of stakeholders: representatives of wine PDO, some cellars that are known for having suffered a fire or for their "good practices" and their engagement in wildfire risk management, wine growers that could be or not members of a wine cooperative or producer association. Most people were already known for their commitment with their territories or with wildfire risk management. Their selection was made through previous contacts in the international wine sector and thanks to recommendations of other local stakeholders during the visit (snowball sampling). In some cases, we met other agriculture stakeholders that could give us complementary explanations. The interviews were semi-structured, with a very open approach to giving the opportunity to the stakeholders to express their own worries and concerns. In some cases interviews lasted 4 hours, while others were very short (particularly when the farmers showed no interest in the theme). Most interviews lasted between 1 hour to 1h 30 minutes.

Part of these visits were conducted in Central Catalonia through a PhD candidate from Genova University (Coline Pacton). Her work allowed for zooming in the reality in the particular PDO Bages.

Figure 12 - Map of visits and interviews (by December 2024)

Case Studies: Wine areas visited

In 2021- 2022 we conducted local visits in Catalonia. The region has several wine PDOs, but with very diverse history and landscape, depending on their economic leaders and structure. We visited the main regions that have been involved in climate change programs and researches and that have suffered fires: PDO Empordà (close to the French border), PDO Penedès (the largest wine territory of Catalonia), DOQ Priorat (the most expensive wine of Catalonia, only two DOQ exist in Spain), PDO Montsant (nearby Priorat), PDO Pla de Bages (around Manresa, near the Montserrat heritage site)

We organized two trips to the south of France in April and in June to figure out existing experiences of using vineyard and agriculture as "firebreaks", combining private interests and public management of the territory: first, Côtes de l'Agly in AOC Languedoc and AOC La Clape near Narbonne, then vineyards surrounding the Montpellier metropolis (PDOs, wineries and administrations of Languedoc, Grès de Montpellier, Terrasses du Larzac, Muscat de Frontignan), Nimes (territories of Costières de Nîmes), and Marseille and Provence (landscapes and natural parks of PDO Côtes de Provence, Bandol, St Tropez).

Then in December we visited the main PDOs of Galicia (Monterrei, Rias Baixas, Valdeorras, Ribera Sacra) with the FIRE-RES partners of Xunta de Galicia, and PDO of Bierzo in Castilla y Leon, which is a historical continuity of Galician territory and vineyard. Galicia, and particularly the PDO Monterrei, is known to be one of the areas of Spain with recurrent wildfires. This last summer (2025) PDOs of Monterrei, Ribeira Sacra, Valdeorras and Bierzo were areas particularly affected by devastating fires in August. 13.2% of Ourense province was burned (96,104 hectares), and 67% suffered extreme temperature from the wildfires that destroyed severely the wildlife and the ecosystem.

The accumulated knowledge about French and Spanish/Catalan cases enabled us to extend our field of research to cases in Portugal and in Italy in 2023-2024. In November 2023 the annual meeting of FIRE-RES introduced us to the LL of Vale de Sousa, included in PDO Vinho Verde, a main wine PDO of Portugal. Then we visited the hinterland, areas that were affected by the main extreme fire in Portugal in 2017. We met wineries and representatives of PDOs of Beira Interior and Dão.

In December 2023 in Catalonia, we visited PDO Alella. This PDO is maintained in a peri-urban context, close to Barcelona, thanks to wine tourism development. Then we looked for complementary examples throughout the whole region to complete our analysis: Serra de Llaberia, PDO Costers del Segre, and Solsonès.

We finally visited Piedmont region in May 2024, thanks to the presence of a FIRE-RES partner in this area, which allowed us to be introduced into a 3D fire analysis training and the logic behind Civil Protection teams and their regional governance. We visited small rural PDOs in narrow valleys affected by land abandonment and main associations of producers.

A supplementary series of interviews about biodiversity and fire risk management in the southwest of France, Cévennes and further, completed our research. The annual meeting of FIRE-RES in November 2024 introduced us finally to the complexity of the relationship between agriculture and forestry industries in Landes and Bordeaux, France.

We conducted interviews to local stakeholders (producers, wineries, sommeliers, farmers' associations, Protected Designations of Origin, local researchers o technicians…) and representatives of local administrations (management of natural area, forest management, land bank, civil security…) when possible, during the visit. The selection of the stakeholders was done through recommendations of experts, local contacts or their reference in local media after a fire event.

Table 1 – List of field visits and meetings. Wineries and wine growers are highlighted in red

NOVEMBER 2021	Penedès	Winery in Torrelavit
	Penedès	wine grower in Gelida
	Riberas de Duero	Winery in Cigales
	Marseille	researcher, ex maire, comissaire enquêteur
	Penedès	Winery in Pacs del Penedès

FEBRUARY 2022	Porto	Sogrape wine group
	Bages	DO Pla de Bages
	Bages	Winery in Manresa
	Penedès	Winery in Font Rubi
	Penedès	DO Penedes
	Penedès	Winery in Avinyonet
	Penedès	Winery in Subirats
	Tarragona	wine grower association in Pla de Manlleu
MARCH 2022	Emporda	Winery in Cantallops
	Emporda	Winery in Campmany
	Emporda	Winery in Vilajuiga
	Bages	Winery in Sta Maria d'Horta d'Avinyo
	Penedès	INCAVI – Catalan Institute of Wine
APRIL 2022	Narbonne	Winery in Narbonne
	Narbonne	PNR la Narbonnaise
MAI 2022	Porto	Symington wine group
field visit	Perpignan	Vignerons des Côtes d'Agly Wine cooperative
	Nîmes	Winery in Beaucaire
	Nîmes	Winery in Générac
JUNE 2022	Montpellier	SAFER
	Montpellier	Wine Cooperative in Euzet
field visit	Montpellier	Winery in Guzargues
Montpellier,	Montpellier	SDIS
Marseille	Montpellier	ONF
	Montpellier	Winery in Vacquières
	Montpellier	Community of municipalities Grand Pic St Loup
	Montpellier	DO Terrasses du Larzac
	Nîmes	Chambre Agriculture du Gard
	St tropez	Wine Cooperative in St Tropez
	Marseille	Grand Site de France Ste Victoire, Marseille Metropolis
	Marseille	PNR Ste Baume
	Béziers	Winery in Roujan
	Montpellier	Domaine Mirabeau public farm and winery
	Montpellier	Agroecological association and winery in Vic la Guardiole
SEPTEMBER 2022	Priorat	DO Montsant
	Priorat	PN Montsant
	Priorat	VITEC

	Priorat	Prioritat association, Consell Comarcal del Priorat
	Priorat	Winery in Falset
	Priorat	DOQ Priorat
DECEMBER 2022 field visit several PDO	Ribeira Sacra	ENONATUR
	Ribeira Sacra	Winery in Doade
	Coruña	Juana de Vega Foundation
	Monterrei	DO Monterrei
	Monterrei	Winery in O Rosal
	Ourense	Xunta de Galicia - civil security
	Ribeira Sacra	DO Ribeira Sacra
	Ribeira Sacra	Winery in Quiroga
	Valdeorras	Winery in Córgomo
	Valdeorras	DO Valdeorras
	Bierzo	Winery in Molinaseca
	Bierzo	DO Bierzo
	Bierzo	Winery in Arganza
	Bierzo	Winery in Corullón
	Lleida	Tremp City Hall
NOVEMBER 2023 field visit	Beira Interior	DO Beira Interior
	Dao	Winery in Covilha
	Dao	Winery in Mangualde
Dao/Beira Interior	Dao	COLAB DAO (6 people)
	Dao	Winery in Tondela
	Vinho Verde	Winery in Penafiel
DECEMBER 2023 field visit Alella	Alella	Winery in Tiana
	Alella	PN Serralada Littoral
	Alella	City Hall
	Alella	Winery in Alella
MARS 2024 field visit	tarragona	Generalitat - Tarragona
	Montsant	EN Serra Llaberia
	Solsona	Forestal Consortium of Catalonia
APRIL 2024	Australia	university of Adelaide, Australian wine research institute
	Bages	wine cooperative in Artes
MAI 2024	Nîmes	Syndicat Hautes Côtes de Cévennes
	Piedmont	Government of Piedmont
field visit	Piedmont	Civil Hall, UNCEM

	Piedmont	Vignaeli Piemontesi (wine group)
	Piedmont	University of Turin
	Piedmont	IPLA of Turin
	Piedmont	Formazione de Protezzione Civil e Incendios Forestales
	Piedmont	Winery, restaurant and farm in Giaglione
JULY 2024	Navarra	St Martin de Unx Civil Hall
	Navarra	St Martin de Unx wine cooperative
	Montpellier	Civil Hall
Visit of Cervoles	Lleida	Cervoles winery, Castell del remei wineries, DO Costers del Segre
	Lleida	Retired ADF
	Languedoc	ARBE (regional biodiversity agency)
	Nîmes	researcher CNRS, responsible PNR Cévennes + fireman
	Paris	WWF
OCTOBER 2024	Solsona	Winery in Oden
NOVEMBER 2024	Bages	Winery in Manresa
field visit	Bages	Winery in Castellfollit del Boix
field visit	Aquitaine	PNR Medoc
	Aquitaine	PNR Landes de Gascogne
FEBRUARY 2025	Greece	University of Thessaloniki

Meetings and Workshops

During the FIRE-RES project we participated in different meetings and workshops. This had two objectives: one the one side, to disseminate the messages regarding how vineyards can contribute to mitigate the risk, and on the other hand, to collect the same qualitative information from the interviews and field visits, this is, the winemakers' concerns, contextual and productive factors, administrative features, and measures to reduce the risk.

In June 2024 we participated at a professional meeting in Formont SCARL per la Formazione Profesionale in Piedmont, Italy, with Polytechnical University of Turin and firefighters, to understand better the topics and challenges of firefighting in mountainous landscapes (Figure 13).

Figure 13 – Training with Civil Protection and firefighting bodies in Piedmont (Italy).

We organized an International seminar the 17th of October 2023. This event presented officially the initiative and its issues, from security point of view and wine sector point of view. The whole event is online on the website Firewine.eu and YouTube platform.

Figure 14 - Header of the International Seminar

We co-organized a workshop in Anoia Region with APF Orpinell-Miralles the 12th of December 2024 (Figure 15). This area is part of Resilient Landscape program of Government of Catalonia. An important part of the valley has been abandoned, the farmers that still maintain cereal and wine production are old and there are worries about the future of the open lands. The Resilient Landscape program was identifying the areas able to collect rainwater to restore underground reserves. Our objective of that workshop was to identify main stakeholders from the agriculture sector and introduce some concrete examples of good practices and strategic actions for Fire Wine (Figure 16). It

allowed also to connect with land bank initiative of Barcelona Provincial Government, and one the main grape producers for PDO Penedès.

Figure 15 - Programme of the Fire Wine event in Orpinell-Miralles.

Figure 16 - Picture of the Orpinell-Miralles workshop.

We also organized a workshop in the Bages county on the 3rd of December of 2024. The field visits of PhD candidate Coline Pacton, and the young landscape architect Antonin Renard gave the opportunity to share and to contrast results with local grape growers and wineries of PDO Pla de Bages. The session was co-organized with ARTIUM wine cooperative and PDO Pla de Bages, and with the support of Municipality of Artes, and the Catalan firefighters.

Figure 17 – Announcement of the Bages workshop.

2.2.2 Survey

An online survey was launched in spring-early autumn 2023 in five languages (French, Spanish, Catalan, Italian and Portuguese). The survey was distributed through professional networks and specialised technical magazines, and respondents engaged on a voluntary basis. The target respondents were mainly land managers (vineyard owners or managers), but a shorter version was also available for other value chain agents, namely wine makers, sommeliers, wineries, or Protected Designation of Origin (PDO) representatives. The view of value chain actors becomes fundamental as they can potentially transmit along the wine production and promotion the externality value through a prospective label.

The survey was semi-structured, containing mostly closed questions -to allow comparability across respondents- and a few open-ended spaces to capture also nuances and comments from the participants. The exploratory interviews fed the concepts underlying the questionnaire. The survey contained 6 blocks (48 questions - Table 2), covering the relationship with their landscape, in particular with their nearby forests and the wildfire risk and interest in a specific label and/or network reckoning the role of vineyards within the wildfire risk management. Respondents' concern on wildfire was captured through a 0-10 scale where they had to score their worry level on wildfire risk.

Table 2 - Survey blocks and variables across Mediterranean countries

Blocks	Variables
Demographics	Age, gender, location
Role within wine sector	Profiles
Productive factors	Rustic holding size
	Ratio of vineyards within the holding
	Wine tourism
	Stockbreeding in vineyards
	Land rights (ownership, rental, both)
Relationship with nearby forests	Forest size
	Ratio within the property
	Tree species
	Membership in land/fire management associations
	Forest planning
	Sources of support
Relationship with wildfire risk	Proximity of wildfire experience
	Wildfire risk mitigation measures
	Insurances
	Perceived hazard: wildfire concern [0,10]
	Perceived exposure: wildfire exposed elements
	Perceived vulnerability: wildfire severity
Demand for recognition and support	Interest in recognition of the fire regulation externality
	Interest in an externality label
	Current labels

The target sample size was the maximum possible, reason for mapping country and regional stakeholders, and sending up to two reminders to networks and contacts' intermediaries avoiding viticulture busy periods (e.g. grape harvest). The survey was closed when further efforts lead to no additional responses. 323 responses were collected from the five questionnaires, out of which 161 were mostly (95%) fulfilled: 101 from Spain (out of which 78 in Catalan), 40 from France, 14 from Italy and 6 from Portugal -see dataset (Górriz-Mifsud et al. 2024) and Figure 18. Interestingly, a significant part of survey abandonment happened when arriving to the question on the property size. The wine region with more responses corresponds to PDO Penedès (Catalonia) (N=40),

followed by PDO Cava (N=26), French regions Bourgogne and Languedoc (N=8 each), and Valdeorras (Galicia) (N=6). The differing rate of voluntary response per country and region probably reflects the uneven interest in this incipiently discussed topic -chiefly, consulted experts have confirmed the notable disconnection between farming and forestry in Portugal (pers. comm.). Being exploratory research, the sample size is a function of the purpose of the study and its complexity, rather than of statistical parameter (Francis et al. 2010). We then understood that data saturation was achieved given that responses represented the diversity and nuances of most of the subject variables (i.e. roles, sizes, wildfire experience, forest ownership, enotourism).

Figure 18 - Location of survey respondents. Source: own elaboration based on GoogleMaps.

2.3 Findings

The regions analysed cover a wide variety of situations: in terms of forest cover and fire regime, the layout of vineyards in relation to the forest and their size, the institutional and sales structure of the area, accessibility and irrigation, among others. Each area therefore has its own particular characteristics in terms of landscape management, although we can identify some common features. One common factor is the landscape itself. Thus, we find regions with 'seas of vineyards', large continuous expanses of vineyards with little forest cover, limited to small corpses or linear groves, e.g. PDO Cariñena, La Mancha. The winegrowers are typically specialised farmers with no connection to forestry. These plots usually have very good agronomic characteristics, with gently sloping terrain and greater accessibility for risk assessment and mechanisation. In terms of fuel management, the only vineyards that may play a significant role are those on the edges of the sea of vines and therefore in contact with the forest. These winegrowers show little concern for fires, as the probability of experiencing them at close quarters is minimal. However, they can be affected by smoke contamination or 'smoke taint' (Brodison 2013). This phenomenon results from the deposition of ash particles on

the fruit (grapes). Since fires usually occur in summer, the grapes are in the middle of the ripening process. Therefore, the biochemical processes that occur in the fruit can be altered, resulting in 'smoked' grapes and therefore a wine with a different flavour. This sometimes causes significant losses in harvest or wine quality, yet insurers currently do not cover these losses. It is difficult to establish a spatial pattern, but this smoke can travel several kilometres before settling. For example, the vineyards of PDO Bierzo sometimes receive ash from fires in Galicia.

Another landscape arrangement is that of an agroforestry matrix. In this case, the vineyards are interspersed with the forest, and the forest mass plays an intermediate or dominant role spatially. The vineyards in this case represent a discontinuity in the forest, and therefore a jump in the fuel model. Their effectiveness in modifying fire behaviour depends on the extent of these vineyards in relation to the extent of the forest mass, their fuel load and the topography, as well as the agricultural practices that are implemented during the fire season. This effectiveness has been reflected in some fires, such as the one in Cap de Creus (Girona, February 2022) where the Espelt vineyard played a key role. In fact, as early as the 1980s in the south of France, the concept of 'firebreak vineyards' was used (Darnay and Gorriz 2023). Our results show that a significant proportion of these winegrowers in agroforestry matrices also own forest plots. This is mainly due to:

- or that plots of land within the property that were historically used for cultivation have been abandoned and have been passively colonised or actively repopulated by forest species;
- or the structure of land inheritance, in which the property was not divided and therefore has both agricultural and forestry uses, and typically also a dwelling.

Figure 19 - Example of the spread of the smoke cloud from fires in Portugal (2024) to other European countries (prevailing westerly wind). Source: AEMET

The damage that the more exposed winegrowers may suffer, in addition to the smoke taint mentioned above, includes losses due to the effects of retardant products dropped by aerial means, or the burning of some vines, especially those closest to the forest, and

even some nearby buildings affected. These winegrowers close to forests often have land with greater production difficulties, namely: steeper slopes, shallower soil, less availability of irrigation, limited motorised accessibility, competition with the surface roots of pine trees, and damage from wildlife. Terracing allows soil to be created, but makes mechanisation difficult. This terroir with forest factors can provide distinctive quality and a greater presence of natural enemies for pests (facilitating agroecology). However, agricultural abandonment implies an increase in the 'agricultural island' effect surrounded by forest, where losses due to wild boars (grapes), rabbits (troncs and new planting) and roe deer (spring shoots) can reach 90% of production. In addition, these vineyards are usually dry-farmed, so productivity declines in drought conditions. This implies relatively higher investments in defensive costs (fencing) and efficient irrigation systems in order to achieve competitive yields. Those winegrowers unable to make such investments are candidates for abandoning cultivation, thereby reducing the fuel discontinuity effect. Similarly, some medium to large wineries have small plots surrounded by forest, but these may be the least financially attractive. Plot size is a distinctive variable between wine-producing regions. Smallholdings limit the capacity to invest in new projects and pose a management challenge at the landscape level, e.g. in the Designations of Origin of Rias Baixas, Ribera Sacra, Monterrey (Galicia).

Winegrowers who are also forest owners show, as expected, a greater degree of concern. In fact, we found that some of these winegrowers (as their main activity) have a forest management plan and/or belong to forestry associations. Thus, for example, in the region of La Garriga (Catalonia), it was a group of wineries that catalysed the creation of the Serra de Llena Forest Owners' Association, with the main aim of reducing the risk of fires (El Punt Avui 2023). Another interesting case is that of the Oller del Mas winery (PDO Bages), where the idea of planting vineyards arose from a severe fire that seriously affected a forest property with a stately farmhouse, and therefore the vineyard around the farmhouse provided a protective belt for the family's cultural heritage. With a similar philosophy, we find a mountain vineyard plantation in Odèn (Lleida Pre-Pyrenees) around a centre for the production of birds of prey for falconry, precisely to separate the cages and breeding buildings from the forest. The type of forest vegetation adjacent to vineyards is relevant, as it is typical Mediterranean forest of *Pinus halepensis*. The profitability of this species is limited, so in most cases a low level of forest management is reported. The accumulation of biomass in these forests, which varies in density, affects the energy released in a potential fire. The geomorphological structure of the landscape and the prevailing winds confirm the fire regimes, which influence the planning of fire management strategies and, therefore, the identification of key areas to maintain or reduce their fuel load—the so-called strategic areas (Krsnik et al. 2024)).

The ideal management of vegetation in these strategic areas can range from creating total discontinuities such as firebreaks, to reducing forest density (through clearing, thinning or silvopasture), to maintaining current crops without fine fuel during the summer, or even changing land use from forestry to agriculture. In this sense, crops around villages have become the belt that maintains the distance between homes and the forest. Vineyards are being used, for example, in Portugal, as plantations in strips under power lines (as an initiative of the National Electricity Network). There is growing interest in the use of grazing between rows of vines to maintain control of ground

vegetation cover (Niles et al. 2018). This vegetation cover is beneficial for maintaining soil moisture, as well as promoting associated biodiversity. However, this grass dries out during the summer, providing fine fuel that can allow fire to spread through the plot. Therefore, a key aspect is that during the season this cover is reduced to a minimum – which experts do not consider contrary to the objective of the cover, since in summer its function seems to be limited given the competition for scarce water. There are possible solutions to the contradiction between agroecology and fire prevention (Darnay and Gorriz 2023). A secondary aspect of grazing is that it is not typically limited to the rows, but that livestock also often enters the forest area. When this happens, the livestock 'clears' the nearby forest, which increases the effect of reducing the intensity of the fire in the event of a fire.

With regard to change of use, Regulation EU 1308/2013 establishes 'vineyard rights' for the wine sector, which restricts ploughing to plant vineyards. In Spain, we observe that in the main Designations of Origin the vineyard quotas are filled, so opening vineyards in forest areas (with the difficulties mentioned above) would be at the expense of reducing them in other areas (which may be more productive). Ploughing is also regulated under different conditions in each Autonomous Community, and even at the local level, if the urban plan does not provide for agricultural use in a strategic area. In Catalonia, we find the initiative of the Tarragona Provincial Service of the Directorate-General for Forestry, which has superimposed strategic areas for fuel management with land clearing requests, thus facilitating permits when these coincide spatially. However, in many autonomous communities, ploughing within Natura 2000 areas is very complex, even if this ploughing is for the purpose of strategically reducing fuel. At the state level, ploughing is prohibited on burned land (under Article 50 of Forestry Law 43/2003). These changes in use, beyond regulatory constraints, also face agronomic limitations. The geomorphological structure conditions agricultural implementation, mechanised access, and its potential profitability - see the analysis of the suitability of mountain land for vine cultivation by Casadó-Tortosa et al. (2024). But if crops cease to be profitable, they end up becoming forest - which is what historically happened with phylloxera in the 19th century (Cervera et al. 2017). Prospective studies predict greater agricultural abandonment in the coming years (Perpiña Castillo et al. 2018), based on rural migration, the lack of generational renewal and limited profitability, with greater risk due to the effects of climate change. In this context, fire risk prevention policy must include support tools to maintain agricultural land to the maximum extent possible.

Figure 20 – Crossing wine areas [DOQ Priorat (green) and PDO Montsant (grey)], authorised ploughing requests (2010-2023) (in red), and wildfire risk management [strategic areas for fuel management (yellow)]. Source: Tarragona Provincial Service of the Catalan Directorate-General for Forestry.

There is also a relationship between producers' concerns and their involvement in wine tourism. This is due to the secondary effects of wildfires: the loss of an intangible asset such as the landscape. The loss of an attractive landscape condemns the development of wine tourism activities for several years, affecting the amortisation of investments made in receiving visitors.

At the institutional level, the role of facilitators in the territory is noteworthy. In some places, this role is taken on by the Designation of Origin. In others, the PDO refers only to marketing aspects, so other dynamic actors emerge specifically for each territory. For example, Natural Parks, tourism promotion entities (e.g. Geoparks), or rural development entities (e.g. Joana de Vega Foundation), or local promotion entities. It can be seen that

agroforestry can be managed by entities that specialise professionally in either agriculture or forestry, or it can be managed holistically by the same stakeholders. In the latter case, the cross-cutting vision makes it easier to identify common interests, despite following different administrative procedures. However, in most cases, we find a lack of knowledge and understanding between the agricultural and forestry sectors. There are wine-growing areas, abandoned in the past, that are being revived with modest projects. These are key initiatives despite their small size. They participate in a chain of positive dynamics for rural development: gastronomic tourism development, maintenance of the economic life of villages, forest surveillance, accessibility, coordination with livestock farming and other artisan products... Their financial viability is sometimes difficult, so they need visibility and support for their efforts: the fight against the risk of fire is another argument for encouraging new projects and the settlement of young people.

2.2.1 Main conclusions from each visit

Living Lab Catalonia

In Catalonia strategic areas for mitigation of wildfires were mapped, mainly designed by firefighter services (Figure 21). For example, the Priority Protection Perimeter refers to an area with a high risk of forest fire and with a continuous forest mass in which large forest fires can occur. The boundaries of these areas correspond to major road infrastructure, non-forested corridors occupied by farmland, population centres or the hydrographic network. To plan prevention measures and provide the area with basic fire prevention infrastructure (low fuel load areas, strategic forest tracks and water reserve points), the corresponding works are done with support from the territory and with supra-municipal coherence, to facilitate the action of firefighting resources in the event of a forest fire.

Another map defines the Strategic Management Points (SMPs) to minimise the effects of forest fires, while limiting their intensity and multiplier effect. In other words, the treatments carried out there reduce the fuel load with the aim of modifying the behaviour of a fire, limiting its spread or providing an opportunity for firefighting teams. These forestry actions have been initiated in the most priority SMPs. A multi-criteria system has been used to prioritise these areas, such as the number of hectares protected, the number of people protected, or expert criteria from a technical and operational point of view. In our case we collected global scale maps to cross with wine sector information: PDO areas and the use of soil (registered vineyards).

Figure 21 – Map of Catalonian strategical areas for fire risk prevention (PPP - in green) crossed with wine production (PDO areas – yellow). Existing vineyards (in purple).

Figure 21 and Figure 22 show the correlation between wine production areas and strategic management areas. They also demonstrate the potential benefits of supporting the expansion of production in some inland areas.

We focused in areas where we could meet wineries that already faced fire risk. The Bages county, with its dominant forest landscape, was of particular interest to us and we organised a workshop and complementary works there which are presented separately.