Innovation Networks of Cork, Resins and Edibles in the Mediterranean basin - INCREDIBLE

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Deliverable 2.3 – iNet final report, knowledge gaps and innovation opportunities and barriers

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Contents

Reference

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List of tables

List of figures

1. Preamble

The Description of Action (DoA) of the INCREdible project initially fixed month 26 for the submission of the Deliverable 2.3 “iNet final report, knowledge gaps and innovation opportunities and barriers”. This deliverable encloses the conclusions of the interregional workshops and Science to Practice events. However, both type of events were still in process at this time. Therefore, the due date of the deliverable was extended until Month 39, allowing to complete the subsequent iNet DELPHI like surveys that feeds from the results of the Interregional Workshops and Science to Practice Events. This deliverable is split in the three main type of activities carried out by the five iNets, namely Interregional Workshops, Science to Practice Events and DELPHI like surveys. The document summarizes the main conclusions of such activities whlist the report 2.3 also includes all the event full reports as appendices.

2. Introduction

2.1. Purpose

The five innovation Networks (iNet) created in the INCREdible project have four main purposes:

- to identify the knowledge and practical experiences that are needed to be summarized and made available in a ready-to-implement way
- to contextualise and guarantee the relevance of compiled knowledge
- to identify persisting knowledge gaps and research priorities
- to highlight key innovation opportunities

Through the initial Scoping seminars, each iNet identified key themes and issues where the project can make significant impact sharing knowledge and promoting innovation. Such relevant topics has been specifically addressed in three **interregional workshops (IW)** per iNet (Task 2.2.1) and a minimum of 45 **science-&practice events** (Task 2.2.2), expanding the obtained results through an iNet DELPHI like survey. The Deliverable 2.3 summarizes the main conclusions of the issued events and activities.

2.2. Scope

The **interregional workshops (IW)** have been initially scheduled in November 2018 (M13), May 2019 (M19) and November 2019 (M25). An individual IW consists in a 2-3 day's event which includes seminars, debates, field trips as well as other innovation activities animated by the innovation facilitators. The workshops were interregional because the audience came from different countries. As stated in the Description of Action (DoA), the workshops have been arranged in different locations within each iNet geographical span. At the end of each IW, the organizer summarized the main outcomes of the event in an individual report. The conclusions of the three IWs have been collectively assessed through a **DELPHI-like survey** (**DS)** which was launched in every iNet at the end of the third Interregional workshop (year 2020).

Complementary to the IW, a series of **Science to practice one-day events (S2P)** was also organized. The main aim of the S2P was transferring knowledge as to fill NWFPs knowledge gaps that were identified by the iNets. The S2P has a more flexible format, including field trips, seminars, open days at research labs, farm to farm innovation transfer sessions, workshops, etc. The theme or knowledge gap addressed by the event as well as the main conclusions are summarized by the organizer in a short report that are all included in the Report 2.3. (R 2.3).

3. Development

3.1. Interregional Workshops (IW)

The DoA established a tentative timetable of three IW rounds, fixing the event organizer as well as the country in which the workshop will be held (Table 1).

Table 1 Initial schedule, organizers and hosting countries of the IWs

	First IW (November 2018)	Second IW (May 2019)	Third IW (November 2019)
Wild nuts and berries	CNPF, France	INIA, Spain	EFI, Spain
Cork	ISA, Portugal	UNAC, Portugal	FORESTAS, Italy
Wild mushrooms and truffles	CFRI, Croatia	ETIFOR, Italy	CESEFOR, Spain
Resin	INIA, Spain	CNPF, France	INRGREF, Tunisia
Aromatic and medicinal plants	UOI, Greece	CTFC, Spain	CFRI, Croatia

However, differences circumstances such as the need of accommodating the event schedule to the most appropriate time for the iNet stakeholders, or logistic reasons affected the initial timetable. The final schedule of the IWs, including organizers and hosting event countries is presented in Table 2.

Table 2 Final schedule, organizers, hosting event countries and status of the IWs

	First IW (November 2018-March 2019)	Second IW (March 2019-June 2019)	Third IW (November 2019-April 2021)
Wild nuts and berries	CNPF, France (7-8 March 2019)	INIA, Spain (12-14 June 2019)	INRGREF, Tunisia (13-14 November 2019)
Cork	ISA, Portugal (25-26 February 2019)	UNAC, Portugal (6-7 June 2019)	FORESTAS, Italy (21-22 November 2019)
Wild mushrooms and truffles	ETIFOR, Italy (5-6 December 2018)	CESEFOR, Spain (7-8 June 2019)	CFRI, Croatia (10-11 December 2019)
Resin	INIA, Spain (21-22 January 2019)	CNPF, France (5-6 March 2019)	EFI, online (13-14 April 2021)
Aromatic and medicinal plants	CTFC, Spain (28-30 November 2018)	UOI, Greece (6-7 June 2019)	CFRI, Croatia (11-12 December 2019)

3.2. Science to Practice Events (S2P)

The organization of at leastf 45 S2P events has been agreed by the consortium partners in the DoA, subdivided into six rounds (first round: August 2018; second round: January 2019; third round: June 2019; fourth round: November 2019; fifth round: April 2020; sixth round: October 2020). To date (February 2021), 49 S2P's have been organized (Table 3). During the last two rounds, the project consortium had to adopt the strategy of moving the organization of *in-person* events to on-line meetings. This decision was forced due to the pandemic situation caused by virus Covid-19 and subsequent national lock-downs.

Another approach of delivering the Science to Practice events was also adopted – Training sessions. Training sessions (TS) were a form of event organization conducted by multiple partners. Each of the partner involved could contribute to the organization on multiple ways (i.e. meeting schedule and participant invitation, paying for on-line meeting platform licenses and hosting the meeting, delivering knowledge and practice through presentations, discussions, etc.). These events also had to last for more than one day. Since the S2P's were counted as one day events, TS's number of days was given by multiplying the number of days by number of organizers (i.e. 2 days of TS event × 3 organizing partners = equivalent to 6 S2P events).

This Science to Practice meeting organization milestone was achieved with two months' delay in December 2020 with 43 S2P's and 2 TS's counted as 6 days. In total 49 events were organized, 4 more than the minimum number needed.

Table 3 Number of S2P events organized by the iNets

	Number of S2P events organized
Wild nuts and berries	8
Cork	12
Wild mushrooms and truffles	12
Resin	8
Aromatic and medicinal plants	9

3.3. DELPHI-like Survey (DS)

The DELPHI like survey follow the same scheme for all the iNets. The process started with the selection of the Expert Panel which included members representing the different countries included in the INCREDIBLE project (Portugal, Spain, France, Italy, Croatia, Tunisia and Greece), but also representatives of international organizations. In the case of the iNets of Wild Nuts & Berries and Wild Mushrooms & Truffles two different panels per iNet were set-up, whilst in the case of the iNets of Cork, Aromatic and Medicinal Plants and Resin one expert panel per iNet was constituted.

A total of 69 expert panellists actively participated in the survey with an unbalanced number of participants per iNet due to the different complexity of the respective value-chains that implies more participants in longer value chains (Table 4). The panellists were selected based on the premise of representing different positions of the value chain looking for different approaches to the same topic. Therefore, landowners, processors, but also forest managers or technicians and experts from technological centres, associations and academia took part in the process.

Table 4 Number of expert panellists who participated in the different iNet DELPHI surveys

	Number of expert panelists
Wild nuts and berries	15
Cork	10
Wild mushrooms and truffles	22
Aromatic and medicinal plants	15
Resin	7

The questionnaire was generally divided into four sections:1) the description of the value chain, 2) SWOT analysis of the Strengths, Weaknesses, Opportunities and Threats of the sector, 3) the different challenges that the sector needs to face in the future, 4) and finally the prioritized actions to be taken in order to increase the resilience of the sector.

The expert panellists received the questionnaire in a first round, to identify and weight the relevance of several statements made about the correspoding sector, based on knowledge collected during iNet activities. The questions were mainly quantitative (Weighting was between 0 (no relevance) and 10 (upmost relevance)), but also qualitative. The outcomings and opinions collected in the first round were analysed to reshape the questionnaire for a second round, after refining or dividing some statements and adding new topics proposed by some expert for the consideration of the entire panelist answers. This second questionnaire was individually addressed, each expert panelist receiving a comparision of their own marks with the average score of each statement. Each expert was requested to confirm their own mark in the first round or to modify it according with the opinion of the rest of expert panelists, looking for possible harmonisation or consensus where possible – without neglecting possible regionally or value-chain position related different points of

view. During the whole process, other experts' identities and performance were treated anonymously according to the privacy law, and there was no possibility to trace their information. All the individual results were analyzed and used in an aggregate way.

The results presented in the current reports are reported as an average of the rate assigned by the experts and the standard deviation of all the expert answers.

4. Main conclusions

4.1. Conclusions of the Interregional Workshops

Conclusions of the Interregional Workshops of the Wild nuts and berries iNet

The first Interregional Workshop of the Wild nuts and berries iNet was held in Marseille, France from the 7th to the 8th of March 2019, being focused on the economic development and products quality of Wild Nuts and berries under the organization of CNPF. The second Interregional Workshop, handled by INIA was entitled "Wild harvested nuts and berries in times of new pests, diseases and climate change". This event was held in Palencia, Spain from the 12th to the 14th of June 2019. The third and last IW was organized by INGREF in Tunis, Tunisia from the 13th to the 14th of November 2019 being focused on the production of edibles from forests and orchards. The development of all the interregional workshops, including the main outcomes have been reported (see Report 2.3). Table 5 summarizes the conclusions of the three IW rounds.

Table 5 Conclusions of the three interregional workshops of the iNet Wild nuts and berries

	Conclusions of the three Interregional Workshops of the Wild nuts and berries iNet
Improved definition of the theme. Take-home messages	• Climate change, combined to pests and diseases directly impact chestnut production, and contribute to speed up the decline of trees. It is crucial that research continue to be done on this subject. • Also stone pine stands in the Spanish Northern Plateau are suffering the effects of climate change towards aridity, though in a lesser degree than the sympatric maritime pine: ✓Decay, lack of natural recruitment, loss of growth and cone productivity; ✓Displacement by better adapted species, such as juniper in limestone, or in a future even *Stipa* grass replacing stone pine as the last persisting tree species on inland dunes, where this pine is displacing currently maritime pine; ✓Specifically, *Leptoglossus occidentalis* is an important pest reducing cone and seed yield, jeopardising the persistence of the sector, both cone pickers and processing industry, putting at risk several hundred employments in the region. • Forest management and treatments can improve the state of the forests, for instances equilibrating stand densities or introducing adequate plant material, including adapted rootstock species for grafted plantations. • Traceability and certification of the product can enhance the added value and the price paid in origin.

	• But certification can be restrictive for small structures (cost of certification, need to obey norms and standard). Costs involved to obtain a certification must be measured, to avoid the "capture" of the market by industrial companies as only players able to access. • A synergy can be generated between local producers and local processors, by introducing a processed product on a market local, national or international. One example are regional breweries of chestnut beer.
Improved understanding of knowledge gaps	• It's relevant the clusterization and structuration of value chain actors, regionally and at European level. • The stakeholders highlighted the need of continue with the research themes that seems to be primary for them, namely adaptation to climate change and integrated control of pests and pathogens, to solve the production losses. • The stakeholders expressed that it's necessary for industries to clarify their position, and to participate much more to develop the sector. Industries are seen to take advantage of informal market because prices paid in origin are lower. It's crucial to include all the actors in structuration dialogue to formalise the value chain. • Stone pine management in Northern Spanish Plateau cannot continue its Business as usual while abiotic and biotic conditions are changing. Innovation is needed. • The situation of the chestnut sector is less critic. Although climatic conditions would affect this species, its situation on higher altitudes means that the effects are still not that clear. In some upland regions like Aliste (Spain), new chestnut orchards are expanding.
New knowledge gaps. New identified themes	• Current chestnut production is not enough to respond to the growing needs of processors for satisfying the increasing market demand. • No effective solutions are available to control the prevalence of Leptoglossus occidentalis. Though experimental spraying with pesticides is currently studied, development of integrated pest management and biologic control should be priority.
Potential solutions-Lessons learnt	• It's relevant finding chestnut rootstocks resilient to ink disease and adapted to climate change,

	• Identify chestnut post-harvest processing that allows to avoid worm infestation and decay, • Joint efforts are needed to address the problem of pests and diseases and to mitigate the effects of climate change. • Obtain funding to tackle the current phytosanitary problems. Despite the creation a European chestnut sector's network, financing requests submitted to solve phytosanitary affections were not conclusive. In case of stone pine, no such a network even exists for delivering sectoral request. • Common commercialisation of demanded varieties allows for targeting the fresh chestnut market, with higher benefits than sale as commodity to processing industry.

Conclusions of the Interregional Workshops of the Cork iNet

The first Interregional Workshop of the cork iNet was held in Lisbon, Portugal from the 25th to the 26th of February 2019, being focused on the genetic variation of cork oak as a tool for regeneration of cork oak woodlands under the organization of ISA-University of Lisbon. The second Interregional Workshop, was also held in Portugal (Lisbon and Coruche) from the 6th to the 7th of June 2019. The workshop was entitled "Cork market and cork quality assessment in the Mediterranean". UNAC-Uniao da Floresta Mediterranica was the organizer of the event. The third and last IW was organized by FORESTAS (Agenzia Forestale Regionales per lo Sviluppo del Territorio e dell'ambiente della Sardegna) in Nuoro, Sardinia (Italy) from the 21th to the 22th of November 2019 being focused on the cork oak forests and ecosystems services: market development tools. Table 6 summarizes the conclusions of the three rounds (the full IW reports are available in R 2.3).

Table 6 Conclusions of the three interregional workshops of the Cork iNet

	Conclusions of the three Interregional Workshops of the Cork iNet
Improved definition of the theme. Take-home messages	• A FAIR project in 2000 allowed seed collection and seedlings production of 35 provenances. Establishment of provenance trials in Portugal, Spain, Italy, France, was supported by national funds; only Tunisia and Morocco had European support (this last one was lost and replaced by umbrella pine). • The cork oak trees from provenances of higher precipitation areas also develop well in drier areas, revealing the high genetic variability of the species and their ability to adapt to climate change.

	• In the Tunisian trial, significant differences were found between cork oak provenances in terms of apical dominance, plagiotropy, foliar area index and fungi attacks. • In the Italian trial no differences were found between provenances in terms of tree height, diameter, cork thickness and phytosanitary issues. • In the Spanish trials, shoot growth, leaf area index, leaf thickness and nitrogen content were assessed. Provenances from warmer regions are very sensitive to low temperatures; in the very dry years all the provenances show the same behaviour - small growth. • In the Portuguese trials, the diameter at breast height was a good indicator in terms of the root development, which is important for the plant survival. In some provenances, drought induced root growth, but not in all. • There is a decrease of cork local firms meaning no competition in the market (one factory buys almost all the cork). • There is a lack of maket and price definition procedures based on cork quality. • Cork oak woodland certification, under both FSC and PEFC standards, is a valuable tool to increase market demand, by demonstrating sound environmental management to the general public (consumers) and contributing to market transparency and greater competitiveness of the whole sector. • Certification of cork oak woodland is highly developed in Portugal and Spain (greatest world cork producers) and little developed in other Mediterranean countries, where forest planning and certification must be encouraged. • The absence of a long-term vision and strategy for cork oak woodland management hamper the adoption of forest management plans and thus forest certification. • PES are largely used in developing countries, and have an important role in marketing but smaller margins of impacting on the profitability of rural economies where the average incomes are higher. • New business models are being set up voluntarily to overcome cork oak woodlands' abandonment, by ensuring

	management of public or private woodlands with the aim of ensuring the long-term supply of cork for processing. • A managed cork has higher carbon offset performances than an abandoned cork oak woodland. The carbon market associated to cork oak management can be a tool to leverage incentives for contrasting cork oak abandonment, although few countries have CO_2 emissions offsetting registers; • Greater coordination among Rural Development measures and CAP is needed for highly diverse and complex systems such as agroforestry systems, to avoid losing the ecological balance between the various components: i.e. forest maintenance, grazing pressure, landscape. • Association of forest owners is essential to overcome fragmentation of land properties. Operational Groups or Private Forest Owners Association are possible alternatives for putting together the cork primary sector. • Cork oak woodlands are an essential element of traditional and historical Mediterranean landscapes. Their conservation through appropriate management is essential for the maintenance of the cultural value of Mediterranean ecosystems; • The potential of cork oak landscapes to attract visitors has not been fully investigated, and needs further attention, but through preliminary studies is showing it is highly valued by both resident communities and tourists. • The traditional and historical value of cork oak woodlands needs to be better valued in territorial marketing strategies that promote the integration of several resources and market segments (food, recreation, culture, fitness and well-being, etc).
Improved understanding of knowledge gaps	• The participants of the first Interregional Workshop stated the relevance of the long term monitoring to assess the differences between the several provenances. Some comparison results between the provenances were very different over time (in Tunisia, 2004 and 2011, for example). • Cork quality sampling is only regularly used as a tool prior to the cork commercialization in Portugal, mainly in Alentejo ahnd Ribatejo, and in Spain, mainly in Extremadura and Andalucía. Specific forest inventory tecnics talking the montado, the cork oak tree and the cork product are available in the scientific literature. They are still applied in

	restricted regions due to the following reasons: Property structure (eg. small farmers with less than 10 ha, in Northen regions of Portugal, Italy and Catalonia); ✓High costs associated with the sampling; ✓Lack of collaboration among the value chain; ✓Lack of professional knowledge (e.g. cork pickers, cork classifiers); ✓Weakness/lack of forest owner's associations; ✓Lack of public support on sustainable management and production • The theme of ecosystem services delivered by forests, and especially by cork oak woodlands is vast and complex and deserves more research.
New knowledge gaps. New identified themes	• The cork quality assessment is a need. But, who will pay this service? There is a need of an analysis of the economical viability. • How to apply the cork quality assessment methodology? There is a lack of knowledge of the product by the forest owners. The forest technicians do not have the necessary know-how to classify the cork. • How to promote the long-term collaboration along the value chain? • How to build a shared vision between the cork producers and the industry? • How to achieve more public support whilst improving coherence and simplification on funding measures? • How to adapt the legal framework to the sector reality? • What are the relationship between soil properties and cork growth and quality? • How to finance and carry out scientific surveys on cork oak woodlands biodiversity by experts in the sector? • How to develop a tool to assess trade-offs among ecosystem services? • How to increase forest profitability: by increasing cork price and putting forests to value?

	• How to develop private owners' associations or networks and facilitate cooperation among them in topics such as certification? • How to develop a strategic vision for cork? • How to foster cooperation and association along the value chain of cork?
Potential solutions-Lessons learnt	• The decision on the first harvesting shouldn't be a management decision relying only in the minimum size of the trees. • It's necessary to increase the training, capacity building and awareness inside and outside the cork sector. This is especially relevant with the topic of quality cork assessment. • It's necessary to define a common rules of cork classification: ✓Common procedures (eg. ISO standard); ✓Standard quality classes with clear limits; ✓To create areas well defined with similar management to define proper sampling standards; ✓To define a geographic region of cork as "cork potential area", sampling in larger scale; ✓To base the system on usage classes not "linear" measures; ✓To find and to approve a consensual image base system in the EU; ✓To create an international working group. • It's necessary to advocate for an implementation of cork oak quality assessment through: ✓Linking the managers to the utility, explaining how useful is to know the quality in order to define the best price and evaluate how to improve the product. ✓Training of quality cork "coaches" that could transfer the methodology. It is necessary to have experts on cork classification. ✓The dissemination to the farmers that a cork quality assessment can imply a fair/good price. ✓The development of apps that will help the stakeholders in identifying the cork quality. • It's necessary to promote the forest certification and thus, increase the number of certified area. Three related actions have been identified for achieving this objective:

	✓Provide tools to facilite access to certification. ✓Monitor the biotic component, increasing the knowledge on biodiversity for a better management of cork oak forests. ✓Raise awareness to the landowners. • It's necessary to enable the framework conditions for cork production. Three related actions have been identified for achieving this objective: ✓Develop a strategic vision for cork (moving from Command & Control compliance to a Vision) in order to have a clear reference framework encompassing the needs of the territories and the "limiting factors". ✓Set-up territorial associations and networks by solving critical issues, improve competitiveness, ensuring sustainability of material and inmaterial investments. ✓Create a Mediterranean Hub/system focusing on the Mediterranean peculiarities.

Conclusions of the Interregional Workshops of the Wild Mushroom and truffles iNet

The first Interregional Workshop of the Wild Mushrooms and truffles iNet was held in Padova, Italy, from the 5th to the 6th of December 2018. This two days meeting, organized by ETIFOR, was centered on the analysis and new proposals on fiscality and taxation system for truffle and mushroom sector. The second Interregional Workshop, handled by the Spanish partner CESEFOR was entitled "Mushrooms and truffles: how to improve quality and market status". It was held in Ioannina, Greece from the 7th to the 8th of June 2019. The third and last IW was organized by CFRI in Varazdin, Croatia from the 10th to the 11th of December 2019 focusing on the management of truffle plantations and development of the mycosilviculture. Table 7 summarizes the conclusions of the three rounds.

Table 7 Conclusions of the three interregional workshops of the iNet Wild Mushrooms and Truffles

	Conclusions of the three Interregional Workshops of the Wild Mushrooms and Truffles iNet
Improved definition of the theme. Take-home messages	• Mushrooms and truffles marketing status has different development situations all over European countries. Different scenarios presented during the interregional workshop have been started and promoted, at some level, by social stakeholders. So in order of the legal approaches to be useful and fully implemented those social initiatives must be taken into consideration with a bottom up approach.

	• In countries where tourism have a big share in GDP, such as Croatia, truffle plantations can also be used in tourism sector where they'll attract more groups of tourists and the tourism season will increase from summer months' tourism to whole year tourism. • It is very important to continue the education based on case studies from countries were truffle management has a more decades' history like Spain, France and Italy. • Development of mycosilviculture is not possible only with the inputs from forest managers. Tourism, trade and education should also be incorporated. • It is needed to continue the research on hypogeous fungi. New fungal species are found each day, and no sustainable management is possible without knowing the abundance of species in connection with the habitat ecology. • Market regulation is needed. Most of the activities is conducted on the 'grey' market, meaning that regulations exist, but they are not respected. Common quality control methods are not developed. • For those regulations that are not developed on country level, EU legislation should be taken into account.
Improved understanding of knowledge gaps	• The legislation in the different countries must be a tool for the marketing development. The incorporation of any specific prices in the legal frameworks has been proved to promote unofficial market and illegal practices. • Cooperation between countries and entities with different approaches must be fostered in order to allow a faster and better development in those European areas with interest in the resource. • Mushrooms and truffles sector has nowadays an economical importance, difficult to evaluate yet, that are far from being a mature marketing product, aspect than can be consider as an opportunity to sustainable growth. • Management of truffle plantations and development of mycosilviculture are two very interesting topics, but not yet developed in countries such as Croatia. The workshop participants were very interested in the topics, especially while listening to the case studies from other countries. We can conclude that the challenges relevant to this iNet are transferrable to all Mediterranean countries.

New knowledge gaps. New identified themes	• How to have an adequate/equitable taxation system for all the value chain actors? • How to involve the public sector to develop and consolidate the sector? • How to manage forests aiming to increase mushroom yields? • Can continuous mushroom picking affect future yields? • How to link mushrooms and truffles with gastronomy and tourism? • How to valorize the product? How to monetize the production? • How to guarantee the traceability of the product? • How to reduce the risk of poisoning? • How to replicate success stories? • How to reduce the interannual production variability? • How to better organize the sector of wild mushrooms and trufflers? • How to manage the truffle orchards in order to increase the production? • How to improve the current legislation to the reality of the truffle sector? • How to restore black truffle production in forest areas and reduce this decline? • How to carry out the certification of the mycorrhized plants? • How to value other truffle species such as *Tuber brumale* or *T. aestivum*? • How can we promote the awareness and consumption of truffles among consumers? • How to increase the expertise of black truffle producers and technicians?
Potential solutions- Lessons learnt	• Current legislation, in terms of fiscality system in many EU countries, appears not adequate to effectively reduce the role of informal producers. Several proposals aiming to improve the current legislation emerged: ✓A reduction of rate VAT for truffle and mushrooms, or equalize rate VAT of these products with other vegetables;

- ✓A differentiation of income tax between Wild Forest Products (WFPs) pickers and cultivators and between occasional and professional pickers;
- ✓Since the complexity of value chains of WFPs, policies and national strategies should be based on a participatory approach with the involvement of main national stakeholders.
- ✓Harmonize the fiscality system among EU countries in order to guarantee fair competition and a dynamic market within EU.

- It is possible to improve the efficiency ot the sector through:
  - ✓The development of agreements between truffle / mushroom pickers association and land owners. Pickers can represent key actors for improve forest management, enhancing the economic and environmental value of some rural areas;
  - ✓The promotion of some WFPs can be strictly linked with the brand of some important touristic destinations, such as Fungo di Borgotaro I.G.P. and Tartufo Nero di Fragno. Both of these examples are connected with the registered trademarks, that guarantee the legal protection of their denomination, according to specific EU Regulations;
  - ✓Increase of interest of mycological and gastronomic culture at both regional and global scale;
  - ✓Develop the mycotourism with a set of alternatives including mushroom picking, gastronomy, and natural resources experience increasing the interest and promotion of rural culture, gastronomy and nature;
  - ✓Domesticate new species;
  - ✓Develop Agrifood production systems complementing the wild mushroom yields.
- The public administration has an important role in stimulating the sector through different instruments: financial assistance, territorial contract, training assistance, and creation of a network.
- Legal frameworks must be developed from the bottom up approach and taking into consideration previous works developed from different organizations (e.g: CESEFOR experience in Castilla y León region, Spain).
- It is necessary to reinforce the applied science connecting researchers and practitioners, applying the research results with the goal of maximizing the truffle production.

	• It is necessary to develop a market action plan that includes the creation of trademarks based on truffle origin, the establishment a traceability system and the minimization of the black/informal market. • It is necessary to develop an educational plan that includes the training of forest owners on added values of mycosilviculture, the education of potential users on truffle plantation development and the awareness of the mushroom and truffle pickers on the sustainable usage of natural resources. • It is necessary to promote the legal changes (Adapted to the different situatians at country/regional level) aiming to incorporate forest species seedlings into agricultural acts, to change the regulations on mushroom and truffle picking to suite their growing in plantations, etc.

Conclusions of the Interregional Workshops of the Aromatic and Medicinal plants iNet

The first IW of the INCREdible project was organized in Seville, Spain from the 28th to the 30th of November 2018 under the umbrella of the aromatic and medicinal plants iNet. This first meeting was focused on wild medicinal and aromatic plants collection, and CTFC was the responsible of the organization. The second Interregional Workshop, handled by the University of Ioannina was entitled "From networking challenge to market opportunities" was held in Ioannina, Greece from the 6th to the 7th of June 2019. The third and last IW was organized by CFRI in Varazdin, Croatia from the 11th to the 12th of December 2019 and focused on the certification, traceability and legal framework adjustment. Table 8 summarizes the conclusions of the three rounds.

Table 8 Conclusions of the three interregional workshops of the iNet Aromatic and Medicinal Plants

	Conclusions of the three Interregional Workshops of the Aromatic and Medicinal Plants iNet
Improved definition of the theme. Take-home messages	• Currently, there is a "Fairwild" certification that guarantee the sustainability of the wild collected plants and the products made with them and exist the need to work with companies that use wild plants to inform them of the benefit of using this certificate. • Management plans for the wild plants harvesting must be done specifically for targeted species. • There are brands of local products or products grown or harvested in a given territory. • There are also brands of local ecotypes or ancestral varieties.

	• It is crutial to inform the consumers about the meaning of the different brands and certificates. • There are ongoing projects such as "ValuePAM" (http://www.valuepam.eu/) and LENA (Local Economy and Nature Conservation in the Danube Region) (http://www.interreg-danube.eu/approved-projects/lena) which try, to a greater or lesser degree, to value the use of wild PAM, organize the collection activity and engaging local companies and stakeholders to do it in a sustainability way. • It is needed to know the biological and ecological aspects of the species collected as well as the commercial channels and the demand for this species. It is also needed to estimate the current status of any resource prior to the collection. • There are many certification methods and many certification companies. The meaning of those certificates is unclear. Maybe, instead of certification methods, we should consider a common traceability system. • Education on sustainable wild raw product material is needed. • Promotion of local eco based products in needed. • Standardization of production procedures is desirable, as well as the creation for common supplies market.
Improved understanding of knowledge gaps	• Different methodologies have been presented to evaluate a wild species as a commercial resource. • It was presented how to establish a management plan to harvest a wild plant. • It was stated the need to unify a management plan for harvesting of a wild plant in a territory (even if in different countries). • Different forms of associationism in the territorial scope around a common activity were presented. • Traceability was mentioned as one of the most priority themes in the AMP sector. The adoption of geographical indication of origin is indispensable for more consistent quality control and development of standards. Setting up geographical indications is very useful method for indicating the origin of goods and services. Participants indicate that a geographical indication must be available for use by all producers of essential oils in that region, for instance small producers and local population. Indeed, using a certification

	mark is sometimes restricted to big producers and processors who comply with the established standards for its use. • Participants mentioned the importance of an appellation of origin for certain products and they explain that certain plants owe their special qualities to the place from which they come. Essential oils production is constrained by price variability on international markets, continuity of internal supply and quality concerns. Lack of marketing information on domestic and international market: new trends in major consumer markets is still unknown. • Participants mentioned that botanical and agronomic research needed to focus on identifying and optimizing AMP production and value-added opportunities.
New knowledge gaps. New identified themes	• Organization of forest owners and AMPs collectors to design a collaborative forest management plan oriented to promote the grown or development of targeted species. • Drawing up management plans for harvesting the resource at a specified location. • Harmonizing wild harvesting regulations (administrative authorizations, trainings, supervision, etc.) in surrounding territories. • Promoting the “wild crops” or the “wild ecotypes crops”, it is possible? • New legal forms of associationism to help the collectors organize their activity and to implement the certification of good practices. • Design the content and format of a periodic course for collectors to be applied in different territories. • Valorization of the byproducts produced in the distillation and drying processes. • Design of new products or/and new formats to promote the local economy. • Does the quality of the raw material (organically or conventional) influence the quality of the essential oil? • Improve the equipment and existing machinery for small producers or artisan producers. • Adapt the legislation of the PAM commercialization in the different countries.

	• In Greece, after many years of economic crisis many people started to try to reinhabit abandoned rural areas and get involved in the primary sector. Aromatic and medicinal plants exploitation is considered as a field with great potential dynamics; however, the lack of information and proper guidance is considered as the main worry for the cultivators or those who want to get involved in AMP exploitation. The problem is the same for the people that are already involved in the AMP exploitation business, as most of them are not properly informed about all the potential uses of their products, the market trends and demands and the regulations. • Areas like Epirus (Greece) combine high biodiversity, many protected areas and environmental conditions that can ensure a competitive production on AMPs. • Involvement of new farmers with the sector seems a charming opportunity for areas where touristic infrastructure already exists and there is already a demand for AMPs. • Depopulation and abandonment, especial after 1960s, as in rest of Europe is a characteristic of the area. Cultivation of AMPs can offer an opportunity for the revival of local communities. • Traditional medicine consists part of the identity of local people. It is important preserving this heritage and create strong brand names that highlight the potential of the natural products together with the history and culture (Good example is the National Park of North Pindos, Greece).
Potential solutions-Lessons learnt	• It's necessary to found a new associacionism formulas to share services and knowledge between all the stakeholders. • it would be necessary to implement a forest management plans to encourage the development of a non-timber species and to be able to assess the impact and results. • It's necessary to make a specifically local brands. • It is necessary to promote the traditional use of AMPs to general consumers. • It is necessary to divulge the different certifications and their meaning and environmental value among consumers. • It is necessary to found new products made by AMP. • Are wild crops possible and economically viable?

	• There are many institutes and organizations in Greece that stakeholders can contact and get technical support and help. However, most people are not properly informed about these infrastructures. The creation of some lists and better networking between all these infrastructures, or even the creation of a central advisory organization that people can contact directly to get answers in various sections would offer a great solution in this direction. • It is necessary to evaluate the impact of the collection. • It is necessary to monitor the collection activity with periodic sampling to make harvest adjustments. The use of drones (and other mechanisms) could be possible tools to assess the resource and to periodically assess the impact of harvesting. • It is necessary to promote partnerships and collaborations between project industry-government, academia and civil society, through the development of a targeted projects. • It is necessary to develop new trade channels (web based or smartphone applications) in order to decrease sale costs. • It is necessary to develop clusters between producers, pickers and end-consumers, together with product branding or trademark development. • It is necessary to increase the training and the societal awareness of the life quality through the usage of natural herbs and plants (gastronomic and medicinal attributes). • It is necessary to promote a proper storage and processing of raw material. • It's necessary to develop research on the sustainable preservation of wild species population as well as on the agrotechnology for their cultivation.

Conclusions of the Interregional Workshops of the Resin iNet

The first Interregional Workshop of the resin iNet was held in Madrid, Spain from the 21th to the 22nd of January 2019, focusing on the resin resource monitoring & modelling in a context of climate change under the organization of INIA. The second Interregional Workshop, handled by CNPF was entitled "Resin extraction as a building block of sustainable forest multifunctionality" and was held in Cestas, France from the 5th to the 6th of March 2019. The third and last IW, organized by EFI, was entitled "Interregional workshop on innovative bio-based resin derivatives: current trends and

promising research opportunities for bio-based colophony, turpentine, CTO and CST derivatives" and was held online (due to covid19 restrictions) from the 13th to the 14th of April 2021. Table 9 summarizes the conclusions of the three rounds.

Table 9 Conclusions of the three interregional workshops of the iNet Resin

	Conclusions of the three Interregional Workshops of the Resin iNet
Improved definition of the theme. Take-home messages	• The European Union is a net importer of products derived from hydrocarbon resins and bio-based resins, which in part can be replaced by local resin production. • The decrease of *Pinus pinaster* areas available for tapping due to the incidence of forest fires, climate change and pests and pathogens poses a serious threat to the sustainable production of natural resin in Mediterranean forests. • The potential for mobilisation of the resin resource in the forests of the Mediterranean basin depends on stable profitable prices in origin, hence in part on the evolution of international markets. • The availability of the local resin resource and the mobilisation potential is conditioned by the labour costs of extraction, the efficiency of the available resination techniques and the productive potential of the forest stands. • The social interest of the mobilisation of the resin resource must be considered, not only in the cost-benefit analysis of the exploitation itself, but also the positive externalities, the contribution to environmental and social sustainability, and the ecosystem services it provides. • Resin extraction activity and the establishment of processing industries have positive implications for the territory from a socio-economic point of view in the form of job creation, population fixation and an increase in the added value of primary production. • The fundamental prerequisite for making a qualified decision regarding the startup of the resination activity in a sustainable way is to know the productive potential of the forest stands under different forestry and environmental hypotheses or scenarios. • The prediction of the resin production of a forest stand through models is possible since the investigations show a

	clear correlation between the environmental parameters, the physiological activity of the pine and the production. • The creation of production models requires real resin production data, dasometric data and georeferenced environmental parameters. • A preliminary version of a production model could be obtained in the short term, if the modelers had access to real production data available from resin producers and the first processing industry. • The extraction of natural resin from forests is compatible to any other forest use, such as hunting, harvesting of pine nuts, mushrooms or fruits, tourism or logging, among others, provided that clear forest management guidelines have been established and are known by all forest users. • The multifunctionality of the resin worker is a characteristic that must be used to promote and consolidate the harvesting of natural resins in Europe through institutional support instruments such as the territorial contract, the reduction of taxes on the activity and the administrative simplification for the exercise of this activity. • There are various parameters that must be improved to increase the profitability of the activity such as forest genetics, the improvement of harvesting techniques and work systems, the training of the workforce, the development of systems that improve the quality of the product obtained such as the "closed cup method", the labelling of the local product or the development of silviculture adapted for a main resin productivity.
Improved understanding of knowledge gaps	• Pine oleoresin, CTO and CST derivatives (all bio-based) are competing with petrochemicals derivatives and biofuels, and their main disadvantages are the price, the intensity of labour (especially for pine oleoresin derivatives) and their availability on the market. • Industries producing bio-based resin derivatives cannot sell commodities (to compete against fossil-based resins): they have to target specialised niches, unless they can increase the production of oleoresin, CTO and CST. In pine oleoresin, raw material is the bottleneck because of labour costs. This is not the case for CTO and CST. Industries also need more raw material coming com certified from sustainable forest

management sources. World-wide, only 25% of pine oleoresin comes from certified forests.

- Pine chemicals have their chances as there is an increasing environmental concern and demand for natural products: oleoresin is so pure that is the only resinous material authorised for human consumption products. Raw materials should be given more importance in the regulations.
- Pine oleoresin is versatile natural product and a very eco-friendly product. When processing it, manufacturers must avoid contaminating it with non-green chemical products, to preserve the product containing oleoresin derivatives as green as the oleoresin is.
- The most promising derivatives and desired qualities from oleoresin, CTO and CST (according to attendees to the 3rd interregional workshop; by decreasing order of importance): biodegradable products on top of bio-based, green fruit waxing, food and pharma products, 100% green derivatives, polymers from gum rosin, products with traceably and certification standards, compatibility between rosin derivatives and polyolefins, new esters for adhesives.
- At present there are no precise data on production and resin production potential in the Mediterranean area (as a whole) due to the absence of specialized systems for obtaining this type of parameters.
- Of 1.2 million metric tones of pine chemicals produced annually, only 50% is produced from forests certified as sustainably managed: this is a weakness and a challenge.
- The existing official registers of fiscal, economic or administrative nature offer partial and impractical information for the industry and forest management of the resin sector and are not enough for the precise evaluation and monitoring of forest resin production.
- The SiResin registration system is a good initiative, although the data collected is incomplete for the resource monitoring, the means of verification are not enough, does not provide users with any added value and is not easy for them to use.
- Although the economic agents of the sector have data on the actual production of resin exploitations, it is difficult for researchers to access these data as they are considered

	sensitive information, which makes it difficult to develop preliminary production models. • A precise version of a production model requires for its calibration long series of production, environmental and dasometric data. • The labelling of European natural resin is an important aspect to be developed because it contributes to enhancing several advantages of the sector: ✓development of a sustainable bio-economy with the production of natural products with high added value; ✓fixation or return of employment in rural areas; ✓production of positive externalities such as fire prevention or forest cleaning.
New knowledge gaps. New identified themes	• Monitoring of the global markets for natural resin, derivatives and substitutes. • Standardization of resin resource evaluation systems: methods of extraction, measurement and data treatment. • Study of the effect of resination on the phenomenon of *Pinus pinaster* decay. • Carbon footprint of natural resin derivatives from Mediterranean forests. • All products should have a renewable carbon label certifying the amount of carbon generated to produce it and which percentage is from renewable sources. • How can pine oleoresin derivatives industries be coordinated as HARRPA is doing for CTO and CST? Oleoresins and CTO-CST are different worlds, but with the same competitor: fossil-based materials. Both worlds have to write a story together. • How can the playing field be levelled between fossil- and bio-based materials? • Study of the possible impact of polluting elements and residues originated by the resin extraction activity, and reduction proposal. • Concretion on the role that resin producers can play in the prevention of fires, pests and diseases. • The physiological mechanisms linked to resination are still insufficiently described, and more research is needed, as well as the availability of long series of production, dendrometry and environmental data.

	• The *Pinus pinaster* decay syndrome requires an investment effort in research for a better understanding of the factors that produce it, as well as the strategic participation of managers, owners and forest workers in its eradication. • What business models are most suitable for the exercise of the resin extraction activity? How do the costs associated with the business model affect the price of the resin? • What are the socio-economic effects of the establishment of resin processing industries in the territory? Does it currently contribute to the fixation of the population in rural areas? • How do local people perceive the establishment and activity of processing industries? • How to finance the implementation and maintenance of a system of control and traceability of products derived from natural resin? • What mechanisms can support, encourage or finance public administration to consolidate the resin extraction from forests? • How to associate the activity of resin harvesting with other forest uses: hunting, habitat protection, public reception? • What complementary agroforestry activities can contribute to the sustainability of the resin worker's activity? • What are consumers' expectations of a label, a mark applied to the resin?
Potential solutions-Lessons learnt	• There is currently a lot of demands for natural products, so there were chances for the market to leave space for pine oleoresin derivatives. • Now is a good moment for European oleoresins: demand is high, prices also, China no longer exports. “Now is the perfect time to act”: the market is offering new perspectives for pine derivatives products. An important effort on communication needs to be made on the products, through storytelling and social medias. In EU, the consumer accepts to pay an extra price, but it needs to have a clear, touching story, with a vision! Some products are more appropriate than other. • The Covid-19 pandemics will have a key impact on the global market and openings for pine derivatives.

	• Development of a resin production model with Physiological Processes Predicting Grow (3PG) methodology. • Establishment of a network of test sites to obtain long series of production data. • Standardization of extraction methodology to obtain reliable production potential data comparable to each other. • Awareness among forest owners, resin producers and industry of the importance of their contribution to the establishment of the network of plots and the transfer of production data. • Drafting of confidentiality agreement to facilitate the contribution of georeferenced real production data by the economic agents involved. • Intra-seasonal monitoring of production by means of periodic resination in the proposed network of plots throughout the campaign. • Use of first-generation production models for the selection of areas of high production and productive classification of small-scale forest stands with application of the models through Geographical Information Systems. • Use of evolved production models for local use that allow estimating production at forest scale. • Use of the new resin parameters included in the next Spanish national forest inventory for the application of supraregional scale models. • Use of remote sensing systems and lidar technology to obtain stand scale variables and even individual trees for the application of evolved production models. • Multi-criteria analysis: The socioeconomic implications of the resination activity should be analyzed by means of a multi-criteria evaluation that, in addition to productive factors, considers the positive externalities, the contribution to environmental and social sustainability, and the ecosystem services it provides. • Proposal for a user-friendly digital system for the traceability of natural resin and its derivatives at European level, generating added value for the user in terms of logistics and administrative management, and allowing the monitoring and sharing of resin production data in real time. The system

should allow the capture of data relating to the type of stimulants used, damage and diseases observed in the mass of origin, aspects related to fire prevention and compliance with applicable rules for conservation of habitats and species.

- Reinforce knowledge and appreciation of the environmental values of local certified natural resin derivatives and their role in achieving Sustainable Development Objectives and generating positive externalities at different scales.
- Creation of an inter-regional register of forest owners, resin workers and first and second transformation industrial facilities, and implementation of a production declaration system.
- Creation of an observatory of the global market for natural resin, derivatives and substitute products.
- It seems essential to improve our knowledge of the profile of resin tappers as well as their expectations and problems. In order to increase the recruitment of workers, it seems necessary to understand which factors most influence their activity among institutional or commercial support for the new worker, the possibility of compatible and complementary jobs, access to technical training and appropriate tools and equipment.
- Public administration has an important role in stimulating the sector through different instruments: financial assistance, territorial contract, training assistance, creation of a network.
- We can use bio-based molecules (monomers) to produce any existing plastic, so industries using fossil-based monomers will not have to change too much their processes if they intend to replace them by bio-based molecules. So, do not change the products, change the "bricks" to use them.
- To be innovative, you have to produce products that will be adopted by industries and make products that are similar (in use) but better than the existing ones. If the new products are not better, they will have to compete on price (which is currently impossible when facing fossil-based products).
- The road from discovery to selling a product is a very long road: the thing entrepreneurs need mostly is confidence, because they need to persuade a lot of people. The most innovative products are not costumer driven. Established big companies have more financial muscle, but more to risk if

	they stop producing an existing product to launch an innovative one that does not succeed.

4.2. Conclusions of the Science to Practice Events

Wild nuts and berries iNet

The iNet of Wild Nuts and Berries organized a total of eight Science to Practice events (Table 10).

Table 10. List of Science to Practice events from Wild Nuts and Berries iNet

EVENT TITLE	ORGANIZING PARTNER	DATE
The chestnut orchards: an opportunity for the rural development	CNPF	27/06/2018
Técnicas de injerto en pino piñonero para plantaciones clonales	INIA	25/03/2019
El castaño: una oportunidad para el desarrollo rural del Bierzo oeste	CESEFOR	22/05/2019
Escenarios de Cambio climático y Producciones Forestales - ¿cómo se pueden adaptar las masas forestales? Claves para propietarios y gestores en la cuenca central del Duero	INIA	09/10/2019
From Research to Practice: Stone pine and pine nuts - more knowledge for a better management	ISA	30/10/2019
Pine forests in Tunisia: importance and perspectives of valorisation	INRGREF	13/11/2019
Impact du Phytophtora dans les châtaigneraies: du diagnostic à l'adaptation	CNPF	12/05/2020
Pinha e Pinhão: desafio e oportunidades	ISA	14/12/2020

The main conclusions of the events (see the full S2P event reports in the Report 2.3) are:

- In Spain, the first 15 elite clones of stone pine *Pinus pinea* for pine nut production have been registered after evaluation as basic materials, while Portugal counts already with a registered clone mixture for its use in grafted plantations. The establishment of mother tree orchards for graft scions has allowed forest nurseries to supply the sector with grafted trees. Next steps are capacity building in grafting, and development of logistics for scion supply to nurseries, as well as of quality standard for grafted treelets.

- Ongoing climate change is restricting further the current "(*no*-)business as usual" of drought-prone forests in Spain. The lack of private profitability is exacerbated by a mean property size of only 3 ha. Most of 0.7 million private forest owners in Castilla y León (2.5

M inhabitants) are non-professional, often absent urban dwellers. Solutions will require also social innovative collaborative schemes. This holds true for non-wood as well as for timber sourcing.

- In Tunisia, the lack of means against the cone pest *Leptoglossus* and the administrations being unable to manage the consequences have caused the threatening situation for stone pine. Also the artisanal process of pine nut extraction from cones requires appropriate technologies and equipment for more efficiency. As for the policy makers, urgent solutions and investments must be found to help preserve the future of stone pine forests and maintain a significant income for the population.

Cork iNet

The iNet of Cork organized a total of twelve Science to Practice events, corresponding to six one day events and two three-day events (Training Sessions) (Table 11).

Table 11. List of Science to Practice events from Cork iNet

EVENT TITLE	ORGANIZING PARTNER	DATE
Cork supply chain: Workshop on Actions and programs for the enhancement of cork cultivation	FORESTAS	26/09/2018
Cork supply chain: Workshop on Actions and programs for the enhancement of cork cultivation	FORESTAS	09/10/2018
La forêt de chêne-liège face aux changements climatiques: Défis et perspectives	INRGREF	19/03/2019
Advances in mechanization of the use of natural resin	CNPF	07/06/2019
From Research to Parctice: Agroforestry systems - cork oak and much more!	ISA	23/09/2019
Cork supply chain: Workshop on Prevention and management of Phytopthora spp. in Mediterranean oaks	FORESTAS	19/02/2020
Cork Quality Assessment Training	INRGREF, UNAC, INIA	7+9/10/2020
Cork Quality Assessment Training	FORESTAS, UNAC, ISA	18-19/11/2020

The main conclusions of the events (see the full S2P event reports in the Report 2.3) are:

- Research findings can fill some part of the existing knowledge gaps about the best options for cork oak management: e.g. genetic studies to improve adaptation to climate change and a greater resilience of the ecosystems.

- More efforts should be devoted to marketing tools and policies to improve multi-functionality and territorial marketing, fiscal regime, cost of labour etc.

- The Tunisian's cork oak forests phytosanitary state is good and are quiet resistant to the climate change; however, they are more vulnerable to humain pressure. The economic value of the forest can be inhanced with the reconciliation of the different stakeholders involved.

- The majority of the cork resource in Corse (France) is characterized by low-value male cork oaks. In a context of climate change where cork oaks are more vulnerable to abandonment, it is essential to develop innovative markets for male cork that must follow the political will of the island in terms of energy renovation of habitats.

- Cork oak management options should be decided “locally”, considering many factors at each stand: soil, water availability, site characteristics, tree density, tree sanitary conditions, age and stand goals. The continuous dissemination of research results among stakeholders will improve the decision-making process and support the sustainable management of cork oak stands.

Wild Mushrooms and truffles iNet

The iNet of Wild Mushrooms and Truffles organized a total of twelve Science to Practice events (Table 12).

Table 12. List of Science to Practice events from Wild Mushrooms and truffles iNet

EVENT TITLE	ORGANIZING PARTNER	DATE
Truffles in Istrian region, Croatia - forest management, policy for truffle management and trade analysis	CFRI	20/10/2018
Mushroom hunting regulated areas: Legal Framework and opportunities	CTFC	19/11/2018
Science to practice event - Rome - Italy	ETIFOR	24/11/2018
Science to practice event - Norcia - Italy	ETIFOR	24/02/2019
Truffles: Revealing the treasures of the forest	UOI	15/05/2019
How to enhance mushroom and truffle sector in Croatia?	CFRI	27/06/2019
Mushroom restricted areas: learned lessons	CTFC	18/10/2016

Seminar on the identification of edible mushrooms	UOI	14/11/2019
Mushrooms and truffles: From forest to table	UOI	15/02/2020
Drafting the Strategy of Sustainable truffle management of Varazdin County, Croatia	CFRI	01/05 – 30/06/2020
Wild mushrooms: sylviculture, production, tourism, consumption	CNPF	06-07/10/2020
From nursery to truffle cultivation	ETIFOR	22/12/2020

The main conclusions of the events (see the full S2P event reports in the Report 2.3) are:

- Constant communication and education among all stakeholders is needed. Learning from other partners is recommendable since many of the case studies can be transferred to Croatian terms.

- The mushroom regulated areas could be an opportunity for the valuation of the mushroom resources generating local economies. However, prior to start with such initiatives a consensus with all the involved stakeholders is needed.

- The truffles market in Italy and Croatia is mainly black, with criticalities in terms of taxation and fiscality, collaboration within countries is needed to regulate the market. In both countries there is a need of improving data and the statistics of the sector to improve transparency.

- Since the collection of truffles in Croatia is entirely orientated in the natural habitats all parts of value chain should be involved in making suggestions and recommendations in creating laws and regulations. It is also important to emphasize that truffle plantations that do not currently exist could strengthen the sector.

- Most territorial stakeholders have a marked interest in forest mushrooms and related issues. The west of the department of Haute Loire has already begun to address the issue of the tourist value of mushrooms. On the upstream part of the value chain, everything remains to be built. The existence of grouping structures for forest management can be a major asset to build on.

Aromatic and Medicinal Plants iNet

The iNet of Aromatic and Medicinal Plants organized a total of nine Science to Practice events (Table 13).

Table 13. List of Science to Practice events from Aromatic and Medicinal Plants iNet

EVENT TITLE	ORGANIZING PARTNER	DATE
Visit Distillery Bordas-Chinchurreta: A growth model in the essential oils sector in Spain	CTFC	28/11/2018
Gestion des ressources naturelles et conservation de la biodiversité: Opportunités et perspectives du secteur des plantes aromatiques médicinales	INRGREF	16/01/2019
Renforcement des capacités de production, marketing et communication des PME et GDA	INRGREF	11/04/2019
Medicinal Plants and their uses in modern Medicine	UOI	08/05/2019
Professional cultivation of aromatic and medicinal plants (MAP's): obtaining essential oils	CTFC	14/06/2019
Aromatics and medicinal plants in Croatia - State of art	CFRI	26/06/2019
Tènchnical field trip: experiences of maps production	CTFC	16-18/07/2019
Using DNA metabarcoding to monitor the illegal trade in medicinal plants and protected orchids, and to detect adulterations in food	UOI	31/01/2020
Aromatic and Medicinal Plants (MAPs) after COVID: what should we expect?	UOI	21/12/2020

The main conclusions of the events (see the full S2P event reports in the Report 2.3) are:

- It is necessary to find a way to work together with companies that use wild plants in order to guide the local production of raw materials.
- There is a real opportunity to produce essential oil crops in Catalonia but, it is necessary to create a main distillation centre capable of processing MAP production from areas larger than 300 ha.
- It is necessary to organise the MAP production by areas and to choose between the different MAP species according to market demand and for that it is convenient to do it in cooperation whit a company or a laboratory that uses essential oils.
- In Croatia there are not a lot of available information about AMP plantations and only a small part of producers are properly educated; so sharing informations and education is first step to improve the sector.

- Following the demand for natural and organic origin of products, the need for accurate and reliable methods for plant species identification in nature and in food products has steadily increased during past decades, particularly with the recent food scares and the development of trade and technological progress in food production. Moreover, the development of high added value products based on plants has raised concerns about adulteration. Thus, reliable methods to protect the producer, the company and the customer are needed.

Resin iNet

The iNet of Resins organized a total of eight Science to Practice events (Table 14).

Table 14. List of Science to Practice events from Resin iNet

EVENT TITLE	ORGANIZING PARTNER	DATE
Tournée forestière	CNPF	15/06/2018
Réunion sur les nouveaux débouchés de la résine de pin maritime	CNPF	27/06/2018
Réunion technique	CNPF	06/09/2018
Future of mechanization of forest resin extraction works to improve profitability, quality and compatibility of forest uses	CESEFOR	23/10/2018
Mejora de la producción resinera mediante mejora genética: familias grandes productores	INIA	24/10/2018
Resin Use, Territorial Development and Demographic Challenge	CESEFOR	05/11/2019
Pine tapping in Tunisia: New socio-economic opportunities?	INRGREF	08/09/2020
Redes colaborativas sobre la resina como materia prima para la bioeconomía	INIA	16/12/2020

The main conclusions of the events (see the full S2P event reports in the Report 2.3) are:

- The silviculturists consider the activity of resin extraction as a cultural heritage of the Landes, France. They have therefore shown their interest in resuming the activity and many of them wish to participate in other events or meetings concerning the transformation and enhancement of the resin.

- Improving the performance of the traditional manual resination method saves time and effort to resin harvesters. Research and advances in mechanization technology (such as new or improved tools like the mechanized resin collector tractor) are essential so that this activity is profitable in local forests, creating employment and incorporating women into the sector. Adaptation of the North American resin tapping system by basal drill or borehole system to the Spanish pine forests, can be a complementary method to the traditional resin system.

- Extracting resin from pine trees offers a new socioeconomic opportunity in Tunisia; first to reduce the pressure on other resources and second to provide additional income to the forest population. Success stories provided the first steps towards new opportunities. However, an efficient application requires an adequate adaptation to the local context.

- Official statistics and information systems for NWFP relay on the diligence of reporting bottom-up and with plausibility checks. As long as input data are incomplete, global figure will underrepresent actual productions. For example, pine cones are exported unprocessed between Portugal, Spain and Italy, hence, the registered location of pine nut extraction can be quite distant from the place the cones were harvested. Only due diligence of all value chain actors for reporting actual flows and transaction will allow for sound figures. In case of resin, were no quality classes are paid differently, as for instance in cork, the most interesting value for forest owners and resin tapper would be to know the resin yield per tree (ranging from 2 to more than 5 kg per year) for agreeing fair lease fees. Nevertheless, few regional reference values are known, and research is needed to predict yields from tree parameters.

4.3. Conclusions of the DELPHI-like surveys

Improved description of the value chains

The value chains of the different products have been initially described during the iNet Scoping Seminars. The expert panelists contributed to refine the ecosystem map that describes the flows and stakeholders involved in the process of harvest/production of the targeted product, his transformation and the commercialization of such products. The Figures 1 to 7 graphically describes the value chains of the different non-wood forest products addressed in the INCREDIBLE project.

The chestnuts are harvested from forests, but more often from groves or modern orchards employing grafted cultivars or varieties, sometimes even private owned on rented public forest land. The harvest is performed normally by the owner or hired hands, and can be traded directly to factory or in fresh to commerce, through cooperatives or, still as in former times, on-farm to itinerant traders, often informally (Figure 1).

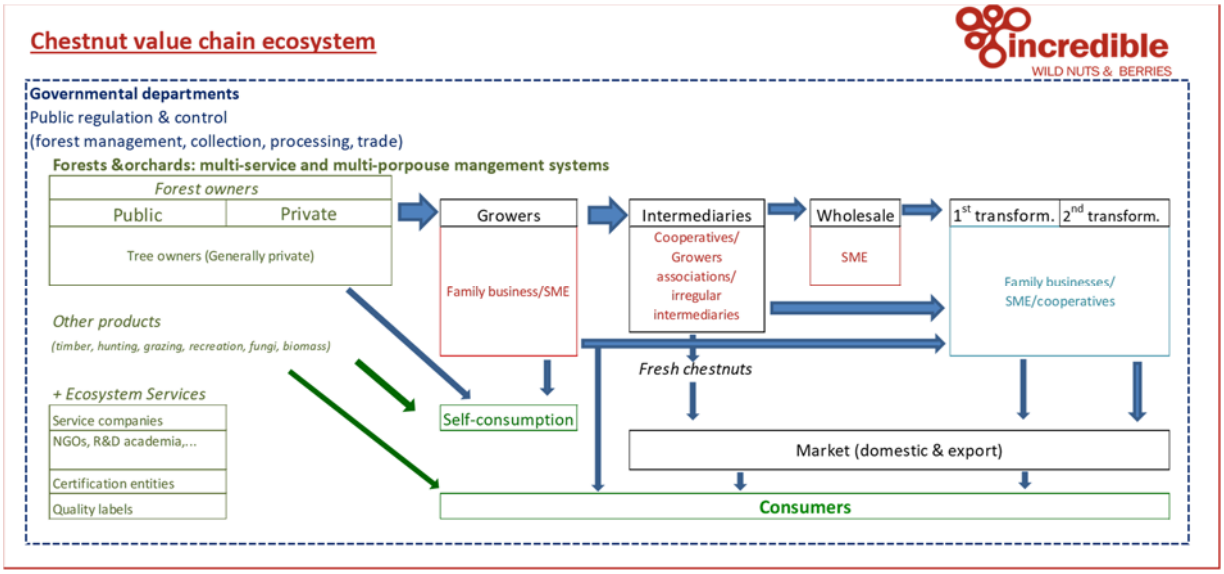

Figure 1. Chestnut value chain ecosystem.

The strict value chain of the Mediterranean pine nuts is centred in the flow of cones, nuts and kernels from the forest to the consumer, depicted in the middle of Figure 2, where the successive products are processed and sold: closed cones are picked, or today harvested by tractor-implemented tree shakers, from forests or plantations during autumn and winter, stored until opening by heat (traditionally by sun exposure in summer, lately in cone-debry biomass fed stoves gaining months in commercialisation) for seed extraction. The seeds, a.k.a. pine nuts, can be stored in dry and cold for years, or be directly processed (shelled) obtaining the white edible kernels, and shells as more woody debris a fuel.

Often the same enterprise integrates several links of the chain (harvesters that process or processors that have own harvest crews), cooperatives or shared processing facilties between several small family entreprises, which are strongly concentrated locally in a few villages or counties

with pine cone processing tradition, namely around Pedrajas de San Esteban in Castile (Spain), Villaviciosa de Córdoba and Almonte in Andalusia (Spain), Alcácer do Sal in Portugal, Kozak in Turkey and one big enterprise near Napolis in Italy. Cones, pine nuts in shell and kernel are traded and resold during the season between autonomous cone pickers, family enterprises, processors, and cooperatives (crisscrossing arrows in the figure).

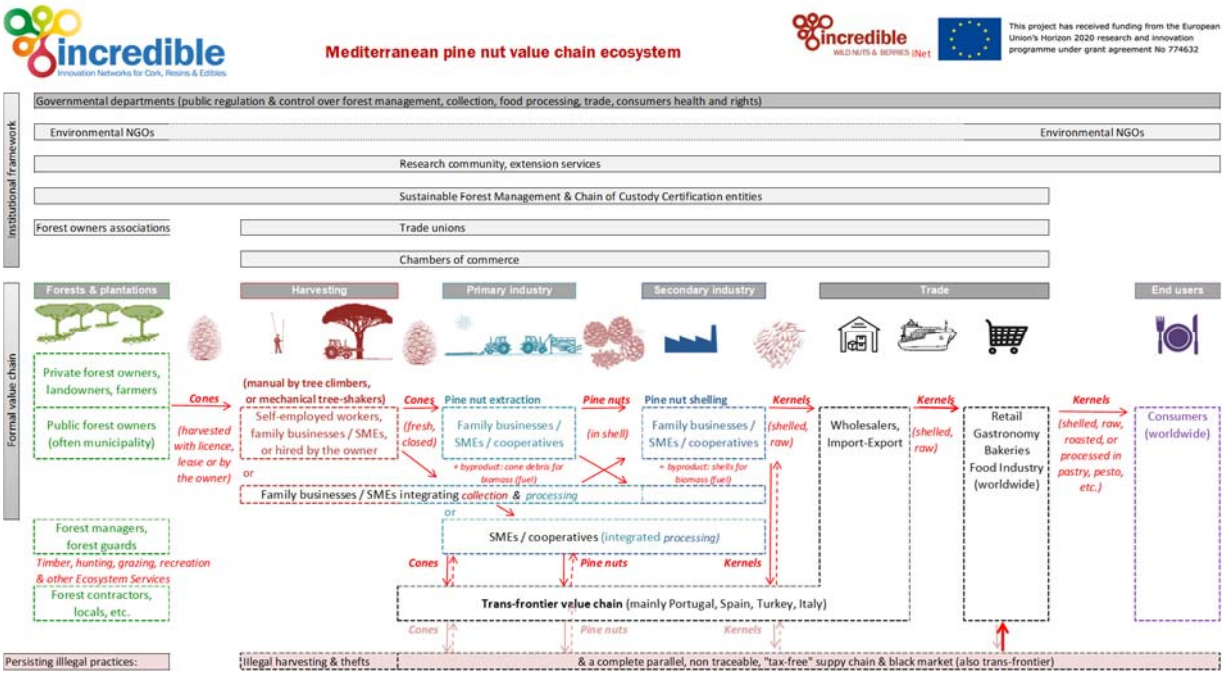

Figure 2. Mediterranean pine nut value chain ecosystem

The iNET Cork Value Chain is organized between four different kind of actors. Beginning in the forest (1st chain link), cork oak forests are managed by private and public landowners, sometimes with the technical support from local or regional associations or cooperatives of landowners. Cork harvesting (2nd chain link) is made mainly through forest contractors, that can be or not the buyers (cork intermediaries) when the cork business is not established directly with the Cork industry.

At the industry, between the preparation and the trading, several products are obtained from cork according to the type of industry: manufacture, granulates and agglomerates. Different qualities of cork are used and transferred between the different industries until the final products – natural cork stoppers, natural cork discs, granulates, champagne cork stoppers, agglomerated cork stoppers, constructions materials (isolation, flooring, etc), black and white granulates.

The main consumer is the wine industry for wine closures and after that the wine consumers. The new products developed in the past years allowed a higher diversification on the industry side, adding to the most common ones (wine industry, construction sector, furniture and flooring) new industries like aerospace, transportation and mobility, fashion and footwear, just to mention a few of them (Figure 3).

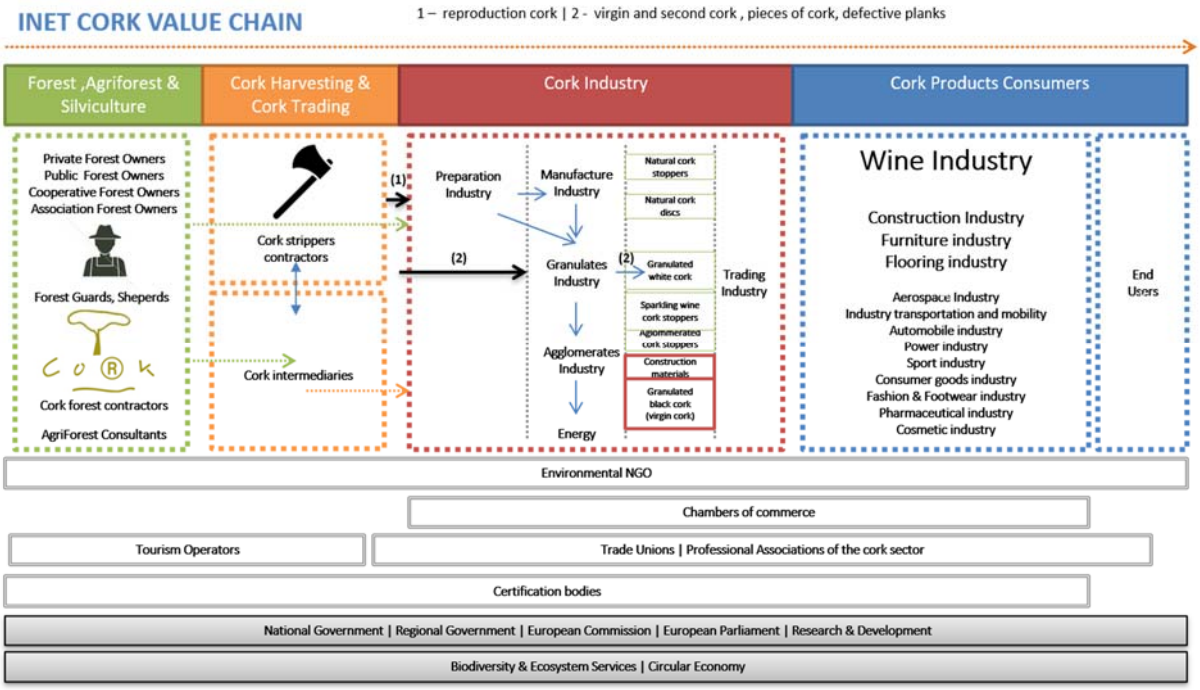

Figure 3. Cork value chain ecosystem

Wild Mushrooms are usually picked by commercial or recreational pickers, with a not always clear distinction between both categories. The picking permission, both in public or private forest lands has not a clear pattern, not only at country level but also at regional or municipal level. The mycological associations or clubs have also a key role in spreading the mycological culture (although in several regions of Greece associations members started to trade mushrooms too, provoking conflicts). In several forest areas, picking permits are well established and accepted by the pickers, but this is not generalized in the Mediterranean area. Wild Mushrooms (picked in the Mediterranean area or imported from other countries) may be consumed as a fresh product or processed product.

Direct selling to other mushroom pickers or final consumers, either restaurants or private individuals, is allowed in France, but normally trading centers or commercial intermediaries intervene in the value chain. General Wild Mushroom trade flow follows the sequence: pickers-intermediates (buy-sale centers) - trader companies (wholesale markets) or retailers or hotels and restaurants – final consumers. The touristic value chain has been established more recently, expanding the traditional Wild Mushroom value chain. Valuable examples of mycotourism already exist in Mediterranean, but this is not very developed yet (Figure 4).

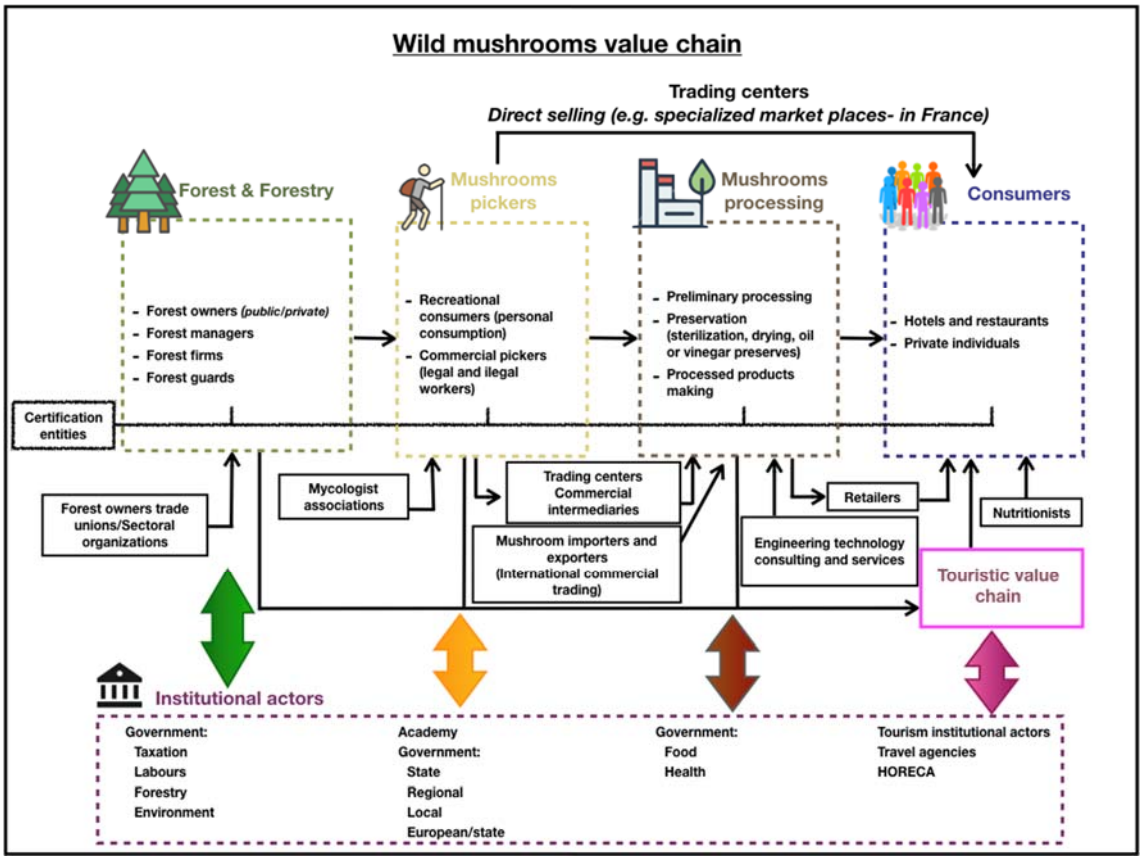

Figure 4. Wild Mushrooms value chain ecosystem

Historically, the truffles were collected from the wild, but the success in inoculating host trees with *Tuber melanosporum* beginning in the 1970's, opened the door to the black truffle cultivation in managed plantations. The commercialization of inoculated seedlings provoked the expansion of the black truffle cultivation and today produce the larger part of marketed truffles, while the quantity of wild truffles collected has been dropping since the last century. In the black truffle plantations, the figure of the owner and the collector normally coincides, but a new figure of the professional truffle picker who collects truffles in others' plantations has merged in recent times. In the case of wild truffières, the situation was the opposite. The truffle pickers are not normally the forest owners, and they may pick truffles in forests that have a truffle picking concession, in free forest areas or directly without permission in forest areas public or privately owned. Once the truffle is picked, the wild and cultivated sub-value chains merged, not distinguishing between the origins. The truffle may be directly consumed as a fresh product, be processed (preserved food) or used as an ingredient for manufactured food products. The direct selling between producers and consumers already exists, but the normal channel is through the industry and/or retailers. The general roadmap from producer to consumer includes the truffle intermediary or trading companies (wholesalers) – retailers – final consumers. The touristic value chain, including truffle picking and truffle consumption in restaurants is relatively recent, with a heterogenity in their development in the Mediterranean area (Figure 5).

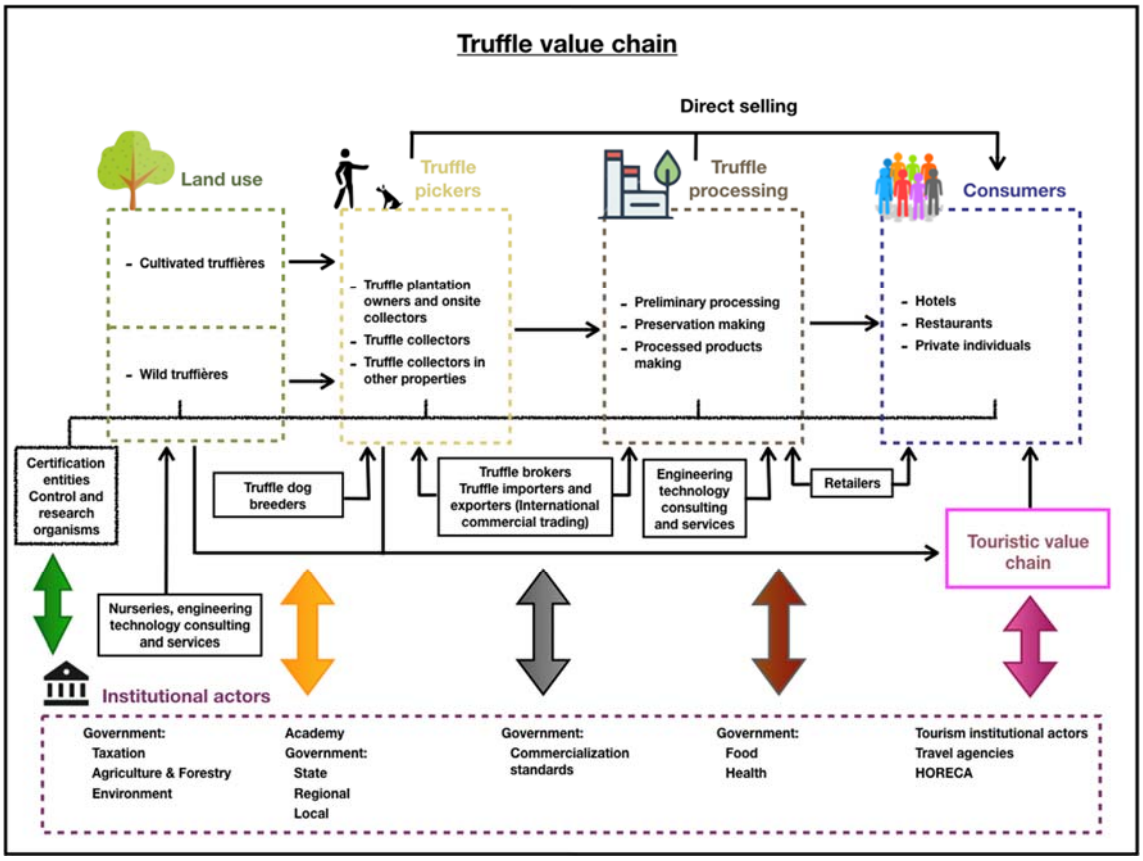

Figure 5. Truffles value chain ecosystem

The value chain of Medicinal and aromatic plants harvested in wild consists of plant products used in the perfume, cosmetics, food and pharmaceutical industries. The AMP value chain involves diferent levels of actors:

1. **MAPs collectors:** they harvest vegetal material from forest areas (public or private). This group includes local population (self-employed workers) organised or not in cooperatives, agricultural development groups and private companies. This actor is considered one of the main stakeholder in the value chain and should be sensitive to biodiversity conservation by applying conservation practices. The collectors often process the harvested herbs and make final products that are sold directly to consumers adding value to their activity. Sometimes, and specially for some species, the harvesters sell the plant material (dried or fresh) directly to laboratories or retailers who condition them to offer it to the final consumer or to the user industry.
2. **MAPs industry:** this category includes processing industry (obtaining raw materials from the plants harvested: dried plant, essential oils, natural extracts, etc. or prepare the processed plant received from the harvesters) and user industry (those who integrate the raw materials in the production of products: food industry, pharmaceutical industry, etc). In addition to MAP harvesting, local population and development groups can also sell essential oils and dried plants to large firms.
3. **Public authorities:** different administrations (Government: technical and control aspects and "academic sector") intervene in all of the value chain.
4. **End users:** They are at the end of the value chain as consumers of a large number of products made from wild harvested plants. Is this group that is increasingly aware of the

importance of product traceability and greater control for sustainable harvesting. emanding more product traceability and greater control for sustainable harvesting.

The MAP value chain is characterised by the informal nature of its upstream base (some collectors without permits) and it is better organised and has more formally structured stakeholders' downstream (processors, wholesalers and retailers). Summing up, the value chain operated with little vertical integration and almost few horizontal collaborations. Collectors have limited access to the end-market information, obtain low benefits in comparison with other actors, and are the least integrated in the value chain. Moreover, interaction between researchers (academic sector) and processors is almost absent to valorise research outputs (Figure 6).

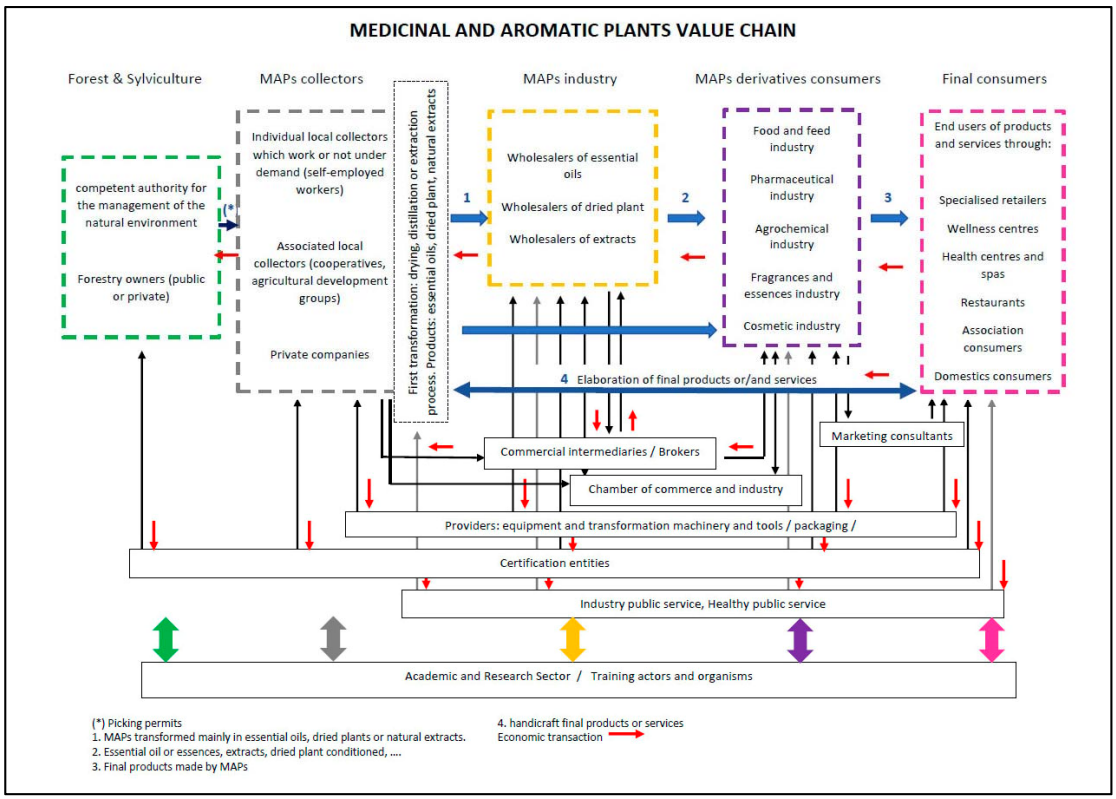

Figure 6. Aromatic & Medicinal Plants value chain ecosystem

There are two origins for the raw material for resin based products value chain; the oil Industry, which produces hydrocarbon resin, and the pine forest, where the natural resin is yield. The natural resin shows, likewise, two different sources, one through the pulp industry, from logged trees and finally from standing trees. The described value chain in this image responds to this last raw material. The ecosystem of the natural resin value chain in the Mediterranean region is characterized by a first distinctly forest segment (0). The pine crude oleoresin extraction from pine trees is carried on by the resin tappers (1), they are specialized forest workers under forest manager supervision. The raw material collected by these workers is initially processed by the primary industry (2) by distillation into colophony (3), turpentine essence (4) and water. These products are then inserted into more sophisticated chains through the chemical transformation of the essential resin components (5) (6). Its technological versatility takes the compounds derived from natural resin to the final consumer (7) as part of high value-added products such as cosmetics, adhesives, inks and coatings or pharmaceutical products among others. The ecosystem is completed with administrative bodies, sub-sector organizations and academic and research institutions that intervene in each one of the value chain links (Figure 7).

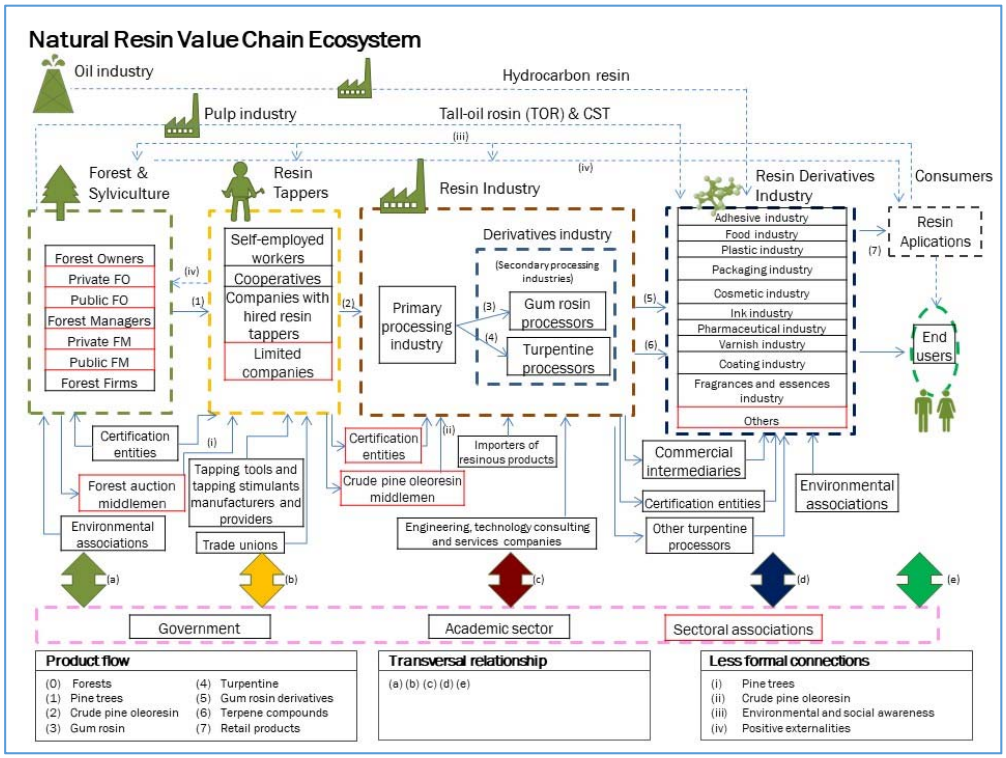

Figure 7. Natural Resin value chain ecosystem

SWOT analysis

The SWOT analysis stands for Strenghts, Weaknesses, Opportunities and Threats for a certain company or sector. In the case of the INCREDIBLE project, the five iNets compiled several SWOT statements during the different events which have been send to the expert panelists for their consideration. The different iNet panels weighted the statements correcting and/or suggesting some new ones. Tables 15-18 summarizes the top ranked Strengths, Weaknesses, Opportunities and Threats selected by the expert panels for the analyzed non-wood forest products (See full DELPHI survey reports for full statement rank in the Report 2.3).

Table 15. Top ranked strengths identified by the iNet expert panels (Only marks higher than 7 have been included in the table).

STRENGHTS	Mark (SD) (0-10)*	NWFP product (iNet)
High quality product (high nutritional value)	9.4 (0.8)	Chestnut (Wild Nuts and berries iNet)
Gluten-free food for coeliac diets	8.3 (2.1)	Chestnut (Wild Nuts and berries iNet)
Versatile ingredient for salt or sweet dishes	8.0 (2.0)	Chestnut (Wild Nuts and berries iNet)
High estimations by consumers (traditional and well-known food, cultural heritage, value-creating natural resource, ecosystem value from additional ecosystem services)	7.3 (1.7)	Chestnut (Wild Nuts and berries iNet)
High quality product (nutritional values, culinary cultural heritage)	9.0 (08)	Pine nuts (Wild Nuts and berries iNet)
Tree well adapted to semiarid conditions and poor soils	7.6 (0.8)	Pine nuts (Wild Nuts and berries iNet)
Cone collection mechanised	7.2 (1.6)	Pine nuts (Wild Nuts and berries iNet)
Co-production from multi-functional pine forests	7.1 (2.6)	Pine nuts (Wild Nuts and berries iNet)
Natural, renewable and recyclable product	10.0 (0.0)	Cork
Valuable and unique product	9.7 (0.7)	Cork
Multifunctional system	9.2 (0.9)	Cork
Relevance in terms of biodiversity conservation and other ecosystem services provision	9.2 (1.0)	Cork

Economic value of cork market	8.2 (1.0)	Cork
The work being done in tourism and particularly in gastronomy is rather relevant. There are many chefs and nutricionists interested in promoting culinary value of mushrooms with excellent added value possibilities	8.2 (1.3)	Wild Mushrooms (Wild Mushrooms and truffles iNet)
Mediterranean ecosystem harbour a big diversity and quality of the mycological resource: Sepecies and yields of great quality, very appreciated at both world and local level, with very well recognized and appreciated species such as Boletes	8.0 (2.0)	Wild Mushrooms (Wild Mushrooms and truffles iNet)
Mushroom picking is strongly linked with other environmental outdoor activities that are increasing their relevance. Wild mushrooms are associated with natural ecosystems (clean activities, healthy…)	7.5 (1.7)	Wild Mushrooms (Wild Mushrooms and truffles iNet)
High product demand, both internationally and locally with reasonable mature markets	7.4 (1.5)	Wild Mushrooms (Wild Mushrooms and truffles iNet)
There is a high entrepreneurship attitude, together with a relevant knowledge of the entrepreneurs in several regions of the Mediterranean	7.3 (1.5)	Wild Mushrooms (Wild Mushrooms and truffles iNet)
The truffle is characterised by a very passionate dimension (e.g.: working with a dog) also obtaining additional incomes	9.1 (0.8)	Truffles (Wild Mushrooms and truffles iNet)
The truffles are very unique products, recognized by their organoleptic quality, highly appreciated in gastronomy	9.0 (1.2)	Truffles (Wild Mushrooms and truffles iNet)
Increasing awareness of the truffle possiiblities in culinary world	8.8 (0.6)	Truffles (Wild Mushrooms and truffles iNet)
There are strong business companies in the Mediterranean that are leading the sector	8.4 (1.2)	Truffles (Wild Mushrooms and truffles iNet)
The cultivation of black truffles is compatible with environmental conservation as it is easily adaptable to organic farming requisites	8.2 (1.5)	Truffles (Wild Mushrooms and truffles iNet)
MAP's use comes from traditions in all countries	8.9 (1.4)	Wild Medicinal and Aromatic Plants
Local processing companies	8.5 (1.5)	Wild Medicinal and Aromatic Plants
Consumers become increasingly interested in alternative and natural medicine/increasing interest and demand in natural products (cosmetics, food supplements, etc…)	8.2 (1.1)	Wild Medicinal and Aromatic Plants

Picking allows production with no additional costs	8.1 (1.4)	Wild Medicinal and Aromatic Plants
Independent work for some pickers	7.8 (1.6)	Wild Medicinal and Aromatic Plants
Renewable, biological, biodegradable and sustainable raw material	9.6 (0.9)	Resin
Local job generator	8.9 (0.7)	Resin
The natural resin extraction is an activity that fits perfectly with the multiple use forest use	8.2 (1.6)	Resin
Socially rooted and generating a valuable local culture	7.6 (2.1)	Resin
Good first and second processing industry in the territory	7.2 (1.5)	Resin

*The mark ranges between 0, non relevant to 10, highly relevant. SD means standard deviation

Table 16. Top ranked weaknesses identified by the iNet expert panels (Only marks higher than 7 have been included in the table).

WEAKNESSES	Mark (SD) (0-10)*	NWFP product (iNet)
Chestnut ink disease (*Phytophthora* sp.)	9.0 (1.4)	Chestnut (Wild Nuts and berries iNet)
Chestnut grove management is not professional (smallholding, unclear ownerships, low association degree, low knowledge or technical transfer, traditional practices without scientific baseis, over-mature, infested groves)	7.3 (2.2)	Chestnut (Wild Nuts and berries iNet)
Biological or integrated pest control not available	8.3 (1.4)	Pine nuts (Wild Nuts and berries iNet)
Low productivity from drought-prone forests (strong masting and frequent crop failures due to droughts)	8.1 (0.6)	Pine nuts (Wild Nuts and berries iNet)
Consumers confusion with cheaper Asiatic pine nuts	7.8 (0.8)	Pine nuts (Wild Nuts and berries iNet)
Lack of control and reporting of production and prices	7.8 (0.6)	Pine nuts (Wild Nuts and berries iNet)
Current forest stands already on the rear edge under climate change	7.6 (1.3)	Pine nuts (Wild Nuts and berries iNet)
Cork quality and quantity decrease	8.0 (1.3)	Cork

Cork oak decline trend (e.g.: aged forests)	8.0 (1.6)	Cork
Low profitability (investments with long term economic results)	7.8 (1.7)	Cork
Lack of strong European lobby	7.7 (2.0)	Cork
Lack of silvicultural knowledge	7.6 (2.0)	Cork
Lack of organization of the sector with still informal markets and operators not compliant with legal regulations in the Mediterranean Europe, favoured by the differential mandatory food certificate systems in all European countries	8.1 (2.4)	Wild Mushrooms (Wild Mushrooms and truffles iNet)
Absence of an European legal framework for mushroom market food chain	8.1 (2.4)	Wild Mushrooms (Wild Mushrooms and truffles iNet)
Conflicts between value chain actors (industry-mycologists)	8.1 (2.5)	Wild Mushrooms (Wild Mushrooms and truffles iNet)
There is a great deal of international competition and lack of traceability in mushroom products, fresh and processed	7.5 (2.4)	Wild Mushrooms (Wild Mushrooms and truffles iNet)
Informal markets, opacity and lack of traceability in the Mediterranean Europe	7.3 (2.6)	Wild Mushrooms (Wild Mushrooms and truffles iNet)
Truffle growers have to contribute to the agricultural social security as soon as they start the activity whereas the truffle production will only take place after years or so	8.9 (2.0)	Truffles (Wild Mushrooms and truffles iNet)
Consumers are not sufficiently informed about truffles and truffle products and their urse in cooking, gastronomy	8.6 (2.0)	Truffles (Wild Mushrooms and truffles iNet)
In spite of associationism, the productive sector is atomized and non-professional. There is an increase of local iniciatives, but a lack of cooperation for the development of greater scope projects	8.4 (1.4)	Truffles (Wild Mushrooms and truffles iNet)
Imprecise management techniques (i.e.: irrigation management, weed control, fertilization, pruning) for truffle cultivation	8.2 (0.7)	Truffles (Wild Mushrooms and truffles iNet)
The return of investment period is long for black truffle plantations (in comparison with other agricultural products)	7.9 (2.0)	Truffles (Wild Mushrooms and truffles iNet)
Lack of organized national-EU plan for the MAPs	8.3 (1.9)	Wild Medicinal and Aromatic Plants

The collectors needs to be trained in botanical and collection practices to avoid bad practices	8.2 (1.3)	Wild Medicinal and Aromatic Plants
Collectors have little information (training) on plant identification, phenology, good harvesting and processing practices, and sustainable management	8.2 (1.3)	Wild Medicinal and Aromatic Plants
Insuficient formation along the value chain	8.2 (1.3)	Wild Medicinal and Aromatic Plants
Fragmented production (small amounts and lack of cooperation) which hinders common access to the market)	8.1 (0.8)	Wild Medicinal and Aromatic Plants
Lack of knowledge on the part of end consumers of the environmental benefits produced by the natural resin sector	8.2 (0.8)	Resin
Lack of communication between tappers and resin industry to face situations of fluctuaction in the price of the resin raw material	8.2 (2.5)	Resin
Lack of associations that protect the tapper and that bring knowledge to the situation of the sector in the present ambiguous conditions	8.0 (2.5)	Resin
Low efficiency of the tapping techniques	7.7 (2.0)	Resin
State of abandonment of the forests	7.6 (3.4)	Resin

*The mark ranges between 0, non relevant to 10, highly relevant. SD means standard deviation

Table 17. Top ranked opportunities identified by the iNet expert panels (Only marks higher than 7 have been included in the table).

OPPORTUNITIES	Mark (SD) (0-10)*	NWFP product (iNet)
Improved marketing strategies (fairs, "chestnut culture")	9.0 (1.2)	Chestnut (Wild Nuts and berries iNet)
Improved management techniques (R&D based)	8.4 (1.9)	Chestnut (Wild Nuts and berries iNet)
New products and markets (chestnut beer, gluten-free flour...)	8.1 (1.9)	Chestnut (Wild Nuts and berries iNet)
Sustainability of cultivation (low-input, near-to nature orchards)	8.0 (1.3)	Chestnut (Wild Nuts and berries iNet)
Sustained and growing demand (traditional natural & healthy food)	8.0 (1.3)	Chestnut (Wild Nuts and berries iNet)

Expansion in new plantations (open grown, grafted)	8.4 (1.3)	Pine nuts (Wild Nuts and berries iNet)
Consumers's awareness (gourmet wild food, healthy and sustainable lifestyle)	7.8 (1.9)	Pine nuts (Wild Nuts and berries iNet)
Protected Geographical indication labels (PGI, PDO, etc…)	7.3 (1.5)	Pine nuts (Wild Nuts and berries iNet)
Organic food certification	7.3 (1.8)	Pine nuts (Wild Nuts and berries iNet)
Green ecnomy driver	9.6 (0.5)	Cork
Multifunctionality policies	8.8 (0.9)	Cork
New markets and products	8.8 (1.1)	Cork
Circular economy	8.7 (0.9)	Cork
Industrial demand increase (wine industry, construction sector, …)	8.4 (1.4)	Cork
Create a real common market organization specifically for wild mushrooms (and other wild products) with common health procedures and labelling	9.3 (1.1)	Wild Mushrooms (Wild Mushrooms and truffles iNet)
Mycotourism with a set of alternatives including mushroom picking, gastronomy, etc. Increase of interest in rural culture, gastronomy and nature	8.0 (2.1)	Wild Mushrooms (Wild Mushrooms and truffles iNet)
Increase of interest of mycological and gastronomic culture at both regional Mediterranean Europe and global scale	7.4 (3.0)	Wild Mushrooms (Wild Mushrooms and truffles iNet)
There are a lot of mushroom species that will be appreciated in the future (food, medicine, cosmetics…) and that remain totally or partially unknown	7.0 (2.4)	Wild Mushrooms (Wild Mushrooms and truffles iNet)
Development of quality brands, mainly for fresh mushrooms, following the example of Fungo di Borgotaro	7.0 (2.8)	Wild Mushrooms (Wild Mushrooms and truffles iNet)
Big potential for touristic and gastronomic activities linked with the truffles	8.9 (1.0)	Truffles (Wild Mushrooms and truffles iNet)
Mediterranean countries still have high potential for truffle cultivation	8.4 (1.1)	Truffles (Wild Mushrooms and truffles iNet)

Integration of the truffle with other products with high rural values that will be attractive with other products with high rural values for a luxury tourism ("terroir" concept) in several regions	8.4 (1.2)	Truffles (Wild Mushrooms and truffles iNet)
Markets are still demanding more truffles, both fresh and processed	8.3 (1.1)	Truffles (Wild Mushrooms and truffles iNet)
Increasing market trend of high quality, ecologic and proximity products (three of the main features of the truffles)	8.0 (1.2)	Truffles (Wild Mushrooms and truffles iNet)
Promoting the creation of collectors' associations and cooperatives for the processing of harvested plants	9.0 (0.8)	Wild Medicinal and Aromatic Plants
There is still room for growth of MAP's sector	8.4 (1.4)	Wild Medicinal and Aromatic Plants
Consumers expect more and more local and "traditional" plants	8.4 (0.7)	Wild Medicinal and Aromatic Plants
Access to local markets and short marketing channels	8.3 (0.9)	Wild Medicinal and Aromatic Plants
Sector aligned with bio-economic strategies	8.1 (1.9)	Wild Medicinal and Aromatic Plants
Sector that fits into the circular bio-economy scheme	8.7 (0.5)	Resin
Sector aligned with bio-economic strategies	8.7 (0.5)	Resin
Natural resins derived products demanded by the European market	8.6 (0.9)	Resin
Product and activity aligned with climate change EU strategies: mitigation and adaptation	8.4 (1.1)	Resin
The existence of large areas of maritime pine for timber production in the Mediterranean region, which are a potential source of resin production	8.0 (0.7)	Resin

*The mark ranges between 0, non relevant to 10, highly relevant. SD means standard deviation

Table 18. Top ranked threats identified by the iNet expert panels (Only marks higher than 7 have been included in the table).

THREATS	Mark (SD) (0-10)*	NWFP product (iNet)
Climate change (droughts, wildfire risk, decline of old groves)	8.9 (0.3)	Chestnut (Wild Nuts and berries iNet)
Upcoming pest & diseases (e.g.: brown rot, *Gnomoniopsis castaneae)*	8.2 (1.6)	Chestnut (Wild Nuts and berries iNet)
Leptoglossus occidentalis, exotic conifer seed bug	8.8 (0.8)	Pine nuts (Wild Nuts and berries iNet)
Precocious cone collection before ripeness (& cone theft)	8.3 (1.4)	Pine nuts (Wild Nuts and berries iNet)
Climate change (increasing droughts)	8.2 (1.0)	Pine nuts (Wild Nuts and berries iNet)
Competition from imports of different Asiatic pine nuts	8.0 (0.5)	Pine nuts (Wild Nuts and berries iNet)
Absence of longterm policies	8.6 (1.6)	Cork
Climate change	8.3 (1.4)	Cork
Land & management abandonment (e.g.: increase the forest fire risk)	7.8 (1.9)	Cork
Economic crisis	7.3 (1.6)	Cork
Loss of forestry culture	7.3 (2.0)	Cork
Several value chain actors are not compliant with the law remaining uncontrolled (including several restaurants who continue to purchase mushrooms from informal pickers)	7.8 (1.4)	Wild Mushrooms (Wild Mushrooms and truffles iNet)
Big disturbances/Large events such as mega-fires or accidents (even if local effect) that affect the mushroom yields	7.6 (1.9)	Wild Mushrooms (Wild Mushrooms and truffles iNet)
The increase of interest in the fungal related activities by mycologists, protectionists and general public may put pressure on politicians who could over protect the forest ecosystems provoking underised impacts to the all mushroom market	7.3 (2.1)	Wild Mushrooms (Wild Mushrooms and truffles iNet)

Present pandemic and future global events that will create economic crisis in tourism sector	9.3 (0.9)	Truffles (Wild Mushrooms and truffles iNet)
Use of phytosanitary produts which can provoke contamination of the truffles, altering the image of natural product	8.9(1.9)	Truffles (Wild Mushrooms and truffles iNet)
Big disturbances/Large events such as mega-fires or accidents (even if local effect) that affect the truffle yields	8.2 (1.9)	Truffles (Wild Mushrooms and truffles iNet)
Increase of wild board populations which are damaging the mostly wild truffle population (in spite of their ecological role of spreading spores)	8.1 (1.7)	Truffles (Wild Mushrooms and truffles iNet)
The chemical compounds that may substitute the truffles in cuisine	7.7 (3.0)	Truffles (Wild Mushrooms and truffles iNet)
Overharvesting	9.2 (0.9)	Wild Medicinal and Aromatic Plants
Difficult availability of specialised and temporary workers	8.8 (0.6)	Wild Medicinal and Aromatic Plants
Production from third countries under much more “low” production requirements	8.6 (0.5)	Wild Medicinal and Aromatic Plants
Competition from third countries (not EU)	8.3 (1.3)	Wild Medicinal and Aromatic Plants
Forest management can threaten some MAP populations (e.g: *Allium ursinum*, wild garlic) due to bad practices	7.5 (1.8)	Wild Medicinal and Aromatic Plants
Fluctuation in the price of natural resin and its derivates	8.9 (1.1)	Resin
Competition from natural resin sources in third countries	8.6 (2.1)	Resin
Petroleum derivatives competition	7.8)1.3)	Resin
Competition from alternative products	7.6 (1.7)	Resin
Climate change	7.5 (1.9)	Resin

*The mark ranges between 0, non relevant to 10, highly relevant. SD means standard deviation

Identified challenges

The SWOT analysis carried out by the iNets, allowed to identify a set of challenges that are classified according to their position in the value chain, namely production & harvesting, processing & transformation, commercialization, market development, research as well as other challenges. Tables 19 to 25 rank the most relevant challenges per product identified by the different expert panels.

Table 19. Top ranked challenges of the chestnut sector identified by the expert panel (Only marks higher than 7 have been included in the table).

CHALLENGE	Type of challenge	Mark (SD) (0-10)*
Adaptation to changing climate	Production/harvesting	9.4 (0.9)
Effective, integrated management of pests and diseases	Production/harvesting	9.1 (0.9)
Modernization and organization of regional producers (group management)	Production/harvesting	7.8 (0.5)
Development of new products, adding value	Processing	8.8 (1.5)
Institutional support for SMEs in rural areas	Processing	8.3 (1.3)
Labels, certification and traceability, chain of custody	Processing	8.1 (2.3)
Preserved product identity (species/varieties, origins)	Processing	7.5 (1.9)
Certified quality standards	Processing	7.5 (1.9)
Product identity profiling (commercial distinction, e.g from Chinese chestnut)	Commercialization	9.1 (1.0)
Traceability & labels (regional & coop. brands, 2nd degree coop, certification)	Commercialization	8.5 (1.7)
Market acceptance of new produccts (chestnut flour, beer, etc..)	Commercialization	7.5 (3.0)
Integration of value chain actors (Interproessional integration)	Other challenges	9.4 (0.8)
Education, training and awareness	Other challenges	8.3 (1.3)
Integration with service sector (tourism, gastronomy, cultural heritage)	Other challenges	8.1 (1.4)

*The mark ranges between 0, non relevant to 10, highly relevant. SD means standard deviation

Table 20. Top ranked challenges of the Mediterranean pine nuts sector identified by the expert panel (Only marks higher than 7 have been included in the table).

CHALLENGE	Type of challenge	Mark (SD) (0-10)*
Integrated/biological pest control	Production/harvesting	8.7 (0.7)
End cone theft and black markets that alter prices in origin	Production/harvesting	8.7 (0.7)
Quality nursery plants	Production/harvesting	8.7 (0.6)
Tackling the climate change (adaptation and mitigation)	Production/harvesting	8.4 (1.3)
Innovation in cone harvesting techniques	Production/harvesting	8.3 (0.6)
Set up inter-operative traceability systems with due diligence "from forest to fork", banning informal sources	Processing	8.0 (1.8)
Quality standards for pine nuts from cones opened in stoves (avoiding low quality product marketed)	Processing	7.6 (1.1)
Quality standards for harvest season, storage processing	Processing	7.4 (1.8)
Define the product profile of Mediterranean pine nuts as high quality nuts(healthy gourmet food, with cultural, gastronomic and touristic added value: promotion and consumers' awareness raising, especially against confusion with cheaper Asiatic pine nuts)	Commercialization	8.2 (1.0)
Fulfilment of EU Food regulation (traceability) as well as UNECE standard respect labelling pine nuts (diligent reporting of botanic species and origin)	Commercialization	8.0 (0.9)
Quality and guarantee schemes for a gourmet nut (DOP, PGI, regional brands, SFM certifications, organic food, process quality standards, etc...)	Commercialization	7.8 (1.3)
Research in causes of yield loss and masting in the last years and develop solutions	Other challenges	8.8 (1.5)
A public agency or auction for transparent sales meeting forest owners and buyers, with transparent trusty quality assessment	Other challenges	8.5 (1.7)
Integration of value chain actors (Inter-professional integration. European Association(s) for lobbying	Other challenges	8.2 (0.4)
Qualification/training of value chain actors	Other challenges	7.4(0.5)

Table 21. Top ranked challenges of the cork sector identified by the expert panel (Only marks higher than 7 have been included in the table).

CHALLENGE	Type of challenge	Mark (SD) (0-10)*
Favour the training of the skilled labour	Production/harvesting	8.6 (1.8)
Tackling the climate change (adaptation and mitigation)	Production/harvesting	8.5 (1.1)
Improve cork harvesting and transport logistics	Production/harvesting	8.3 (1.4)
Foster policies that support the valorization of the cork multifunctionality	Production/harvesting	8.3 (1.9)
Long-term profitability	Production/harvesting	8.2 (2.3)
Improved communication directed to the consumers	Processing/ Commercialization	9.2 (1.0)
Guarantee the production to the stoppers	Processing/ Commercialization	8.4 (1.3)
New marketing strategies (e.g. sectors such as construction, furniture or car industry)	Processing/ Commercialization	8.4 (1.5)
Recycling cork and advancing towards a circular economy	Processing/ Commercialization	8.3 (2.6)
Development of new business models	Processing/ Commercialization	8.1 (1.6)

*The mark ranges between 0, non relevant to 10, highly relevant. SD means standard deviation

Table 22. Top ranked challenges of the Wild Mushrooms sector identified by the expert panel (Only marks higher than 7 have been included in the table).

CHALLENGE	Type of challenge	Mark (SD) (0-10)*
More coordination of the different administrations that intervenes with the mushroom related activities	Production/harvesting	9.0 (0.9)
Common protocol in EU to the mandatory analysis on chemical residues	Production/harvesting	8.1 (1.3)
Appropriate taxation for mushroom picking activity in the Mediterranean Europe (adapted to its complementary character)	Production/harvesting	8.0 (2.2)

Product traceability	Transformation	7.8 (2.7)
Common quality standards	Transformation	7.2 (3.3)
Labels and certification	Transformation	7.1 (3.4)
Product traceability	Commercialization	7.1 (2.8)
Education, training and awareness	Other challenges	7.6 (1.2)

*The mark ranges between 0, non relevant to 10, highly relevant. SD means standard deviation

Table 23. Top ranked challenges of the Truffles sector identified by the expert panel (Only marks higher than 7 have been included in the table).

CHALLENGE	Type of challenge	Mark (SD) (0-10)*
Common procedure for the certification of truffle inoculated seedlings (not only for black truffles)	Production/harvesting	8.9 (0.9)
Improve new techniques and new tools for the management of productive truffle orchards: Mechanization	Production/harvesting	7.9 (2.0)
Promote the CMO (Common market organizations) for truffles in Europe	Transformation	8.6 (1.6)
Common Quality standards	Transformation	7.9 (1.6)
Product traceability	Transformation	7.7 (2.9)
Discard chemical substitutes to the truffle aroma	Transformation	7.4 (2.3)
Increase of the communicative efforts focusing on countries who not have tradition in truffle consumption	Commercialization	8.9 (0.8)
Truffle tourism	Commercialization	8.6 (1.5)
Traceability, labels, regional & cooperative brands, certification	Commercialization	7.7 (1.9)

Education, training and awareness	Other challenges	7.9 (1.7)
Minimize the fraud, commercialization of products that mislead consumers	Other challenges	7.4 (1.7)
Consolidation of the actor organizations, particularly the producers by adequate means, before an inter-professional integration	Other challenges	7.3 (0.9)

*The mark ranges between 0, non relevant to 10, highly relevant. SD means standard deviation

Table 24. Top ranked challenges of the Aromatic and Medicinal Plants sector identified by the expert panel (Only marks higher than 7 have been included in the table).

CHALLENGE	Type of challenge	Mark (SD) (0-10)*
Promote the creation of producers' associations that establish specifications for the harvesting of the main species, provide training, interact with the industry and administration, establish self-monitoring among their members, stimulate business activity, etc...	Market development	9.1 (1.3)
Training and dissemination to the final consumer	Market development	9.0 (0.9)
Development of clusters between producers-pickers and consumers	Market development	8.1 (1.1)
Design of new products or/and new formats with MAP's to promote the local economy	Market development	7.9 (1.1)
Product branding or trademark development that link the product with the geographical area of origin, tradition or culture and history	Market development	7.8 (1.4)
Getting recognition of traditional uses of MAPs. For this, regulatory development is an important issue for the whole chain	Consumption promotion	8.2 (1.4)
Proper storage and processing of raw material (it concerns to the quality aspects of the plant that reaches the final consumer)	Consumption promotion	8.2 (1.2)
Education on gastronomic and medicinal attributes of natural herbs and plants	Consumption promotion	7.6 (1.8)
Education of picking medicinal plants from nature	Consumption promotion	7.4 (1.9)

Train people in the collection and processing (drying and destilling) of MAP's according to the GACP's guidelines	Research development	9.0 (1.0)
Preservation of wild species populations. PAM's exploitation and proper ecosystem management and conservation can stand together	Research development	8.9 (1.2)
Improving cultivation techniques	Research development	8.2 (2.7)
Development of measures for wild harvesting	Research development	8.1 (1.5)
Knowledge dissemination and training	Research development	8.0 (1.2)
Biodiversity conservation	Certification	8.2 (2.5)
Certification of local ecotypes of wild populations	Certification	7.9 (1.2)
To make different information on certification easily, reachable and understandable	Certification	7.7 (2.5)
To overcome gaps in legislation between different countries	Certification	7.5 (2.5)
To explain the differences between different certification labels	Certification	7.3 (1.6)

*The mark ranges between 0, non relevant to 10, highly relevant. SD means standard deviation

Table 25. Top ranked challenges of the resins sector identified by the expert panel (Only marks higher than 7 have been included in the table).

CHALLENGE	Type of challenge	Mark (SD) (0-10)*
Genetic improvement for resin production	Production/harvesting	9.0 (0.0)
Development of a range of extraction & transport methods of different heaviness and work charge, including mechanized ones	Production/harvesting	8.7 (1.0)
Development of a range of extraction work models based on efficiency parameters and combination with other sources of incomes	Production/harvesting	8.7 (1.0)

Use of remote sensing systems and Lidar technology to obtain individual tree variables to estimate the resin production potential	Production/harvesting	7.5 (0.9)
Development of an European natural resin label to contribute to the enhancement of the sectoral contribution to the bioeconomy via sustainable and technological products, the fixation or return of population in rural areas and the production of positive externalities such as CO_2 fixation or fire prevention	Commercialization	9.8 (0.5)
Monitoring of the global markets for natural resin, derivatives and substitutes	Commercialization	8.2 (0.8)
Development of a traceability system useful for logistics that also allows for obtaining objective data that can be used to monitor the resource	Commercialization	7.7 (2.3)
To promote the consumer awareness and recognition of the positive externalities provided by the use of European natural resin	Commercialization	7.4 (2.1)
Carbon footprint assessment produced in the Mediterranean forests	Other challenges	8.8 (0.8)
Lack of business models alternatives clearly identified to adapt the resin extraction activity at different market scenarios and resin prices	Other challenges	8.4 (0.6)
To promote specific support policy to consolidate forest extraction activity	Other challenges	7.6 (2.0)
Improve the existing official fiscal, economic and administrative registers which area offering impractical information for the industry and forest management in the resin sector	Other challenges	7.4 (1.3)

*The mark ranges between 0, non relevant to 10, highly relevant. SD means standard deviation

Prioritized actions to be taken

The DELPHI-like survey allowed to prioritize the actions to be taken in order to strength the targeted non-wood forest products sectors increasing its resilience (Table 26).

Table 26. Top ranked prioritized actions to be taken identified by the iNet expert panels (Only marks higher than 7 have been included in the table).

PRIORITIZED ACTIONS TO BE TAKEN	Mark (SD) (0-10)*	NWFP product (iNet)
Long –term availability and supply in a global change context	9.8 (0.5)	Chestnut (Wild Nuts and berries iNet)
Foster research and technical development for understanding and mitigating the impacts of climate change and for an integrated and biological control of pests and diseases	9.7 (0.6)	Chestnut (Wild Nuts and berries iNet)
Resource management through the improvement of the resource mobilization by a sustained supply implementing plantation management as orchard crop	8.3 (0.6)	Chestnut (Wild Nuts and berries iNet)
Marketing, product innovation and consumer awareness	8.0 (2.0)	Chestnut (Wild Nuts and berries iNet)
Inter-professional integration of the value chain	8.0 (2.3)	Chestnut (Wild Nuts and berries iNet)
Long-term availability and supply in a global change context (Understand and mitigate impacts of climate change. Integrated and biological control of pests and diseases)	9.1 (0.7)	Pine nuts (Wild Nuts and berries iNet)
Increase resources for research in forest pests and diseases	8.8 (1.0)	Pine nuts (Wild Nuts and berries iNet)
Resource management. Mobilization and sustained supply thanks to multipurpose forest management (including new forestations) and plantation management as orchard crop (grafted)	8.8 (1.0)	Pine nuts (Wild Nuts and berries iNet)
Web presence of product and sector	7.8 (1.5)	Pine nuts (Wild Nuts and berries iNet)
Marketing, product innovation and consumer awareness inter-professional integration of the value chains, enforcement of traceability and due diligence “from forest to fork”, fosterage of certification (SFM, FairWild & Organic Food labels), profile product identities and promotion of Mediterranean gourmet nuts	7.7 (1.5)	Pine nuts (Wild Nuts and berries iNet)
Maintaining cork quality and quantity	9.7 (0.5)	Cork

Minimizing climate change effects: Pests and diseases spreading, extreme droughts, wildfires	8.8 (0.8)	Cork
Support the development of new technologies in debarking	8.3 (2.0)	Cork
Promote a greater involvement of the public in forest matters	8.2 (1.0)	Cork
To achieve an improved coherence and simplification in funding measures (e.g: multi-fund systems directed in order to be able to direct the management towards the intended objectives)	8.2 (1.9)	Cork
Create a common list of mushrooms that can be commercialized freely in EU	9.3 (0.9)	Wild Mushrooms (Wild Mushrooms and truffles iNet)
Strenght the link between mushrooms and gastronomy	8.5 (0.9)	Wild Mushrooms (Wild Mushrooms and truffles iNet)
Development of an adequate/equitable taxation system for all the value chain actors	7.9 (2.4)	Wild Mushrooms (Wild Mushrooms and truffles iNet)
Request financial support to the mycosilviculture of natural forest areas, especially in marginal areas supported by CAP policies as an additional product to be professionally harvested	7.7 (3.6)	Wild Mushrooms (Wild Mushrooms and truffles iNet)
Traceability of the product	7.6 (2.4)	Wild Mushrooms (Wild Mushrooms and truffles iNet)
Strenght the link between truffles, tourism and gastronomy	9.1 (0.9)	Truffles (Wild Mushrooms and truffles iNet)
Evaluate the role of truffles as important mycorrhizal symbionts in reforestation after serious forest fires	9.1 (1.2)	Truffles (Wild Mushrooms and truffles iNet)
Increase the effort at European level for the recognition of truffle production, helping to develop their culture and marketing	8.9 (1.2)	Truffles (Wild Mushrooms and truffles iNet)
Homogenize the international EU trade and taxation policies	8.9 (1.6)	Truffles (Wild Mushrooms and truffles iNet)
Develop a coomon protocol for the certification of the mycorrhized seedlings	8.7 (10)	Truffles (Wild Mushrooms and truffles iNet)
Implementing management plans addressed to the main species collected in a specific area	8.2 (1.2)	Wild Medicinal and Aromatic Plants

Harmonizing wild harvesting regulations (administrative authorizations, training, supervision, etc) in surrounding territories	8.1 (0.8)	Wild Medicinal and Aromatic Plants
To design the content and format of a periodic course for collectors to be applied in different territories	8.1 (1.0)	Wild Medicinal and Aromatic Plants
To found new associationism formulas to share services and knowledge between all the stakeholders	8.1 (1.0)	Wild Medicinal and Aromatic Plants
To promote a collaborative plan between the forest owners and PAM's collectors aiming to promote the development of targeted species	7.9 (1.4)	Wild Medicinal and Aromatic Plants
To develop an European natural resin label	9.8 (0.5)	Resin
To promote a plan for the genetic improvement for resin production	9.0 (0.0)	Resin
To develop a range of extraction and transport methods of different heaviness and work charge, including mechanized ones	8.7 (1.0)	Resin
To establish a permanent monitoring of the global markets for natural resin, derivatives and substitutes	8.2 (0.8)	Resin
To develop a traceability system	7.7 (2.3)	Resin

*The mark ranges between 0, non relevant to 10, highly relevant. SD means standard deviation