

**A Road Map for innovating NWFPs value chains
for the
Resins iNet**



**Conclusions issued from the Scoping seminar – 8 & 9 May 2018
of the
Innovation Networks of Cork, Resins and Edibles in the Mediterranean basin
project**



Reference:

INCREDIBLE Resins iNet (2018). Toward a Road Map for innovating NWFPs value chains, Part of Deliverable D1.3. H2020 project no.774632 RUR-10-2016-2017 European Commission, 21 pp.

Authors:

Anton Brenko, Dino Buršič, Željko Zgrablić (CFRI), Inazio Martínez de Arano (EFI), Henri Husson (CRPF), Paula Soares (ISA), Javier Calvo-Simón (Cesefor)

Reviewers:

Mariana Jorge Ferreira (Luresa Resinas, S.L.)

CONTENTS

1. Introduction to the innovation networks (iNets).....	4
1.1. INCREDIBLE project overview	4
1.2. Resins iNet narrative	4
2. Scoping seminars.....	6
2.1. Scoping seminar report of the Resins iNet	7
2.1.1. Summary output.....	7
2.1.2. Description of new/better characterised actors and fluxes in the value chain	7
2.1.3. Priority themes to focus INCREDIBLE actions	10
2.1.4. How can INCREDIBLE better contribute.....	12
3. Discussion and findings.....	14
3.1. Overview	14
3.2. Innovation challenges in non-wood forest products in the Mediterranean region: common themes across iNets	15
3.3. Cross-cutting areas for action	17
4. Roadmap for INCREDIBLE and beyond.....	20
4.1. Resins iNet roadmap	20
5. Annexes.....	22
5.1. Access to scoping seminar reports and other materials	22

1. Introduction to the innovation networks (iNets)

1.1. INCREDIBLE project overview

Mediterranean forests are facing significant challenges at many levels. In the northern Mediterranean, rural abandonment leads to a rapid expansion of unmanaged forests and increased risk of catastrophic forest fires. In the southern and eastern Mediterranean, rural and peri-urban populations are putting pressure on forest resources. The lack of well-developed forest products value chains that can generate jobs and income can be seen as a common underlying factor that jeopardises the capacity to sustainably manage forest resources already menaced by climate change. Non-Wood Forest Products (NWFP) can be part of the solution, if they can contribute to a smart and inclusive bio-based economy that can create value from and investment streams for sustainable forest management. Developing existing potentials requires the collaboration and knowledge exchange between NWFP practitioners and scientists, and among regions. The INCREDIBLE project is designed to speed up the flow of credible, salient and useful knowledge from science and experience, in order facilitate innovation to happen.

Interregional Innovation Networks (iNets) are the core tool of the INCREDIBLE project to promote knowledge exchange on NWFP across the Mediterranean basin. These networks will allow to seed, collect, co-create and disseminate relevant technological, economic, innovative and research knowledge linked to the main NWFP value chains. iNets are innovation networks where individuals meet to bring forward and co-create knowledge on selected topics. While being interregional in their structure, iNets will be actively working at the local, national and international scales in terms of dissemination outputs and activities.

INCREDIBLE has developed five iNets for the main Mediterranean NWFP: cork, resins, aromatic and medicinal plants, mushrooms and truffles, and wild nuts and berries, to better process the issues of NWFP across the Mediterranean basin. Each iNet will aim to gather the best practical and science knowledge related to NWFP production, transformation and trade channels. Special attention will be drawn to cross-cutting sectorial issues.

Within the iNets, the goal is to achieve and implement innovations through the project. The project concept is to identify challenges and needs in practice for each iNet and explore methods to address them by creating the competences and contributions of many various actors within the iNet ecosystem. The innovations in this context have to be interpreted like an innovation process in which actors from different organisations participate on its creation. Key to this is successful stakeholder engagement, allowing the various actors of the iNet ecosystem to be involved and to be a part of the innovation process.

The participation of stakeholders relevant to the iNet regional ecosystems in the discussions and decision-making process is the best way to ensure that their own perspective and knowledge contribute to the project's outcomes. Stakeholder participation not only results in a better narrative with a richer picture of the iNet challenges, but also allows to better expressing the innovation objectives and the options to reach these goals. Successful outcome also requires dealing with barriers to the implementation of the innovation. These barriers will be discussed and explored during the activities of the iNet.

1.2. Resins iNet narrative

Gum resin is a natural raw material that has multiple applications in the manufacturing of chemicals products. Historically, the production of gum resin has been a relevant economic

resource in the coniferous forests from Mediterranean Europe, mainly in forests of maritime pine (*Pinus pinaster*) and in to a lesser extent, Aleppo pine (*Pinus halepensis*), Stone pine (*Pinus pinea*) and black pine (*Pinus nigra*). The European productive peak was reached in 1965, with 250,000 tons produced. Since then, the sector declined gradually in the continent due to lack of competitiveness against foreign gum resins and substitutive oil based products. In the decade of the 1990s, European production almost stopped. In the first decade of the 21th century, a change in the global market situation allowed a revival of the harvest activity in the most traditional areas of the Iberian Peninsula. This timid reactivation has been possible because of a marginal activity sustained by some first transformation local factories, the know-how hoarded by ancient workers, the interest of some institutional owners and the existence of forests ready for the exploitation thanks to their sustained management. Simultaneously, several institutions have launched their research programs in the gum resin area, regarding the improvement of the whole value chain from forest to market.

Nowadays, the industrial demand for resinous products in Europe is estimated at 300,000 tons per year. The reactivation of the Mediterranean forest production could supply part of this demand. Potentially, the revival of natural resin production in Spain could be replicated in other Mediterranean countries rich in suitable pine forests, contributing to a greener economy, improved rural livelihoods and creating industrial jobs. There are, however, significant hurdles related to profitability, uncertainty on the compatibility with other forest uses, the potential impacts of climate change and the lack or loss of traditional know-how. In this context, the focus of the iNet of resins will be to explore existing research and innovation knowledge and the best practices across European gum resin value chain in order to deal with the main challenges that the sector is facing.

2. Scoping seminars

The scoping seminar was the first official meeting of each iNet. Its main goal was to create a specific road map for better targeting specific issues within its topic. Five seminars were organised by the iNet coordinators and they were held in Tunisia (Aromatic and Medicinal Plants), Spain (Resins, Mushrooms and Truffles), Portugal (Wild Nuts and Berries), and Italy (Cork). All iNet members were invited and a special attention was given to ensure the participation of key stakeholders. At the scoping seminar, stakeholders had an opportunity to validate previous work, to propose bottom-up, complementary activities and to contribute to the iNet future development.

The main objectives of each scoping seminar were:

- a) to validate the narrative, and to establish a road map for the development of the iNet. The object was to focus on the themes that will be addressed throughout the project,
- b) to manage expectations on what can be achieved,
- c) to give participants opportunities for networking.

At the scoping seminar, stakeholders gathered from all links of the value chain had an opportunity to share their opinion and bring up problems and difficulties of their sector. This was a unique chance for everyone to learn about challenges and to get a wider picture of the condition in the sector. Most of the stakeholders were from the country where the scoping seminar was organised but international stakeholders were participating too. It was interesting to local stakeholders to learn and compare the difficulties, qualities and solutions in other countries.

The number of stakeholders attending scoping seminars (Table 1) was higher than expected (targeted number was 30) in three of the events, which tells us that the stakeholders were well informed and interested in collaboration. Despite the different concerns among participants from different countries, and even among regions in the same country, the participants agreed on the identification of challenges as well as the priority themes for reinforcing the NWFP sector.

	Cork iNet	Resins iNet	Aromatic and medicinal plants iNet	Mushroom and truffles iNet	Wild nuts and berries iNet
	Number of participants				
Spain	1	28	4	48	4
Portugal	4	7	1		15
France		3	2	2	1
Belgium	1	1	1		
Greece			1	2	
Italy	20			2	
Croatia				2	
Tunis	1	1	37		
Total	27	39	46	56	20

Table 1. Number of participants at each scoping seminar.

Per iNet, this chapter summarises:

- the main outputs from each Scoping seminar;
- the improvements that this event brought to the value chain map (improved description or addition of new stakeholders and fluxes), and

- the priority themes on which the INCREDIBLE project should focus, those that would have a bigger positive impact on the value chain.

2.1. Scoping seminar report of the Resins iNet

2.1.1. Summary output

The Resins iNet scoping seminar was held during the month of May in Valladolid, Spain, it was well attended by members of the value chain of the European resins sector. The participants came almost entirely from Spain, France and Portugal, the three countries that have historically led resin production in Europe.

From the point of view of sectorial representativeness, it can be said that there were participants from all the links in the natural resin value chain, with the exception of consumers. In future events, special efforts will have to be made to include representatives from this part of the value chain, as they are the real driving force behind resin production in the Mediterranean region.

The exercises of evaluation of expectations, review of the value chain map and generation of a SWOT analysis of the sector served to make the stakeholders recognise themselves, reflecting at the same time on the problems and deficiencies of the group, which can be covered by R&D initiatives. This is a first step, which in future INCREDIBLE events should be used to help improve sectorial cohesion as an essential objective to animate the innovation network.

In the work dynamics, the participants showed great interest in the joint resolution of the challenges facing the sector. A good proof of this is the volume and quality of the reflections made. It should be noted that in the working sessions in which representatives of the different links of the value chain interacted there was a desire for complementarity and the search for meeting and common points.

Many innovation priorities were put on the table, of which four were finally chosen as the most pressing:

- resource modelling in a context of climate change;
- progress in the compatibility of resin harvesting with other forest uses;
- improvement of the working conditions of the resin tappers;
- development of new natural resin derivative products.

2.1.2. Description of new/better characterised actors and fluxes in the value chain

The ecosystem of the natural resin value chain is characterized by a first distinctly forest segment, from pine crude oleoresin extraction from the pine tree in the forest to its fractionation by distillation into colophony, turpentine essence and water, which is then inserted into more sophisticated chains through the chemical transformation of the essential resin components. Its technological versatility takes the compounds derived from natural resin to the final consumer 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 1).

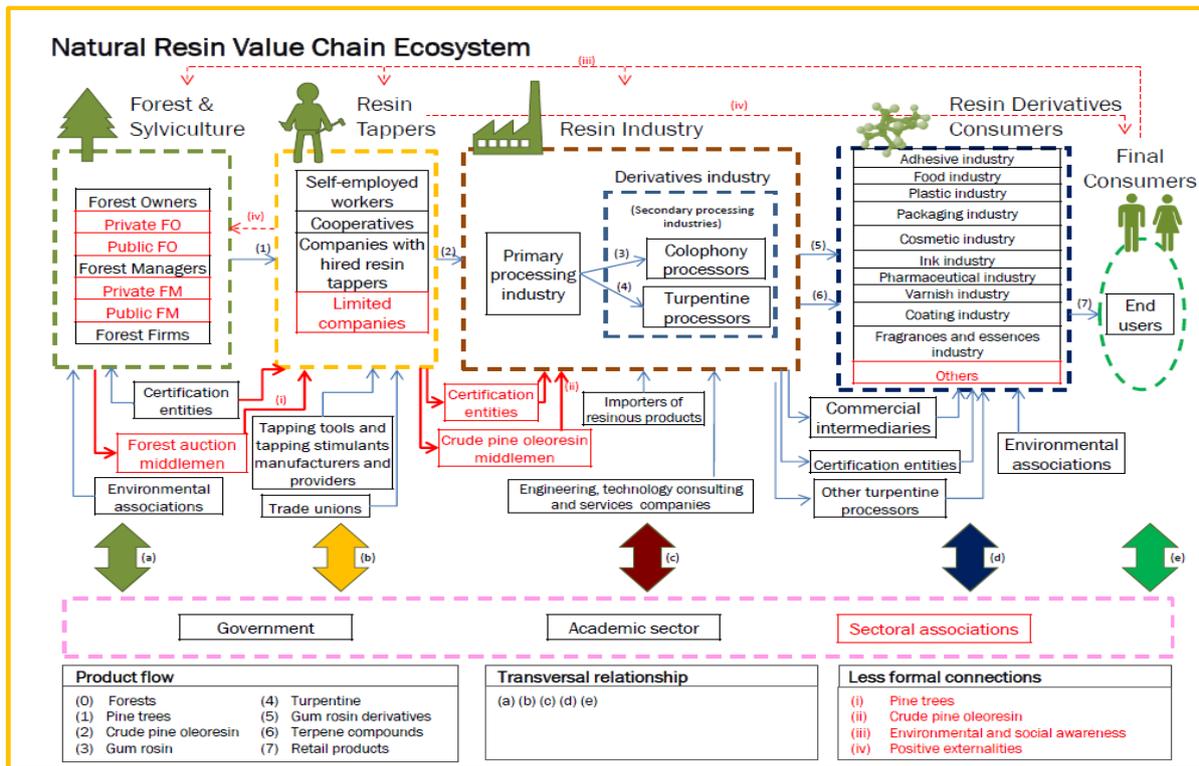


Figure 1. Reviewed natural resin value chain map. Note in red the contributions entered in the scoping seminar.

The forest owner receives income from the resinous use of his/her woodlands as a rental from the pine tree, usually to the resin tappers. The contracting unit is the tree, setting a fixed price per tree. Particularly important in the transaction are the ways in which the pines are allocated, giving preference to local workers or not, and the contract specifications, which emphasise use times, resin extraction methods and assembly and disassembly of the installation. Contracts are usually signed for one to five consecutive years, depending on the circumstances.

The forest owner is also aware of the indirect benefits and positive externalities that the resin tappers activity has for his/her property in the form of surveillance, cleaning and fire prevention. In the case of public landowners, resin extraction is often a political tool to fix population into the territory.

The resin tapper is the forest worker, usually self-employed or organised in worker cooperatives, who extracts the resin from pines. He usually rents the pine trees to the forest owner and sells the resin to the primary processing industry. The selling unit of crude pine oleoresin is the kilogram. Contracts between resin tappers and industry include not only price, but also aspects related to payment methods throughout the campaign, transport costs or product quality, among others, which are key to closing operations.

The resin industry is classified in two sections: primary processing industry, which only performs the fractionation of the resin by distillation; and secondary processing industry, in which modification and fragmentation of colophony and turpentine are carried out.

The companies of the Mediterranean basin that perform the primary transformation of the crude pine oleoresin buy the raw material from the local resin makers, or import it from third countries,

generally Asian and Central or South American Therefore, purchase prices are very conditioned by the international price of the product.

The secondary transformation takes place in much more sophisticated specialised facilities, either the modification of the colophony or the fragmentation of the turpentine essence. Some companies integrate the primary transformation with the subsequent transformation of the colophony and/or turpentine essence. This secondary transformation has an advanced technological component, which allows the elaboration of tailored derivative products.

The resin derivatives consumers are industries belonging to the sector of the industrial chemistry. They not always manufacture products aimed at the end consumer, but sometimes still make new transformations and intermediate products that will be used in the composition of products for the end user.

During the presentation of the narrative and value chain in the scoping seminar sessions, actors and fluxes of the initially proposed scheme were identified and accurately defined.

New actors identified:

- Forest auction middlemen: individuals who buy tapping rights and sell it to resin tappers. Their activity could affect resin tappers profitability. This actor should not be confused with some processing companies that buy resin extraction rights for transferring it to resin tappers and make it easier for them to access the activity.
- Crude pine oleoresin middlemen: individuals who trade with crude pine oleoresin between resin tappers and primary processing industry. It is an occasional figure that may rarely appear in some regions. Considering the current crude pine oleoresin prices, is not a very profitable nor sustainable activity, and can damage the resin tapper activity in areas where it is not well stabilised yet.
- Limited companies: in the resin tappers side, they represent some rare cases of companies devoted to crude pine oleoresin extraction.
- Others (resin derivatives consumers): that label represents the large amount of others applications of resin derivatives that characterize the versatility of this raw material.
- Sectorial associations: forest owners associations, resin tappers associations, and resin derivative associations. The resins industry has not well-developed associations.

Better characterised actors:

- Forest owners: it is essential to differentiate between public and private forest owners. It is also very different their role among the different regions.

Public ownership:

Portugal: municipalities, *baldíos*, which are community areas, and the State.

Spain: municipalities, regional governments and the State.

Private ownership:

Portugal: enterprises, small owners and large owners, forest owners associations.

Spain: the same as in Portugal and, in addition, the “partner forests” which are *pro indiviso* forest properties owned by a group of natural and/or legal persons.

- Forest managers: it is essential to differentiate between public and private forest management. It is also very different their role among the different regions.

Public management:

Portugal: in both public and private forests, communication of intention to use, ensures compliance with specific legislation.

Control resin of transactions and agents of the sector through a website.

Spain: lack of homogeneity between Autonomous Communities. In general, in public forests: management of the forest, specifications for the use and control of the uses. In private forests: it processes the use authorizations and it ensures compliance with specific legislation.

New fluxes identified:

- Pine trees: regarding the new “Forest auction middlemen” actor identified.
- Crude pine oleoresin: regarding the new “Crude pine oleoresin middlemen” actor above mentioned.
- Environmental and social awareness: underlying the final consumer's attitude there is an interest in socially and environmentally sustainable products, which in the case of products derived from natural resin is not well perceived due to the remoteness within the value chain between these consumers and the activity of resins tappers.
- Positive externalities: they are generated by the resin tapper activity, in the direction of the forest, as forest keeper and forest maintainer, and in the direction of the final consumers, as sustainable chemical products and ecosystem services provider.

Better characterised fluxes:

- Certification entities: their activity has been extended in the scheme from forest to factories, passing through resins tappers, to represent the importance of crude pine oleoresin traceability. Many of the publicly owned resinous forests where the activity is currently carried out own sustainable forest management certification. However, few consumers of derivatives apply for forest certification of products, so product certification or chain of custody is hardly implemented in the sector.
- Academic sector: it works in the new forest model's definition, e.g. over stone pine (*Pinus pinea*) tapping, it provides training to technicians and forest managers and it undertakes research projects.

2.1.3. Priority themes to focus INCREDIBLE actions

A plenary session proposed a number of priority themes to focus innovation efforts on. The proposals were grouped by theme, establishing four themes covering all the proposals. The work of reflection concluded with a vote in which the topics were prioritised in the following order:

1. Long term resource availability in a context of climate change
2. Compatibility of resin harvesting with other forest uses and with forest health
3. Improvement profitability of tapping and working conditions for workers
4. Development of new derivative products.

LONG-TERM RESOURCE AVAILABILITY IN A CONTEXT OF CLIMATE CHANGE

Recent investments in new processing capacity in southern Europe underscores the existing uncertainty of the medium- and long-term supply capacity of the resin-producing forest stands as well as the need to better communicate improved available knowledge to potential investors, resource managers and other decision makers.

Long-term availability will be conditioned by ecological and forest management factors (e.g. productivity) socio-economic and labour market factors (e.g. economic viability) and technological factors (e.g. new technologies and products). Improved resource modelling can contribute to reduced uncertainty and better decision making.

The stability, continuity and persistence of resin-producing forest stands in the Mediterranean may be threatened by climatic changes, or by the effect of forest fires, specific pests and diseases and other anthropogenic and natural risks. Lowering water tables due to irrigation of neighbouring crops is thought to be a major threat in Central Spain. The demographic evolution of the resin-producing areas and the possibility of finding skilled labour is another factor that may jeopardise the productive capacity of the system. Finally, the appearance of technological developments that facilitate the exploitation of natural resin can contribute favourably to the stability of supply. There is a lack of large-scale predictive models, both on natural resin productive volume side and on the possible evolution of the state of the maritime pine stands under the impact of biological risks.

Ideal situation: a common monitoring protocol (indicators) for Mediterranean countries shall be established to regularly evaluate and communicate the state of current and potential production capacity of resin-producing forests. An optimal approach would be the integration of this protocol into national forest inventories and forest management plans. Based on these assessments, the effects of climate change would be modelled and the results shared as a tool to accompany regional forest management plans. Ideally, stakeholders should be informed and aware on current and future resource availability under plausible scenarios. There is the necessary understanding and support for the actions and investments required to carry out the planned monitoring as well as to define and implement control and corrective measures.

COMPATIBILITY OF RESIN HARVESTING WITH OTHER FOREST USES AND WITH FOREST HEALTH

This is considered a scientific/technological challenge. The owners and managers of pine forests lack factual knowledge on the interactions between production of timber products and natural resin extraction, through different tapping methods and periods. Existing knowledge in this area is dispersed and not available to directly advise stakeholders. Historically, both productions were carried out in a complementary way in many regions of the maritime pine distribution area. There are certain gaps in knowledge, from the technical point of view, about how resin tapping affects the structural or aesthetic characteristics of pine wood. The effect of resin tapping on other forest products, such as stone pine cones, is not well known. New resin extraction technologies might have better economic behaviour in wood producing areas (borehole technics). In addition, there are concerns on potential impacts of resin extraction on the spread of severe diseases, as is the case of the pine wood nematode (*Bursaphelenchus xylophilus*). There might be significant knowledge in “grey literature” and coming from personal experience that could be identified, evaluated and shared,

Ideal situation: all stakeholders are well informed, share reliable information and know the benefits and disadvantages of making both productions (timber and resin) compatible to make appropriate technical decisions. This comprises current and improved methodologies and tapping intensities and approaches (e.g. tapping periods in relation to production of timber).

IMPROVEMENT PROFITABILITY OF TAPPING AND WORKING CONDITIONS FOR WORKERS

Cost of resin extraction is critical as natural resin derivatives compete with tar-oil and synthetic derivatives in globalised markets. Resin is a heavy product, produced in small *per tree* quantities and requiring large production areas. Efficient production poses significant logistic challenges. In fact, hard working conditions and limited profitability are the main obstacles for resin extraction in Europe. Improving profitability and working conditions is mainly considered a technological challenge, linked to the development of new resin stimulants, the mechanisation of tree and stand preparation, the bark chipping operation, improved resin tapping technologies and the optimisation of logistics. In addition, from a socioeconomic perspective, resin extraction could benefit from improved work continuity and income complementation. This could be achieved through the payment for ecosystem services (PES) schemes (e.g. linked to fire prevention) and/or through preferential access to work related to forest maintenance.

Ideal situation: develop more efficient tapping operations, better ergonomics, increased profitability with less effort and continuity of income. Generalise the recognition of positive externalities produced by tapping (by society, value chain actors and the public administrations) materialised in additional income for resin workers through, among other methods, PES schemes.

DEVELOPMENT OF NEW DERIVATIVE AND UNIQUE PRODUCTS

Innovation on resin derivatives could benefit from improved market knowledge in order to focus on the development of competitive products, especially against substitute products. Demand is complex and varied. It is necessary to identify and classify business opportunities to establish product development strategies based either on niche markets or on mass consumer products. The development of new natural resin derivative products has to be based on the eco-friendly and sustainable features of the raw material. On that note, some stakeholders considered advisable the creation of a designation of origin of the Mediterranean natural resin. The technological development of new logistic solutions would facilitate the traceability of the crude pine oleoresin. However, the potential real benefits and trade-offs of a designation of origin brand are not necessarily well understood.

Ideal situation: reach a good knowledge on the demand for high added-value products across the most relevant markets is a main objective to achieve. Achieve a good identification of products with compounds derived from natural resin as organic and eco-products, currently of high demand by the intermediate and end consumer. Consolidate a stable and equitable supply chain. Reach a good collaboration among actors of the resin ecosystem and a good traceability system that is easy to maintain and involves little administrative burden.

2.1.4. How can INCREDIBLE better contribute

Preparing a systematic review of existing knowledge in relation to:

- resource assessment, modelling and monitoring;
- tapping and logistic solutions;
- compatibility of uses and externalities produced;
- existing business models and contractual arrangements.

Developing monitoring approaches for resin production capacity, maybe in cooperation with national forest inventories and existing certification schemes.

Compiling knowledge gaps, available research resources, and key infrastructures.

Adopting a transnational research agenda. The agenda should identify the most relevant knowledge gaps and contribute to increase investment in R&D on resource modelling, resin production, compatibility of uses, positive and negative externalities of tapping valuation and operationalisation of ecosystem services, and socio-economic arrangements and business models.

Supporting information and awareness rising efforts, providing unbiased and scientifically accurate facts and figures, aimed at public decision-makers and general public.

Better understanding of the potential role of current European, national and regional policies with the role of resins tappers in their materialisation, as could be the case of territorial contracts. This can be based on documenting relevant cases from other sectors.

Stimulating innovation and entrepreneurship in relation to technological or social challenges, thought, for example, open innovation initiatives.

Evaluating the feasibility of designation of origin or other labelling approaches, providing examples from other relevant sectors and collaborating in the establishment of common working rules for traceability, the definition of standards and the establishment of origin criteria.

3. Discussion and findings

3.1. Overview

In the period from 8th of May 2018 to 12th of July 2018 five iNet scoping seminars were held in Spain (two), Portugal, Tunisia and Italy, with the total number of 184 attendees, coming from different backgrounds, positions in the value chain and also diverse interests and expertise. They included land owners and managers (both public and private), government officials, collectors, processing industries and retailers of different sizes, industry and retail associations, intermediaries and service companies (e.g. nurseries, consulting, etc.), researchers and technicians from various disciplines and, finally representatives of boundary sectors, as hotel and restaurants. In general terms, the biggest interest on the scoping seminars was found among the industry/trader representatives (29% of the attendees; Figure 2) and private and public forest owners and managers (20%) and the research community (12%).

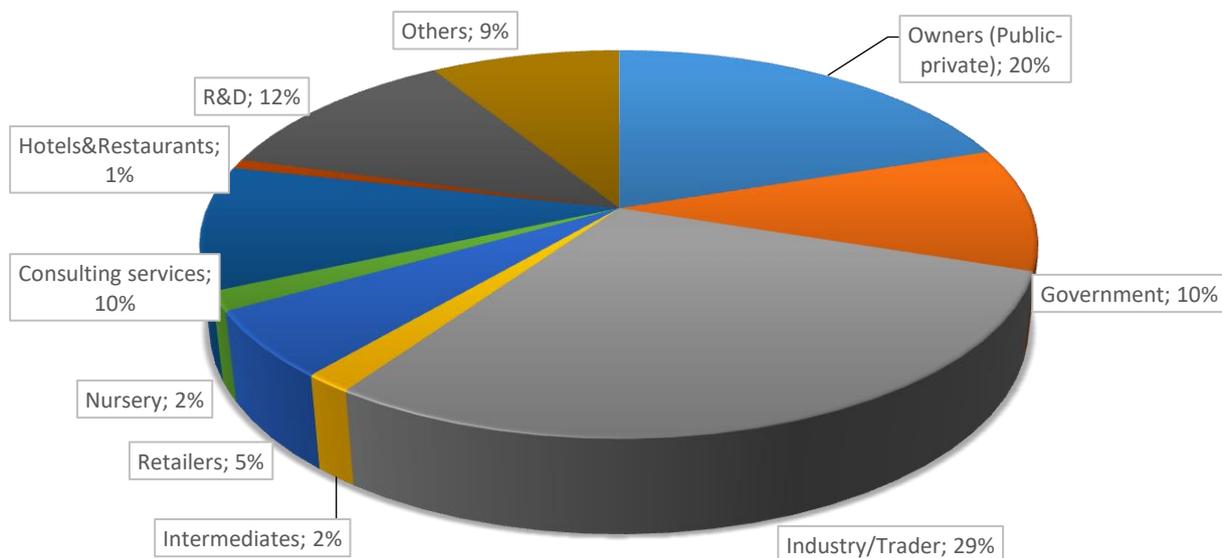


Figure 2. Percentage of attendees from all scoping seminars grouped by their value chain position.

This scoping seminars were aimed at better understanding the most relevant needs and opportunities for innovation and strengthening the respective value chains. The methodology was based on a combination of plenary, break-up groups and informal discussions during coffee breaks, lunch and fieldtrips. Starting point of all discussions was an understanding of all the actors and fluxes involved in the different value chains and their extended ecosystem. There was no attempt to generate consensus on a desired scenario for every non-wood forest product sector, as this could lead to roadblocks due to diverging interests among different actors of the value chains. The objective was rather to develop a collective assessment of the functioning of the value chains and the identification of challenges or opportunities, as perceived by the different actors. As expected, this approach facilitated an extensive discovery of themes and topics, the identification of new or better characterised actors and fluxes in the value chain. Similarly, no hard prioritising was sought although, in some cases, participants were asked to vote

priorities as a tool to stimulate discussions. The methodology was designed to rather capture all issues and priorities, and to further process and distil them in an iterative approach, to better understand them and to allow common priorities to emerge naturally.

Successful completion of the scoping seminars proved that the chosen methodology fully meets the expectations of project outputs. High rates of stakeholders and individual responses to join the scoping seminars is just one of the indicators. More important, the results of scoping seminars revealed precise problems, needs, expectations and possible solutions for problems in each of the five iNets. That clearly indicates that the project topic is highly relevant for the European NWFP sector as it is for the overall development of rural communities across Europe.

3.2. Innovation challenges in non-wood forest products in the Mediterranean region: common themes across iNets

Since the different NWFP are collected, produced, processed and marketed in different social-ecological systems (as a consequence of divers biophysical, socio-economic, technological and cultural aspects), different priority themes arose at each iNet scoping seminar. The analysis of the outcomes, however, shows common knowledge gaps and challenges for innovation. The identified cross-cutting themes are described below.

LONG-TERM AVAILABILITY AND SUPPLY OF NWFP IN A CONTEXT OF GLOBAL CHANGE

Understanding and mitigating the impacts of climate change

Climate change is recognised as a major threat to all forest ecosystems and is predicted to have especially intense impacts in the Mediterranean region. Higher temperatures and reduced precipitation will directly affect the composition, structure and productivity of forest ecosystems and thus, of non-wood forest products. How this will affect the production of NWFP and what are the options to mitigate this impacts is an area that needs research and knowledge transfer. While agronomic practices can be adapted for domesticated products (e.g. irrigation in truffle or chestnut), mitigation options for wild NWFP are less evident. The same can be said for emergent pests and diseases. Climate change can also affect the length of the production/collection period and increase the inter-annual variability in production, hampering the development of the value chains. In some cases, the impacts of climate change can be exacerbated by human activities. For example, irrigation of agricultural crops can reduce underground water availability for nearby forests, thus jeopardizing also the production of NWFP.

Sustainable production and harvesting

In the case of many wild NWFP, sustainable harvesting levels are not well understood. The condition and availability of the resource is not regularly monitored nor evidence-based harvesting levels are estimated or enforced. This situation can become critical as market develops and demands increases. Also because intense harvesting can concentrate in the most accessible areas. What would be the impact of increasing mushroom picking in long-term production? What is the impact of using rakes to increase harvesting by professional pickers instead of the traditional picker knife? What will be the long-term availability of rosemary for wild collection in a context of high picking pressures and climate change? How much resin can be produced in southern Europe under plausible climatic and social scenarios? How can NWFP primary processing industries can forecast their investments with such uncertainties? In some

cases, the lack of knowledge on future resource availability difficult rational business and policy decisions.

In the case of more domesticated products, there are still significant knowledge gaps in relation to, for example, genotype x site interaction for relevant characteristics as it can be cork quality in cork oaks stands or kernel productivity by stone pine groves. Management of pests and diseases are also a critical issue that requires increased knowledge generation and transfer. In all domesticated crops, optimization of irrigation to improve yields, quality and economic return with maximum efficiency is also a very relevant area (e.g. truffle, cork and stone pine).

UNSECURED AND IRREGULAR SUPPLY

There are also critical socio-economic challenges related a stable and secure supply of NWFP. Supply of forest products depend on individual non-professional collectors (mushrooms, wild truffles, some aromatic plants) and sometimes on professional crews working for periods, with inadequate labour conditions and limited knowledge on the sustainable collecting practices (mushrooms and AMP mainly). In some cases, there is lack of workers due to hard working conditions and relatively low income as it can be the case for resin and cork in high-income regions. This situation makes difficult the creation of stable value chains and in some cases limits the market expansion in well established industrial activities (cork, resin, some essential oils).

For all widely collected products, there is inadequate knowledge on the size of the market and its economic relevance. Black and grey markets are very important and there is a generalised lack of traceability. This, consequently, favours black and grey markets and also robbery, as in pine nuts, and the concurrence with uncontrolled substituting products from other regions (e.g. pine nuts from east Asia, mushrooms from Russia, etc.). The lack of traceability can have especially negative effects for those products used as food, in cosmetics and related to human health. New business organisations, improved or adapted regulation and registration of collectors, or mobile ITC are some of the promising innovations, either social or technological, that can help tackling some of these issues and that could be adapted and adopted more widely. However, firstly, challenges should be better understood.

REDUCED PROFITABILITY

The situation described above is partially related to the tight profitability of NWFP production and collection. Most of the wildly collected or only partially domesticated NWFP analysed in the different scoping seminars have limited capacity to generate sufficient income for producers (private forest owners, forest municipalities, etc.) or for collectors (resin tappers, AMP collectors, etc.). This is a structural weakness that in some cases almost totally prevents the development of NWFP business activities or that jeopardises its future. This is especially true in countries or regions with a high average income and explains the almost inexistent resin or cork production in France, or the incapacity to mobilise cork from the forest to meet the existing demands as it happens in Catalonia (Spain). Some social, managerial and technological innovations can help in improving NWFP production and harvesting profitability. These are related to mechanisation (e.g. pine nuts or chestnut collection, cork debarking, resin tapping), to harvesting methodologies more adapted to the socio-economic context (e.g. borehole resin tapping in timber-oriented stands), to silvicultural or agronomic practices that increase productivity (e.g. improved genetics, forest management practices that improve mushrooms yield, truffle plantations irrigation), to logistics, etc. Evidently, the development of high added-value products based in NWFP is a necessary

condition to maintain and improve the profitability for producers and collectors, although it does not guarantee equity and fairness within the value chain. At the same time, the recognition of the positive externalities produced by the NWFP production, as through PES schemes, is seen as a strategic component on the economic viability of, at least, cork and resin value chains.

In some cases, producers or collectors have weak bargaining power in relation to the primary processing industries and they are not able to get a fair compensation, or they feel so. In other cases, processor cannot mobilise the resource because they cannot meet the expectations of producers that may have unrealistic views on the market value of their products, as it can happen in cork. Improved awareness on market functioning, transparent and widely recognised procedures to measure quality or public price observatories can reduce tension within the value chain, along with contractual arrangements and new forms of collaboration among producers/collectors.

ACCESS TO THE RESOURCE

Across the Mediterranean region there is a large diversity of forest tenure regimes and different regulations on who and how can access wild resources. Free access to forest and the right to collect NWFP for all citizens irrespective of tenure is rooted in many countries. However, the risk of overexploitation or the need to manage conflicts between recreational collectors and professional collectors are fuelling the adoption of new regulations.

LACK OF AWARENESS OF CONSUMERS, POLICY MAKERS AND SOCIETY AT LARGE

The lack of awareness of the economic, social and environmental benefits that NWFP production provide is common among all five NWPF; for those that reach the consumer highly transformed (resins and AMP) as well as for those that are easily recognisable by end-users when eaten (mushrooms and truffles, nuts and berries) or used (cork). The lack of awareness is of different nature depending on the NWFP: knowing the origin of the product or the ecosystem services its production provides, being able to distinguish between a given product and its substitute, or simply identifying that a NWPF (or its derivatives) enter in the composition of a manufactured good.

In this case, the challenge is related to marketing. Already existing tools to tackle this challenge are marketing campaigns, product traceability labels and regulated geographical indications or designations of origin.

3.3. Cross-cutting areas for action

On the one hand, climate change, globalisation, urbanisation, tertiarisation are megatrends affecting the development and sustainability of non-wood forest products and explain to a large extent the challenges identified. Competition in the global markets with other producing countries and with alternative products put high pressures on profitability of raw materials (e.g. pine nuts, cork, resin, essential oils). Rural abandonment makes difficult to find labour. All this favours black and grey markets for products and labour to reduce costs. On the other hand, the emerging trends represent new, even immense, opportunities. Nature-based and experiential tourism, green care, societal preference for natural cosmetics and natural food are experiencing and increasing demand. The need to replace oil-based or non-renewable products with bio-based solutions in creating a new market pull for manufacturing and construction (cork or resin and other plant-based chemicals). Facing challenges and making the best of emerging opportunities

requires concerted action of diverse actors in multiple directions. The outcomes of the Scoping seminars allow us to highlight three domains that require specific attention as they can provide the necessary conditions for sustainability and innovation to happen.

BETTER FOCUSED RESEARCH AND IMPROVED KNOWLEDGE FLOWS

Research, development and extension capacities are very different between Mediterranean countries and there is much to be learnt from cross-regional cooperation. Some countries had a long tradition of using NWFP. The lack of research is often related to insufficient number of specialised researchers for some NWFP, non-existent financial and/or development programs to implement specific projects and the lack of interest from political and governmental structures. Research capacities are fragmented across countries and among institutions within one country. In the case of cork and wild nuts, there are different field trials, not always connected to each other, despite being highly complementary. Sometimes in-house research produced by companies (e.g. resin stimulants, new resin tapping technologies, etc.) is neither published nor disseminated. Usually, across the region, support for NWFP research and rural innovation is weak.

IMPROVED GOVERNANCE

Having better, stronger, more comprehensive governance frameworks for NWFP should allow for better decision-making by all actors, should facilitate stronger and more equitable value chain arrangements and contribute long-term social and environmental sustainability. Institutional arrangements and public regulation varies from country to country and between NWFP, becoming much weaker or inexistent as we move from fully domesticated products to completely wild products. In general, governance is considered fragmented, confusing, inadequate, limited or totally inexistent by INCREDIBLE project stakeholders.

In the case of wild NWFP, some Mediterranean countries or regions do have a regulation that covers aspects related to collecting rights, access to the resource or permits and taxes. However, this is totally absent in other. In some cases, existing regulation is not helping to facilitate cooperation and transparency inside the value chains or can even represent an obstacle for collection, production and trade. As an example, forest or environmental regulation, or the way it is interpreted by the competent authorities, can limit the establishment of new truffle plantations in forestlands in central Spain. Across the iNets, the need to overcome this problem is recognised as one of the most important. In the case of edibles, regulating quality, forest to fork traceability and allowing for effective protection of origin is a specific challenge.

Governance approaches, arrangements and procedures by private (e.g. companies) and other non-governmental actors (e.g. forest certification entities) are much less known. Formally adopted good practices codes or due diligence systems among collectors and processors are generally missing or have not been yet identified and properly described. Some NWFP are covered by sustainable forest management certification schemes (e.g. cork in PEFC and FSC), although they might not be generating the added value that could be expected or desired.

Addressing these and other related issues (market and environment, plant health regulation, incentives and PES schemes, irrigation rights, etc.) will greatly benefit from more structured public-private cooperation.

MORE EFFECTIVE COMMUNICATION FOR GREATER SOCIAL AWARENESS

When sustainably managed, the production, collection, and transformation of NWFP can generate multiple positive externalities: rural development, forest fire prevention, climate change adaptation and mitigation, etc. However these benefits are rarely recognised in the markets, where Mediterranean NWFP compete with petroleum-based counterparts (e.g. petroleum derivatives, plastic stoppers, etc.) and with imported products that can differ in quality and environmental performance (Asian pine nuts, Russian mushrooms, etc.). Stakeholders across the iNets are convinced that it is extremely important to increase the awareness about the current situation and existing potential for NWFP and the environmental, social and economic benefits that they can provide. Product, environmental and geographical certification schemes are seen as promising tools.

On the one hand, the actors in the value chain could better communicate outside their sector. On the other hand, the need for better communication along the value chains (between producers, processors, market and government) is clearly identified by the stakeholders. Between different stakeholders, there are different communication problems. Depending on the region or the country, the problems are identified as:

- reduced information flows between producers/collectors, traders and transformers;
- lack or not existent knowledge and technology transfer between actors of the value chain;
- lack of cooperation towards potential common goals such traceability schemes, quality assurance, joint marketing and certification;
- lack of awareness by policy makers on the barriers and opportunities for NWFP that translate into fragmented, inadequate or non-existing regulation.

Consequently, better dissemination of information between procedures for quality control and certification methods from certification entities, both for harvesting and processing is needed. For those sectors where we have good practices, dissemination between actors in the value chain should be increased. For the sectors where quality control and certification methods are not established, it is necessary to make a complete analysis and to set up good foundations so certification entities can produce a uniformed method for quality control and certification of every product in each iNet.

4. Roadmap for INCREDIBLE and beyond

The reports from each Scoping seminar are very concise; they perfectly represent the situation on the field and are a good starting point for each future regional or international events organised by the INCREDIBLE project. Adopting new knowledge and ideas to existing ones, spreading the existing discussions and trying to solve the small problems through networking guarantees successful future work of each iNet. The following discussion will try to gather the conclusions and propose next steps for each iNet based on the Scoping seminar reports.

4.1. Resins iNet roadmap

It is estimated that today needs for resin derivatives exceed 300,000 tonnes on European market and that production of natural resin in Spain, Portugal and France barely reaches 23,000 tonnes, although the pic of natural European resin production was 250,000 tonnes in the year 1965.

The Mediterranean potential remains high: in southern Europe, pine stands with potential to produce resin exceed 3 million hectares. This resource is jeopardised by natural and anthropic risks and uncertainties, and consequently a large extent of this area is not mobilised in terms of natural resin production because of lack of efforts in counting resin extraction and other forest uses. A large barrier for natural resin mobilisation in the Mediterranean basin is the low profitability of the extraction activity for the resin tappers. The engine of the whole value chain is the Mediterranean chemical industry demand. Natural resin must compete against substitute products via derivatives diversification and specialisation for reaching market niches only available for natural products.

Proposals for solving the before mentioned bolded issues are:

RESOURCE MODELLING IN A CONTEXT OF CLIMATE CHANGE

Make available an updated and comprehensive image of the state and potentiality of the resource at a Mediterranean scale. This proposal involves:

- collection of technical and scientific knowledge;
- divulgation among policymakers and population at large to make them aware of the importance of the issues that the resinous forest faces;
- assessment of knowledge gaps and identifying new monitoring tools, and
- establishment of a structure for sharing, disseminating and improving the updated information for technical and management uses.

PROGRESS IN THE COMPATIBILITY OF RESIN HARVESTING WITH OTHER FOREST USES

The compatibility and integration of forest products value chains are key for reaching the best profitability in the forest activity. However, there is no adequate knowledge about the compatibility of resin tapping activity with other forest productions such as wood, biomass, pine cones, etc., and with the forest ecosystem services provided. The progress in compatibility involves:

- gathering existing information about natural resin production compatibility;
- establishing a research agenda to advance in the study of resin, wood and other NWFP compatibility;

- developing new forestry models and extraction techniques adapted to compatibility;
- identifying research resources;
- developing R&D projects to fill the gaps of knowledge identified, and
- disseminating the necessary knowledge to technicians and owners for their implementation.

IMPROVEMENT OF THE WORKING CONDITIONS OF THE RESIN TAPPERS

There is a common agreement among stakeholders considering that resin tappers workers are both a bottleneck in the natural resin production and the weakest link of the resin value chain. This is a major concern that needs to be addressed from both a technical and a socio-political perspective, in four main axes:

- document and disseminate the role of the resin tappers in the rural and green economies, as a way to increase social awareness;
- document and disseminate the environmental externalities of resin tapping;
- scan for new technologies and logistic solutions to reduced workloads and improve efficiency;
- identify opportunities to support the activity in rural development policies and examine the viability of payment for ecosystem services or related schemes, and
- advance in professional training regulation and recognition, mapping existing approaches at the global level.

MARKET DEVELOPMENT THROUGH IMPROVED COMPETITIVENESS WITH OIL-BASED ANALOGUES AND THROUGH THE DEVELOPMENT OF NEW PRODUCTS

The resin derivatives market is more and more complex due to the vast range of products and the strong competition against substitute products. INCREDIBLE project should focus efforts on:

- improving knowledge on the global demand and market fluxes;
- generating a common understanding on the potential benefits of environmental and/or product origin certification, and
- advancing in traceability, bringing together value chain actors and stimulating the establishment of common working rules for traceability.

5. Annexes

5.1. Access to scoping seminar reports and other materials

- Cork iNet: <https://incredibleforest.net/inet/cork>
- Resins iNet: <https://incredibleforest.net/inet/resins>
- Aromatic and medicinal plants iNet: <https://incredibleforest.net/inet/aromatic-medicinal-plants>
- Mushrooms and truffles iNet: <https://incredibleforest.net/inet/mushrooms-and-truffles>
- Wild nuts and berries iNet: <https://incredibleforest.net/inet/wild-nuts-and-berries>