



The FOREST4EU Factsheet Collection brings together the key findings, best practices, and innovative tools developed within the project. Each factsheet offers a clear, concise, and accessible summary of a specific topic, ranging from novel wood-based products and climate resilience strategies to advanced monitoring technologies.

FACTSHEETS

BOOKLET COLLECTION

ITHub4

Non-wood forest
products



Resin Data Observatory

Introduction

Throughout 2022 and 2023, GO Resinlab has worked, as one of its main objectives, on the construction of a tool for knowledge transfer, sector transparency, scientific and technical cooperation and decision support. This tool has finally materialised in the form of a collaborative digital platform called "Resin Data Observatory". This web platform gathers quantitative and qualitative information on the resin sector in Spain and seeks to meet the needs of the different stakeholders involved in the resin value chain.

Approach and main results

The Resin Observatory is structured in four main blocks: (i) Databases on harvesting for consultation and a geographical viewer. (ii) A network of experts who provide the observatory with data and information relevant to the sector. (iii) A repository of scientific, technical and dissemination publications that provide information on the resin sector. (iv) Digital tool for decision making and estimation of the profitability of the operation of the exploitation. (v) A section with news and current information on training, ongoing projects and other news of interest to the sector. The data panel section provides relevant information including a snapshot of the national situation in terms of trade in this raw material. Includes (i) Resin-producing areas (ii) Processing industries (iii) experimental plots for resin innovation (iv) Production by province (v) Resin prices (vi) P. pinaster area and potential forest area for tapping activity (vii) international trade data.

Much of this information can also be consulted through the web viewer. Through this tool we can also identify the location and main results of the experimental plots where different trials for the technological improvement of resin extraction have taken place in the last 10 years. It is also worth highlighting the elaboration of an optimal potentiality map for Spain. This map is the result of a theoretical model that needs field work to verify its results.

The knowledge repository shows more than 50 titles that can be consulted through different filtering methods that allow easy use. This section of the website will be constantly fed by the expert group that constitutes the platform core.

The group of experts brings together more than 60 professionals who contribute knowledge and experience to feed this platform, generate knowledge transfer and scientific and technical cooperation and solve problems

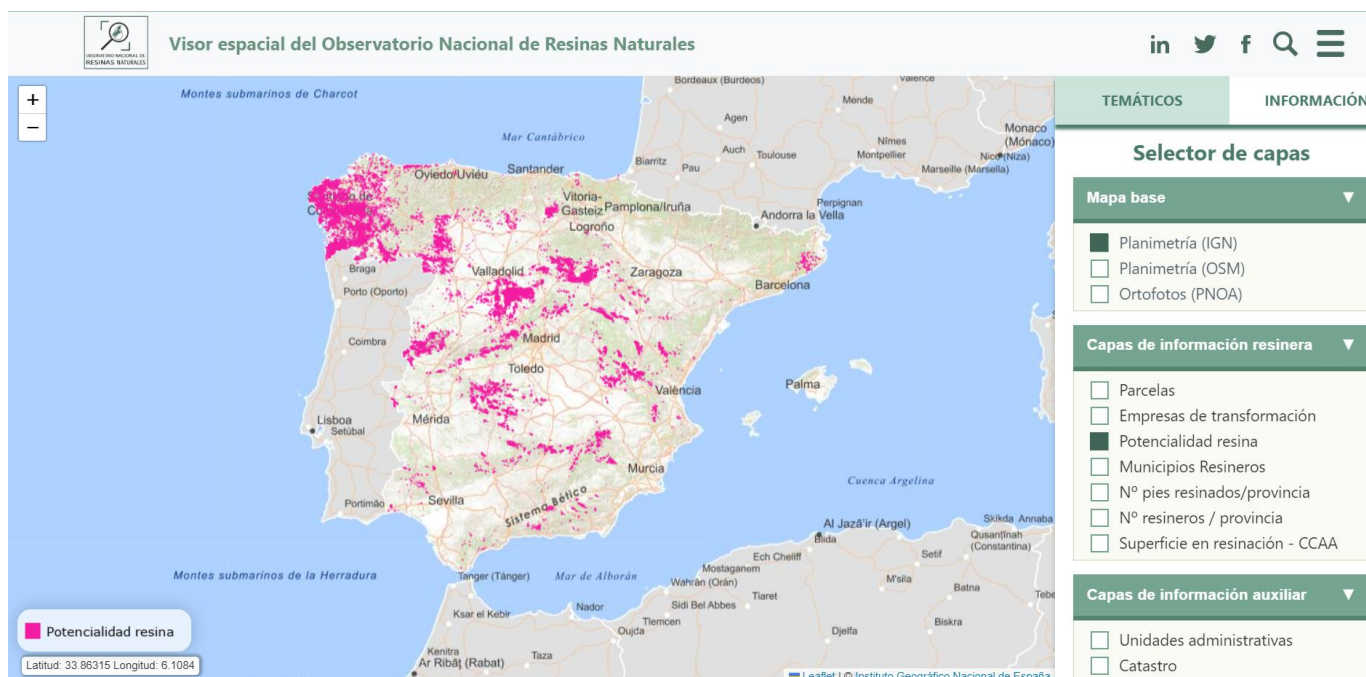
that new resin producers, owners or industry may have. These experts have signed collaboration agreements with this observatory to provide quality and stability to this tool. A subgroup of this group of experts called the Core Group (steering committee) is responsible for the tasks necessary for the correct functioning and veracity of the data shown, as well as for the communication and promotion of the observatory itself.

Finally, the decision support tool is developed in order to help the three main actors in the resin value chain: resin producers, owners and the processing industry. It is organized in two distinct parts: on the one hand, it answers the main questions that may affect each of them in order to start their activity, receive aid or develop resin production in the most efficient and sustainable way. On the other hand, it offers a profitability calculator that will allow the resin worker and the forest owner to know if the resin activity will be profitable in the area where they want to establish it. This tool is also a living element in the care of the group of experts, so that over time it will incorporate new information that is considered useful.

Lessons learned

The development of this tool has highlighted some of the sector's weaknesses, such as the lack of transparency and lack of organization. In Spain this sector is small and underdeveloped, however, its potential to make our forests living, sustainably managed territories, reduce the risk of fire and contribute to the bioeconomy is indisputable. The development of this web site has required the collaboration of many resin sector stakeholders and many limitations have been detected in order to obtain reliable information. Furthermore, the dissemination of its existence and usefulness has been limited by the end of the project and it remains to be seen whether the acceptance, legitimacy and maintenance of the Observatory by potential users will be confirmed in the coming years. It has been identified that the active involvement of a minimum number of people representative of the sector is essential for the success of this tool, but it remains to be seen whether this will be achieved. A number of measures have been implemented by the project to minimize the risk of abandonment: commitment documents, organization of regular meetings and events. However, once the project has been completed, the project leaders will take a back seat to these tasks and it will be the actors in the sector themselves who will determine the future of the observatory.

Figure 1. Appearance of the website “Observatorio Nacional de la Resina”



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Further information

<https://observatorioresinasnaturales.es/>



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CORAZÓN FORESTAL, espíritu investigador

GORESINLAB

RED DE TERRITORIOS PARA EL MAPA DE LA ACTIVIDAD RESINERA

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Mechanised resin extraction method

Introduction

Although the practices used in resin extraction have been improving in yield and quality, the extractive method remains the same: collecting the resin that emanates from a bare wood surface as a result of incisions, called picks, made repeatedly over time on the surface of the tree. With the development of mechanised extraction methods, the aim is to obtain a raw material with greater purity, less physical effort and skill in execution, and good yields

Approach and main results

The method tested in this OG is the so-called borehole at height. This method, which has existed for decades but has not yet been applied in Spain, has been tested and improved in this project. The methodology consists of drilling 3 simultaneous holes of 1.6 cm in diameter and 12 cm deep, with an inclination of 10 gr with tangential orientation (not radial), leaving a horizontal space between holes of 10 cm and a vertical space of 2 cm. For the borehole method, three extraction bags were used simultaneously, which were raised in height each time the picks were refreshed in an upward direction, with a periodicity of 14 days between picks. The results show that the borehole method produced 8.5 % more *P. pinaster* and 15 % more *P. radiata* than the other methods tested (traditional method and surface drilling method). The Borehole method is suitable for stands destined for chipping wood, and the yields obtained are very interesting, even without the application of stimulants. Stimulants have increased resin production by 70 % for traditional pica and circular notching, but only by 40 % for borehole. The high borehole productions stand out, especially in the non-stimulated trees, reaching productions of 1,796 g for *P. pinaster* and 1,162 g for *P. radiata*. The increase in production in 2022 compared to 2021 is very small for the borehole method, from which it can be deduced that the borehole wood penetration production system has a smaller cumulative effect per season and/or is less influenced by the different environmental conditions between seasons. For example, the production increases for Borehole, depending on the species and extraction technology, range between 8 and 10% in 2022, while for the traditional and circular notching system the increases are 34.5% and 30.22% respectively in 2022.

Lessons learned

The generation of innovation in resin extraction processes requires long-term trials and a large number of individual specimens (trees) studied. Resin production is affected by numerous variables, including climatic, edaphic, dasometric and, of course, human factors. This means that in order to extrapolate an innovation in this field to different scenarios, it requires longer study periods than those currently provided by the OG. On the other hand, the complexity of scientific and technical cooperation has become manifest. Good communication of the real interests of the parties is essential for the success of these processes. On the scientific side, data collection in the field, which is carried out by the tapping workers, as well as the execution of the work, is essential to scientist work. Without reliable data, all research results will be useless. On the other hand, the researchers developing the experimental designs must know and communicate frequently and closely with the tapping workers or the designs cannot be realistically implemented

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Identification of compounds of industrial interest

Introduction

The bark of *Pinus radiata* is an under-utilized forest residue that is renewable, abundant and has the potential to become a source of sustainable high-value chemicals. However, the use of this bark within a biorefinery for advanced applications is hindered by its intractable characteristics: high integrity, complex composition, and high heterogeneity. Most of the bark is burnt to provide energy and heat. The bark contains a high portion of phenolic extractives, constituting a potential source of valuable compounds. It also contains the heteropolymer suberin, a source of unique building blocks for developing innovative materials with potential broad bactericidal properties. Removal of phenolic extractives and suberin from bark simplifies down-streaming pulping processing of bark's lignocellulosic part.

Methodology and results

The GO implemented an effective green strategy to sequentially extract the lipophilic bark constituents and suberin, exploring scCO₂ (40, 50 or 60 °C / 200, 350 or 500 bar) and a biocompatible ionic liquid catalyst. The obtained scCO₂ extracts had similar diversity of lipophilic compounds and predominantly contained resin acids. Further extraction of the scCO₂ extracted bark yielded suberin amounts of 2.25% wt. The bark's suberin structure shows archetypal chemical features yet has an idiosyncratic high abundance of alkanolic acids, which is not common in most sources. The findings of this opening bark biorefinery study deserve further development and complementary techno-economic analyses to secure new value chains for the bark's major lipophilic compounds consisting of resin acids and bark suberin

Lessons learned

The amount of underused bark globally is impressively large. The United Nations Food and Agriculture Organization (FAO) estimated that in 2020, round wood production was 3.97 billion m³, with a growth rate of 5.8% since 2015 (Food and Agriculture Organization, 2018). Considering a 10% bark by wood mass, it has been estimated that more than 190 million tons of pine bark are produced annually. This study demonstrated the dual potential of *Pinus radiata* bark for sequential recovery of scCO₂ soluble constituents (up to 5.2% wt) and cell wall polymer suberin (2.25% wt). Using green solvents in a multistep approach is essential to creating

sustainable bark biorefineries, with two “state of the art” green technologies. The potential to convert underexploited bark residues into a rich portfolio of bio-based compounds through multistep green extraction technologies can directly support the future development of sustainable bark biorefinery concepts (schematically shown in Fig. 6). Importantly, removing the scCO₂ soluble constituents and suberin from *Pinus radiata* bark is expected to produce a material displaying higher thermal stability with further uses in polymer-wood composites (Shebani et al., 2008). Further studies are required to understand the optimal value chains, besides the lignocellulosic-based leftovers after suberin extraction, for the major bark scCO₂ soluble compounds: resin acids, and bark suberin.

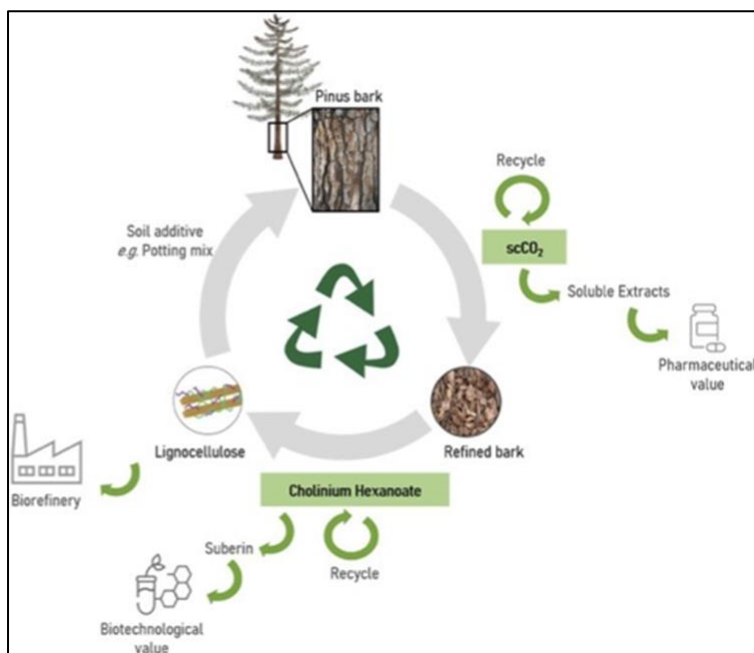


Figure 1. Schematic model of a potential sustainable bark biorefinery

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<https://pinusresina.blc3.pt/>; <https://www.rederural.gov.pt/centro-de-recursos?task=download.send&id=2129&catid=115&m=0>
<https://pinusresina.blc3.pt/>



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Postharvest coatings from mushroom by-products

Introduction

The MicoCoating initiative aims to apply bioactive compounds of natural origin, via mushrooms that produce functional compounds, in edible coatings for the food market. Currently, the increase in shelf life, via the organic market, through the significant reduction of preservatives in the context of the clean label market, and even the consumer demand for healthier foods, is one of the main challenges of the food industry. The use of edible films and coatings has proven to be a technology with great potential to achieve longer shelf lives, while ensuring food safety and quality attributes. Market demands have led to the need to invest in alternative compounds for application in coatings that inactivate the deteriorating reactions in food while guaranteeing the quality attributes expected by the consumer.

The compounds that make up the coatings must meet certain requirements, namely having a natural origin, being renewable and edible, and should also, if possible, give the coatings bioactive and preservative properties. The search for new compounds opened new opportunities for the incorporation of natural preservatives derived from plants, animals, bacteria, algae and fungi that act as antioxidant and antimicrobial agents. Among fungi, mushrooms are generally consumed as food and it has been demonstrated, namely by the operational group, that they have the potential to be used as a source of antimicrobials and antioxidants. Thus, the bet on mushrooms of wild species (forest co-products, with no food value) and production mushrooms (using agroforestry substrates) as a source of functional compounds presents itself as a great opportunity with high added value. Taking into account the most recent developments, the main objective of this initiative was the application of bioactive compounds of natural origin, via mushrooms that produce functional compounds, in edible coatings for the food market, to increase shelf life. Operations for sorting mushrooms at the industrial level usually generate large amounts of bio-residues not conforming to strict morphological criteria for commercial purposes, even though their biological content is not compromised. In this context, the present work aimed at evaluating the potential for reutilizing industrially discarded *Agaricus blazei* Murill (ABM).

Methodology and results

Thus, the content of essential nutrients and the chemical composition were determined, and MTT and LDH assays were used to evaluate the viability and cell death of Caco-2 and HT29 cell lines of an ethanolic extract prepared from ABM (preliminary safety tests for nutraceutical applications). The extract was incorporated into a semi-solid base cosmetic cream and cell viability effects of the extract, and of the final cream formulation, on a keratinocyte cell line (HaCaT) were studied (preliminary safety tests for cosmeceutical applications). Essential nutrients, such as proteins and carbohydrates, and a low-fat content were determined for ABM. Twenty-two fatty acids were detected, with polyunsaturated fatty acids (PUFA) (~53%) being the most abundant fraction. The cell viabilities of Caco-2 and HT29 cells were maintained up to 100 µg mL⁻¹. After incorporation into the base cream, a formulation with a pale-yellow colour and favourable pH was obtained. The cell viability of HaCaT cells in the presence of the extract and the final cream formulation was maintained in a concentration dependent manner, which indicates the safety of this extract for cosmeceutical applications. The results suggest that ABM residues can be used as an inexpensive and sustainable source of nutraceutical and cosmeceutical ingredients.

Lessons learned

Despite the discovery of many medicinal mushrooms and the identification of their bioactive polysaccharides, there are only a handful of functional food products where these polysaccharides are used. This is probably because there are several concerns regarding the application of these important molecules in final food products, such as the diversity of the biopolymers, the unstable quantity, quality and availability of these mushroom polysaccharides, the impact of the purification process and food processing on the bioactivity of the biopolymers and their production costs. Additionally, safety issues and regulation are essential for considering the marketing of functional food products. An example of this point is the limited practical applications of ergosterol and vitamin D₂ from mushroom by-products, which requires further work to achieve food and pharmaceutical industries applications.

The majority of the studies concerning the mushrooms potential bioactivity are conducted with samples of fruiting bodies. Nevertheless, the by-products generated from mushroom production also represent a good source of valuable compounds. These bioactive compounds could originate from solid substrate fermentation (caps and stipes from fruiting bodies, mycelium from SMS and SMS) or from submerged liquid fermentation (fermentation broth and surplus mycelium).

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Value the traditional chestnuts production

Introduction

The innovation presented here was developed in a project aimed at improving the chestnut mechanical harvesting process, improving the preservation of nut quality between harvesting and the consumer, as well as promoting other presentation forms of nuts for consumption in kind.

Objectives

The main objectives are: 1) Improve the chestnut mechanical harvesting process; 2) Enhance nut quality preservation between harvest and consumer by developing a new disinfestation method, creating a protocol for efficient fungal control during storage at room or cold temperature to extend commercialization and minimize water loss; 3) Promote alternative chestnut products like smoked and soft chestnuts, or chestnut flour for use in items such as bread, biscuits, and beer to expand market presence.



Figure 1 – Chestnut production field.



Figure 2 – Chestnut harvest.

Results

The main results are: 1) In very humid groves with thick debris, the elemental inoperative time increased (8.7% to 12.04%), though field efficiency remained at 82%. Equipment capacity for warehouse cleaning ranged from 1000 to 1500 kg/hour, lower in older groves. Aggregates with the nuts required extra cleaning and manual selection before industry delivery. 2) No scientific conclusions for post-harvest vermin control and prototype testing due to technical difficulties. 3) Paraffin and beeswax coatings effectively prevented water loss and maintained sensory quality, with volatile additives suggested to reduce microbial growth (rot). 4) MAP, VAC, and PM bags effectively prevented weight loss and mold, with MAP and VAC better for less than 3 months, and PM bags for 6 months. Non-packaged or macroperforated bags showed over 9% weight loss and mold. 5) Chestnut flour is promising for fresh and dried pasta, imparting softness and lightness, though it darkens the product; the optimal incorporation is 50%. 6) A chestnut sample with Tawny Port Wine and almonds was highly preferred in sensory tests for appreciation, color, aroma, texture, flavor, and purchase intention.

Lessons learned

Mechanized harvesting significantly reduces costs compared to manual methods, addressing labor shortages and improving chestnut health. Efficient harvesting requires good soil management, with vegetation cover and minimal residues, and is incompatible with mobilized groves. Regarding packaging, the high cost of using 0.5 kg plastic bags and manual labor makes it economically unfeasible. Larger plastic bags and automated filling are suggested to cut costs. Chestnut processing showed promising results (e.g., powder, fruit mix, patisserie), but further experimentation and cost evaluation are needed.

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Further information

[https://www.utad.pt/gpfe \(indirect\)](https://www.utad.pt/gpfe (indirect))



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The Burgundy truffle, a quality product with high added value

Introduction

The Burgundy truffle (*Tuber uncinatum*) is an important player in the regional economic market and is illustrated by the exponential planting of new truffle orchards. To promote an excellent quality product, markets have been set up over the past ten years to offer quality-controlled truffles. If the quality of the Burgundy truffle depends on its maturity, other factors can have an influence on the development of its aromas: local climatic variations, nature of the soil, microbiota of the truffle (bacteria, yeasts, viruses, etc.), its specific genetic characteristics or its method of conservation after harvest. The sector must also anticipate climate change and adapt truffle farming to more difficult and water-poor environments. The challenge is to increase and regularize quality agricultural and forestry production.

Methodology and results

In order to develop competitive and sustainable truffle farming, the project was structured around three objectives:

- Develop quality control tools for Burgundy truffles. Develop molecular tools for identifying the provenance of Burgundy truffles as well as sensory and physicochemical analyzes to better understand the origin and diversity of Burgundy truffle aromas.
- Acquire references to cultivation techniques that anticipate climate change to optimize production in truffle orchards (temporarily floodable valley or on dry limestone plateau).
- Develop sustainable silvicultural management to produce both wood and truffles. Develop a tool for predicting the distribution of truffles in forest environments; characterize the stations favorable to Burgundy truffles; evaluate the effects of silviculture (thinning experiments) on truffle production.

Researchers from INRAE in Dijon (Center for Taste and Food Sciences and UMR Agroecology) carried out analyzes to characterize the aromatic complexity of Burgundy truffles. Sensory analysis sessions were also carried out by researchers from the ChemoSens platform. The results highlighted three “typical profiles” of Burgundy truffles: truffles characterized by more intense forest odors (button mushroom, undergrowth), more spicy odors (vanilla, smoked, pepper) and truffles presenting more negative odors (animal, earth, etc.). At the

same time, researchers have developed methods and tools for the analysis of the chemical compounds responsible for the odor of *Tuber uncinatum*, as well as molecular tools making it possible to determine the geographical origin of the truffles.

Two pilot truffle farms have been set up. The first in Leuglay, in a flood zone, and the second in La Cras, in a dry environment. On the La Cras site, analyzes of the roots of truffle trees and estimates of the mycorrhization rate were carried out. The results show good maintenance of the mycorrhization of 3 out of 4 species in conditions of major water deficit.

Finally, a prediction model for areas favorable to Burgundy truffles based on LIDAR data was established. Its extension to the scale of a forest massif will be possible based on adequate digging data.

Different methods of thinning coppices under high forests have been implemented. Their monitoring over time will make it possible to study the effects of forestry on truffle harvests.

Lessons learned

The project made it possible to develop a partnership approach rich in exchanges between the different stakeholders interested in recognizing the value of the Burgundy truffle among institutions and the general public. The IGP (controlled geographical indication) approach was not successful because research is still necessary to successfully differentiate the *aestivum* truffle from the *autumnal uncinatum* variety. The project made it possible to improve the recognition of the Burgundy truffle with the French Federation of Trufficulteurs.

BIJOU has also encouraged better consideration of this truffle in management plans in private and public forests in order to promote forest heritage and produce added value to wood. The partners also recommend integrating the Burgundy Truffle into agroforestry projects.

It is necessary to adapt regulations and require traceability of truffles to avoid the parallel market. Likewise, technical routes should also be shared to guarantee the development of the production of national truffles while the French market is flooded by Burgundy truffles from Eastern countries.



Figure 1. Image of a Burgundi truffle
Eric Hell © CNPF

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Further information

<http://www.artbfc.fr/>



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Fertilization recommendations for cork oak

Introduction

Although the cork oak is one of the main forest species and the national tree of Portugal, there was not much information about fertilization recommendations for the development of this species. The practice was to carry out soil analyzes only for the installation of under-cover pastures, forgetting the arboreal component of the system.

GO NUTRISUBER carried out the characterization of the soils of 30 cork oak forests and the monitoring of their fertility in the areas where the species occurs in greater density and where it is most economically exploited: Alentejo and Ribatejo.

The soil, in addition to the water and air it contains, is made up of mineral and organic particles of various sizes that give it different characteristics, depending on whether one or the other dominates and, within these, whether the finest or the coarsest. In Portugal, most soils are mineral, that is, mineral matter is dominant, with very few organic soils (with contents greater than 15% of organic matter). From the point of view of plant nutrition, only the finest particles, with dimensions smaller than 2 mm - the so-called fine earth - are considered, and this is the fraction that is analysed to assess the state of soil fertility. Some of the characteristics of the soil can be observed in the field, just by looking closely at its profile. Others, such as texture, organic matter and mineral nutrient content, reaction (pH) and cation exchange capacity, can only be evaluated through laboratory analysis.

In addition to soil analyses, this work demonstrates the importance of leaf analysis of nutrients for understanding the true state of nutrition of cork oaks to allow giving recommendations for fertilization. Methodologies for collecting soil and leaf samples were defined in order to obtain more efficient results, and dissemination videos were made for technicians and forestry producers.

Lessons learned

The main result of this project was the creation of fertilization tables for different states of development of the cork oak forest stands: Stand installation phase; Young phase until the first stripping; Adulthood.

All the information was compiled in a manual on cork oak fertilization, which describes the physical, chemical and biological characteristics of the soils in the cork oak forests. In addition, it makes a simple description of the forms and availability of soil nutrients for plants, creating a table that classifies the forest stand in fertility class (very low, low, medium, high and very high) according to chemical parameters such

as phosphorus (P_2O_5), potassium (K_2O) and magnesium (Mg). At the end, it presents the mentioned fertilization tables with the recommended amounts of fertilizer to apply for a correct fertilization of the Montado. These tables are based on the previously mentioned fertility classes that resulted from the analysis of soil samples and foliar samples, defining the amounts of nutrients to be applied per hectare.



Figure 1. Published scientific material related to the project.

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Further information

<https://www.inia.pt/images/publicacoes/livros-manuais/MANUAL-DE-FERTILIZACAO-DO-SOBREIRO.pdf>

<https://www.unac.pt/index.php?id-i/grupos-operacionais-accao-1-1-ndr2020/nutrisuber>





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Brochure for the collection of soil samples in cork oak forests

Introduction

The analysis of soil samples collected in cork oak forests allows knowing the physical and chemical characteristics of the soil, constituting, together with foliar analysis, support for the most appropriate fertilization recommendation.

However, although this practice is not new, it is not a practice followed by the majority of forestry producers, who, although viewing cork production as a lucrative economic activity, do not understand the need to analyze the nutritional status of forest stands and carry out necessary fertilization and soil amendments.

The collection of soil samples must be carried out well in advance of the application of fertilizers, being advisable the period in which the soil has a moisture content that allows this operation to be carried out, which generally happens in autumn - winter.

If the land is not uniform, it should be divided into relatively homogeneous plots with regard to color, slope, drainage and type of forest management.

Samples must not be taken in wet areas, near paths, houses, stables or in places that have been occupied with manure, sludge, fertilizers, ashes or other products.

Lessons learned

Thus, to sensitize forestry producers, a publicity leaflet was prepared, which is available in paper and online, in accessible and easy-to-understand language. The leaflet defines when the analysis should be carried out, how it should be carried out depending on the type of existing forest stand: before the stand, in a young stand, in an adult stand or even in modern irrigated cork oak plantations. It also defines what equipment is necessary for the correct collection of samples and how to pack and send them to the laboratory to obtain the results.

Figura 1. Material necessário à colheita das amostras de terra



- No caso de se utilizar uma sonda, é necessário possuir também um punho e uma marreta **Fig. 1 e Fig. 2**.

Figura 2.
Pormenor do punho e da sonda de meia cana



Figure 1. Upper photos - needed material to gather soil samples. When using a soil sampler prober, a sledgehammer is needed. Lower photo - use of the soil sampler probe on the field.

Figura 3. Pontos de recolha de subamostras de terra

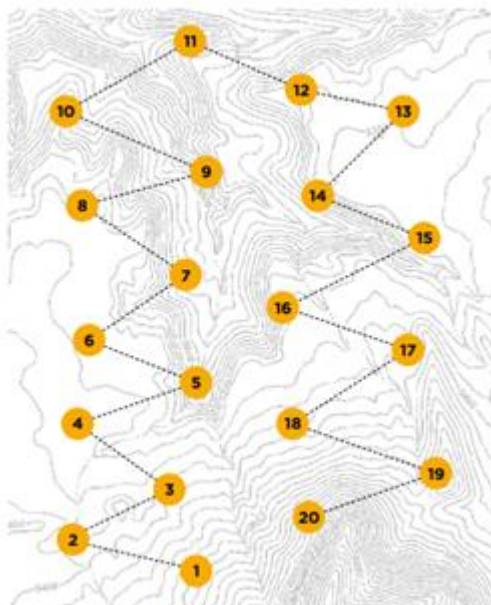


Figure 2. Locations where the soil samples were gathered showing the gathering pattern.

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Further information

https://eu-cap-network.ec.europa.eu/projects/nutrition-and-fertilization-cork-oak-forest-nutrisuber_en





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Brochure for the collection of soil samples in stone pine

Introduction

The analysis of soil samples collected in stone pine forests allows knowing the physical and chemical characteristics of the soil, constituting, together with foliar analysis, support for the most appropriate fertilization recommendation.

However, although this practice is not new, it is not a practice followed by the majority of forestry producers, who, although viewing pine nuts production as a lucrative economic activity, do not understand the need to analyse the nutritional status of forest stands and carry out necessary fertilization and soil amendments.

The collection of soil samples must be carried out well in advance of the application of fertilizers, being advisable the period in which the soil has a moisture content that allows this operation to be carried out, which generally happens in autumn - winter.

If the land is not uniform, it should be divided into relatively homogeneous plots with regard to color, slope, drainage and type of forest management.

Samples must not be taken in wet areas, near paths, houses, stables or in places that have been occupied with manure, sludge, fertilizers, ashes or other products.

Lessons learned

Thus, to sensitize forestry producers, a publicity leaflet was prepared, which is available in paper and online, in accessible and easy-to-understand language. The leaflet defines when the analysis should be carried out, how it should be carried out depending on the type of existing forest stand: before the stand, in a young stand, in an adult stand. It also defines what equipment is necessary for the correct collection of samples and how to pack and send them to the laboratory to obtain the results.

Figura 1. Material necessário à colheita das amostras de terra



- No caso de se utilizar uma sonda, é necessário possuir também um punho e uma marreta Fig. 1 e Fig. 2.

Figura 2.
Pormenor
do punho
e da sonda
de meia cana



Figure 1. Upper photos - needed material to gather soil samples. When using a soil sampler prober, a sledgehammer is needed. Lower photo - use of the soil sampler probe on the field.

Figura 4. Esquema da orientação da colheita das amostras de terra

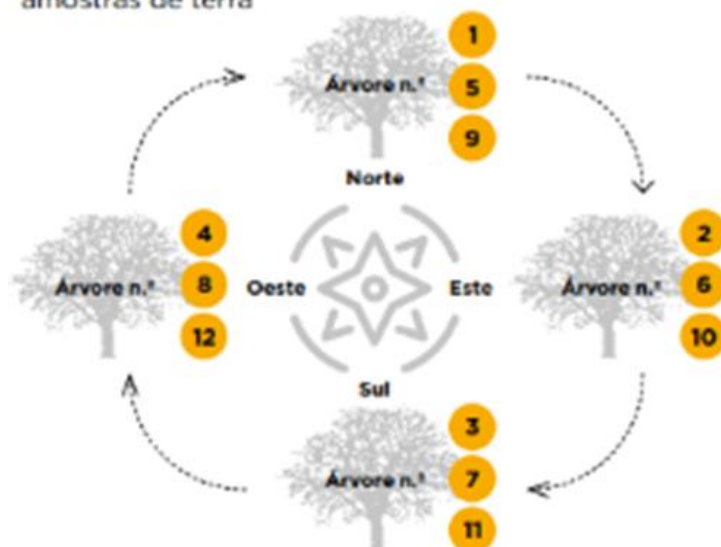


Figure 2. Scheme showing the soil sampling orientation (cardinal direction).

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Further information

<https://www.unac.pt/index.php/id-i/grupos-operacionais-accao-1-1-pdr2020/fertipinea>





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Pinea ClimaDAT: a tool for pine harvest prediction

Introduction

One of the main objectives of the OG Pinea has been to establish a system for predicting pine cone harvests. The estimation of harvests on a real scale in Castilla y León is still done visually carried out by environmental agents. There is an increasing disparity between what is estimated and what is harvested. For this reason, as opposed to direct measurement, the aim is to develop a predictive model that allows a reliable estimate of harvests.

Approach and main results

Pinea ClimaDAT is an application for simulating pine cone harvests at the forest scale several months (or even years) in advance, which is a fundamental tool for predicting harvests, and facilitates the management and organization of forest management. This app has been developed in two phases: In the first phase, during 2017, the application was developed by research centers, private enterprise and local administration in areas where this activity has economical relevance. The purpose of Pinea ClimaDAT in this first version was to calculate - both for historical series and for the current year - the annual pine cone production and biomass stocks for *Pinus pinea* public utility forests. It was developed for a specific province of the Spanish territory in which there was an extensive database for the development of the model underlying the application. In addition, it allowed simulations to be carried out on user-defined climate data or on climate scenario projections. In a second phase, during the years 2022 and 2023, within the framework of the PINEA OG, an improvement of the application has been carried out, which can be summarized as follows: (i) The geographical validity of the App has been extended to two more provenance regions. (ii) Pine cone harvest data available until 2021 are included. (iii) The App is made compatible with public GIS data. (iv) The natural units used by the tool to relocate the study area are redefined. (v) The effect of *Leptoglossus occidentalis* on pine cones production is incorporated. (vi) The use of new climatic variables is evaluated. The simulations of this tool are performed by applying different pine cone production models, including the model of Calama et al. 2016. These models use data from available forest management inventories. In the case of the usability of the application referring to how to carry out a simulation with user-defined data, the following are requested: A) Location data B) Forestry characterization (surface area, number of trees for stone pine and the rest of the species) C) Select the season for which the simulation is to be carried out. With these three simple steps you can simulate pine cone production in tn and

kg/ha. It also allows you to compare production with previous seasons. This application is available for free on the project's website

Lessons learned

Building predictive models requires a significant amount of quality data to produce accurate and reliable results; the quality of the record has a bearing on the quality of the model. Maintaining continuity in data collection can become complicated in periods of crisis with budget constraints. The data recorded are from a limited number of experimental plots, although the prediction system has been able to extrapolate to neighbouring areas within the same source area, it has not been able to reach other more distant territories. The arrival of *Leptoglossus occidentalis* in Europe had a disruptive impact on the historical data series that previously reflected the strong influence of climate on pine cone production, in addition to the difficulty of detecting the presence of the insect - due to its elusive nature and the lack of an effective monitoring system - and being able to predict the effect of its population on production in a given area. The forthcoming arrival of new exotic pests or diseases (such as the alert that already exists in France or Italy for *Toumeyella parvicornis*) may change the dynamics of ecosystems in an unpredictable way and alter the data series used to feed the prediction models, so that all the calculations and formulas used will have to be readjusted once again.

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Further information

<https://gopinea.org/climadat/>

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Smartbasket: an app for mushroom collectors

Introduction

The increasing activity of collecting and trading wild mushrooms has led many public administrations to regulate the use of mycological resources. Shortcomings have been detected in terms of legal regulation and the professionalization of collectors. As a result, this project (OG Pinea) seeks to manage the regulation of the mycological resource and proposes the use of technological tools. Priority is given to guaranteeing sustainability in harvesting, traceability in the value chain and generating useful information for both, the collector and the business sector.

Approach and main results

Among the different proposals developed by the OG, the Smartbasket application has been selected as an innovation. This tool is a data collection device. It is a pedagogical tool based on learning through gamification techniques, being a mobile technology and accessible to all users (GPS, camera, audio...). These techniques are based on learning that transfers the mechanics of games to the educational-professional field to achieve better results. In this case, the more collecting areas you register in your application, the higher your ranking will be compared to other users. In addition, you will be able to access a greater number of species identification queries. Smartbasket aims to involve society through Citizen Science tools. The aim is to stimulate active collaboration in the collection of field data from collectors and lovers of nature and the mycological resource, as well as to open a channel of information with society and raise awareness about the need to respect, care for and protect our mycological resource. Within the application we find the following features:

USER ROLES: The possible user roles are: collector, identifier, collaborating professional and administrator. Each of them has access to various features of the app that facilitate their work.

SETALS (collection areas): The app user can manage his collection areas through smartbasket, identifying species, location, date of sighting, etc.

WARNINGS: The smartbasket warning functionality allows the user to report bad practices detected in the forest. It also allows the user to collaborate with the system by sending data related to the mushroom market, which become part of a BigData aimed at facilitating the sustainable management of the mycological resource.

RANKING: As a recreational component, smartbasket recognizes the participation of the expert identifiers and that of the users, collected in ordered lists where the identification is only by the user's alias. Each user has also an account of credits that increases with his participation and use of smartbasket: each time a user

participates in smartbasket, the number of credits increases. Each user also has a credit account that increases with his participation and use of smartbasket: each collected area, itinerary or notice adds credits to the user's account, which can be invested in requesting identifications. REQUEST RESOLUTION BY THE IDENTIFICATION EXPERT The request for identification of a species must be accompanied by one or more photographs taken at the collection site. The expert identifier has the capacity to identify species through the photographs sent by the user collector in the identification requests.

Lessons learned

The digital skills of the user collector are highly variable, as the activity is performed by a wide demographic profile. The data collection App has to have a design that is very simple and easily understandable by less digitally skilled users. Functionalities have to be developed that connect collectors to each other, for mutual transfer of knowledge and information. One initial difficulty is the reluctance of collectors to share information about their mushroom collecting areas, so prior work must be done to build trust and provide assurance that the data collected through this application are confidential, are not shared with other users and are for their exclusive use for analysis and research.

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Further information

https://www.youtube.com/watch?v=dLQ732Zp_j8&ab_channel=FundacionCesefor
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Inter-territorial Association of Wild Mushroom Harvesting Professionals

Introduction

Go Mikogest states that it is crucial to use the sectorial associationism as a tool to professionalize the primary sector of the mycological activity. With the growing activity of collecting and marketing mushrooms, most regional administrations have independently regulated their mycological exploitation. This lack of legislative homogeneity in the territory causes difficulties in the management of the mycological resource, among which the following have been detected: (i) Lack of coordination between the different sectors concerned. (ii) Lack of knowledge of mycological production in the territory, as well as its local economic impact. It is precisely the local collectors who obtain a large part of the mycological resource for subsequent sale. However, the lack of professionalism in this sector, most of them being sporadic collectors, forces a dispersion of the resource to other sales channels, making it very difficult to quantify collection data in producing areas.

Approach and main results

GO Mikogest's proposal to face the problem of the lack of professionalism in this sector has been the creation and promotion of the Inter-territorial Association of Wild Mushroom Harvesting Professionals. The association's statutes have been drafted for their subsequent registration and constitution, accompanying these actions with the development of a training plan aimed at the professional collector. Thus, with the creation of this national professional association, it is intended to: (i) Achieve the professionalization of the group of collectors. (ii) To provide the necessary training for the unequivocal identification of edible species. (iii) To ensure the conservation of all mycological species. (iv) To prevent indiscriminate collection by people outside the municipality or locality. (v) To avoid the loss of the usual local collector. The association develops its activities throughout the Spanish territory, represents the wild mushroom collecting sector, and arises to defend and promote the economic and social interests that are proper to this activity, both in its individual and collective development. Membership is open to all individuals who hold the status of professional wild mushroom picker

Lessons learned

To ensure the success of a partnership, in addition to encouraging its establishment, it is essential to have a period of accompaniment, which can last one or two years. This will allow the initiative to move beyond the initial start-up phase and give it a better chance of success.

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Further information

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App Micontrol

Introduction

This operational group pursues to manage the regulation of the mycological resource through tools based on Information and Communication Technologies (ICT), guaranteeing sustainability in the use of the mycological resource, traceability in the value chain and offering useful information to both the collector and the business sector. One of the problems identified in the mycological sector is related to the difficulty of harvesting control tasks

Approach and main results

As an innovative solution, GO Mikogest has developed the Micontrol app, designed to facilitate the work of harvest control of the guards in the mycological areas. In addition, it captures data on the development of the harvesting activity through the quantities collected and yields by species with socioeconomic interest. This application has two objectives: - Facilitate the management of the environmental agent in the control of harvesting in his task of verifying that the activity is carried out according to the conditions of collection established in the enclosure. - Capture data of the harvesting activity. The app has been designed to be used by multiple users through any model of mobile device. A web space has also been developed for each user, from which they can manage the data of all their inspections, visualize them through GIS technology, access their images and verify the data of each inspection. The application has two different functionalities: 1-Control of harvesting activity: With the harvesting control, it is verified that the activity is carried out according to the harvesting conditions established in the enclosure. The environmental agents carry out the inspection activity to the collectors, verifying that they have authorization (license) and that they respect harvestable species, sizes and quantities, being able to carry out the pertinent proceedings for the processing of complaints if the situation requires it. 2- Inspection Manager: Micontrol is a manager of inspections carried out, which facilitates and organizes the work done in the field by the agents. The capture of the collector's personal data can be done manually, or through the capture of this data by means of a QR reader, which speeds up and prevents the data entered from being erroneous. This QR reader is only valid for enclosures that include this code in their harvesting permit. In addition, through the micontrol app, the rural guard, private field guard or civil guard-seprona, verifies in real time (with mobile coverage) fraud by falsification of harvesting permits. This functionality is only available for certain reserves, integrated in the Micocyl mycological exploitation system.

The application sends a query to the database receiving a valid or unmatched permit message. The activity of harvesting control generates a very important volume of data about the harvesting that is being carried out in the territory. Micontrol enables a simple system for the capture and management of this data, contemplating the different scenarios faced by the agent in his control activity.

Lessons learned

The digital skills of the people who carry out the collection control are highly variable, so it is advisable that the data capture app has a very simple design that is easily understood by less digitally skilled users. It is important that any control that is performed on a collector takes as little time as possible, so that the use of this application is both attractive and convenient. If the monitoring process involves lengthy data collection over time, it may reduce interest in using the application.

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Further information

<https://www.mikogest.net/pagina/micontrol>

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Exchange between chestnut growers

Introduction

During INGECA project, a lot of effort was put into dissemination activities, with 8 thematic meetings, 2 seminars and 2 field visits. These activities permitted to chestnut growers to share experiences about the innovations tested (endothermic treatments with *Trichoderma* spp., use of BITE technology, mobile charcoal kiln prototype for local biochar production), to share approaches in chestnut grove management and production as well as to explore specific aspects like grafting, pruning, variety, disease control, in different regions (Tuscany, Lazio and Calabria). The project began in 2020, right at the beginning of the Covid19 pandemic crisis, so it was decided not to conduct remote dissemination activities, but rather to wait for the end of pandemic restrictions.

Lessons learned

Dissemination activities were very useful to engage chestnut growers and to demonstrate the effectiveness of a chestnut grove management that's also economically and environmentally sustainable.

The project started in 2020 exactly at the beginning of the Covid19 pandemic crisis. In order to enhance real knowledge exchange between partners, it was chosen not to do remote dissemination activities but rather to wait until the end of pandemic restrictions. This has favored personal contacts, allowed participants to know important chestnut growing realities on a regional and extra-regional scale and practical demonstrations in the field. The chestnut production sector is facing many difficulties due to environmental, social and economic aspects. These sharing-knowledge activities are fundamental to establishing durable relationships between the multiple actors of the production chain and to build stable networks, capable to operate also after the end of the project.

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Further information

<https://www.psingeca.it/it>



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Integrated management of resources (water and soil) in nuts production

Introduction

The initiative focused on soil and water management in four species that produce nuts: chestnut, almond, hazel and walnut. The OG aimed to evaluate the effect of different natural and sown plant covers on chestnut crops in order to select the type of cover best suited to each crop. Also, to evaluate different soil fertilization strategies, via foliar and/or fertirrigation in the four species studied with a view to knowing the response of these species to the main nutrients and recommend some corrections.

The objectives were assumed as differentiated, according to the specimen to be analysed, and aligned with the most evident problems that arise in the production practice. As a previous point, the OG stated the importance of knowing the characteristics of the place where the plantation will be located, and act accordingly:

- drainage: in soil with poor drainage it is not possible to establish an orchard- then, establish some practices to increase the draining capacity;
- pH: is probably the soil property that can impose the most constraints to the development of plants- then, to correct it is important;
- organic matter: it is important to contribute to the correction of its availability, for the plants;
- correction of phosphorus content, accordingly with the results of correction in the ph.

The OG worked several field stations, with extended experiences for the distinct specimens here considered. The results, by specimen, may be referentiated like this:

Results by specimen

- Walnuts, even not being a particularly demanding crop in nutrients, need good soil structure and aggregation conditions provided by a good organic matter content, from deep soils with good storage capacity for water, and must also be ventilated and well drained;
- Chestnut tree must receive nitrogen annually and boron as fertilizers. Potassium also should be applied regularly. The phosphorus should be required in smaller quantities than nitrogen and potassium and is

less important the annual regularity of its application. The foliar analysis helps in the quantification of these applications;

- Hazelnut, due to the growing impact caused by climate change, ways are being studied to reduce the amount of water to be applied through irrigation, mainly through regulated deficit irrigation (RDI). The adoption of drip or micro-sprinkler irrigation, combined with irrigation strategies deficit, are the most viable solution to the current scenario of decreasing water reserves available for irrigation;
- Almonds, the use of indicators water and thermal stress of the plant is essential for adequate irrigation management deficit. It is essential to monitor the water status of the crop in the initial stages and evaluate the need to start watering earlier, considering the importance of satisfying water needs of the crop in the first phases of its cycle. The irregularity of Mediterranean climate reinforces the need of this control;

Other considerations and conclusions for the orchards: install biodiverse pastures; make legumes profitable for orchards, improve soil structure, use alternative fertilizers such as e.g. ex. algae, establish technically supported fertilization plans and install adapted irrigation systems, for each case.

Lessons learned

It is a need to go deeper in practical experiences regarding nuts systems. Traditionally, they are produced in dry conditions, without special care in soil management, fertiliation, irrigation and varieties. The uncertainty in climate and the need to be more profitable appeals to more applied research, field experiments and farmers' engagement. Alternative nutrients sources, more frequent analysis (foliar and soil), technological advanced solutions for irrigation and biodiverse pastures are among the most suitable practices to improve nuts productions.

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Further information

<https://egis.cncfs.pt/projeto>



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Biological Treatment of Chestnut Blight (*Cryphonectria parasitica*) in Portugal

Introduction

The OG focused on the chestnut cancer, with the aim of finding biological tools and management to decrease the effects of the parasite; the conventional treatment until now hasn't been efficient in fighting this disease. Chestnut cancer is associated with the fungus *Cryphonectria parasitica* (Murril) Barr, a species of Asian origin, invasive and very aggressive on chestnut trees, causing death of the branches and progressively of the entire tree. A European and Mediterranean Plant Protection Organization (EPPO) categorizes the fungus *C. parasitica* as an organism of quarantine on the A2 list, i.e. a quarantine organism but already present in many of the European countries (EPPO, 2022).

Methodology

OG BioChestnut - IBM had 4 phases:

1. Characterization of the virulent *C. parasitica* population;
2. Know the presence of natural hypovirulence in the *C. parasitica* population in Portugal;
3. Monitor the effectiveness of treatments;
4. Develop formulations of the DICTIS bioproduct for use in different disease situations in chestnut trees.

Following a strict experimental design, essays were made with the biological products, supported by laboratory analysis and field observations. Considering that the biological control using hypovirulent strains of *C. parasitica* (hypovirulence) is a very effective means of control that promotes the healing of cancers and the full recovery of diseased chestnut trees and considered by EFSA (2016) as the most adequate and more effective to mitigate and control the high risks that the disease with CHV1 Strains is necessary to complete the following:

- stage 1 - Scientific and technical studies (Pre-Application). Population Study of the Parasitic Fungus Present in Soutos, Production and Formulation of the Bioproduct, Experimental Development;
- stage 2 - Treatment of Cancers, by puncturing or brushing with CHV1 Strains Compatible;
- stage 3 - Monitoring and Evaluating the Efficacy of Treatments;

- stage 4 – Compliance with IPB Regulatory Commitments, Chestnut Producers, Producer Associations, Other Authorized Entities.

Lessons learned

Find the best practices and develop action and interaction tools between different participants was one of the objectives of the GO - Biochestnut -IPM- project to implement measures effective fight against chestnut and almond trees. The participation of researchers, technicians and chestnut producers as well as the different entities involved in the organization of production,

management of the territory and official entities allowed the transfer to take place of technology and the adoption of the new biological control method in the treatment of breast cancer chestnut. The success achieved translates into the treatment of 4028 (plots) chestnut trees and 59452 chestnut trees recovered, thus guaranteeing productivity for producers, but also the sustainability and resilience of the chestnut ecosystem of high environmental value in the mountain regions of Portugal.

The “Experimental Program for the Biological Treatment of Chestnut Canker Based in Hypovirulent Strains of *Cryphonectria parasitica* - CHV1 Strains” effectively resolves and will continue to ensure the long-term resilience of the chestnut ecosystem. The new parasites and mutations need similar approach, in continuous.



Figure 1. Treatment of the chestnut blight

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Further information

<https://biochestnut.cncfs.pt/>



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Mobile charcoal pile prototype for biochar production in situ

Introduction

A prototype of vertical mobile charcoal kiln has been developed on a farm scale, with quite small dimensions, whose work for the charcoal-making operations is such that only one worker's day is sufficient.

The transformation of chestnut cultivation residues into biochar and charcoal is a good practice from a phytosanitary point of view, and furthermore, this activity allows for increased profitability on a small company scale, mainly focused on forest owners. These products can be further valorised on the farm or sold to third parties, thus becoming an additional source of income from materials that would otherwise have to be disposed of. Other promising products are condensate liquids derived from the pyrolysis process.

The prototype is structured with a vertical development, outlining a type of mobile kiln called 'vertical kilns with discontinuous operation', capable of operating in direct and indirect carbonization process.

The input material can be in the form of wood with varying diameters and length reduced to approximately one metre, (direct or indirect system), but also chopped wood or other residues (indirect system), coming from the cultivation of the chestnut grove, but also supplied by other sources within the owner forest production, such as pruning residues of other fruit trees or residues of silvicultural operations. The product obtained therefore has characteristics, even if only dimensional ones, that are peculiar and therefore destined to be used in the production of chestnuts.

The carbonisation that can be carried out in this prototype is a slow process that takes place at a low to medium temperature (below 500 °C), and is the system that yields a higher yield in solid product (charcoal), compared to rapid and/or high temperature pyrolysis systems (Bridgwater, 2007), an element that should not be underestimated at farm level.

Lessons learned

Considering the excellent results and the current need of chestnut growers to diversify and increase income, the mobile charcoal kiln has proved to be a machine capable of responding to the needs of chestnut farms, and the versatility of the direct and indirect system process also makes it suitable for all those farms that have agro-forestry waste, such as prunings from olive groves and vineyards, making the project multi-purpose in creating economic and employment induced from elements previously considered waste and above all not exclusively linked to chestnut growing.

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Endotherapeutic treatments with *Trichoderma* spp. in chestnut groves

Introduction

Tuscan chestnut cultivation is still carried out using traditional methods. Climatic, economic and social factors led in recent decades to the ageing and physiological decline of chestnut groves. Moreover, the arrival of new pathogens and pests as well as the resurgence of already known parasites severely curtail chestnut production. Phytosanitary control in chestnut groves has always been carried out by traditional treatments, that caused a high product dispersion in the environment and a low efficacy.

For the above reasons the introduction of new, economically viable tree cultivation and protection techniques may provide a valuable solution. The objective was to transfer to chestnut groves biocontrol protocols that have already been tested and validated in others crop systems. This was the first case of application of biocontrol agents (BCAs) in chestnut groves. BCAs are beneficial microorganisms that live naturally in soil and/or within plants tissues (endopythos). *Trichoderma* spp., in particular, have been widely used in agricultural crops as “biopesticides” proving to be highly effective in enhancing plants growth and increasing parasite resistance.

Endotherapeutic treatments were carried out with various local strains of *Trichoderma* spp. These were directly injected into the tree sapwood by using the new, minimally invasive BITE® (Blade for Infusion in TrEes) injection tool, at 1,30 m of height. The best period for treatments is during the growing season when the tree canopy is fully developed, with transpiration and water transport within trees very high, so that the *Trichoderma* suspension can be quickly adsorbed and moved to the upper part of the crown. The same microorganisms were also inoculated into the soil where they can protect tree roots in the rhizosphere.

The results showed that *Trichoderma* empowers natural plant defenses, so that the tree is also more resistant to pathogens. In particular, this methodology has shown very significative results in limiting the nut rot disease caused by *Gnomognopsis castaneae*, which strongly impacts chestnut fruit production. Disease incidence reduction was by 30-35% in the first year and 60% in the second year.

The same BCAs were also used to protect pruning wounds (both ordinary and phytosanitary cuts) because some pathogens (e.g. the agent of chestnut blight *Chryphonectria parasitica*) cause wound infections. Moreover, biocontrol treatments proved also effective in increasing the density of *Torymus sinensis* larvae.

Lessons learned

Biological control, when coupled with good management practices, leads to a reduction in the incidence and severity of pest attacks on the fruit and, as a consequence, a remarkable increase in chestnut production. Tree endotherapy with local *Trichoderma* is functional to safeguarding ecological integrity and biodiversity of chestnut groves as well as to maintaining the ecosystem services these stands provide.

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Further information

<https://www.psingeca.it/it>



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Methodology for plantations

Introduction

ClimCast installed a network of 7 demonstration groves in different soil and climatic contexts of the country. These chestnut trees were made up of specimens of 11 chestnut cultivars and are equipped with meteorological stations. It was thought to be an embryonic basis of a knowledge network to serve the sector, according to the needs. Chestnut production is strongly conditioned by weather conditions averages and extremes observed during its annual cycle. Diseases and pests that affect and decimate chestnut trees are also associated with specific environmental conditions. Like this, the economic potential and development strategy of the value chain, in Portugal, face difficulties resulting from climate variability and climate change. The chestnut tree presents weaknesses resulting from poor tolerance to the combination of water and thermal stresses that result in loss of vigour and productivity as well as an abnormal increase in tree mortality rate. As objectives, it had: (i) characterize the evolution of soil and climate conditions in the main producing regions in terms of potential for chestnut production; (ii) identify the best adapted varieties future climate conditions; (iii) develop tools to estimate future production; (iv) develop a manual of good chestnut cultivation practices to be adopted by producers (v) create a warning network for chestnuts.

Results

The results are mainly related to the large number of meteorological variables that were identified, detection indices remote control and other parameters with influence on the chestnut tree and predictive potential of chestnut productivity in Portugal. The climatic characterization of the main chestnut regions and chestnut producing regions, under current climate conditions and future. These results allow selecting the best cultivar for each situation edaphoclimatic and understand the impacts of climate change in oil-producing regions brunette. Based on this knowledge, climate models were developed for simulation and forecasting nut productivity and mapping climatic suitability for chestnut production. The methodology developed allowed identifying the regions producers and potential producers of chestnuts depending on their characteristics climate and provides a gradation of the risk situation of the crop.

Lessons learned

This OG arose with the aim of taking advantage of the opportunity of the development of the sector and, in the context of climate change. Monitoring soil evolution will make it possible to assess the impact of climate change in the soil and make the necessary adjustments to the fertilization plans. A climate productivity model and potential production chart will be developed of chestnuts in Portugal. This model will allow us to better systematize knowledge about the climatic conditions of production and with some advance help to predict the annual chestnut production, an aspect of the greatest importance for the industry.

Finally, is the grove network complemented with stations weather forecasts that are set up, allowing the creation of a warning network that will work from RefCast (producers association). Future financial support is expected to continue the work. The available data and the methodology for the field experiments was an example to be followed.

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<https://www.citab.utad.pt/>

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Valorisation of neglected plant

Introduction

OG SambucusValor aimed to develop value-added food products from elderberries, with a view to increasing their market penetration. It was assumed that the management and valorisation of elderberry cultivation based on the creation of quality indicators and sustainable production and transformation strategies, namely through the integration of skills and resources installed in partner entities, which should lead to the creation of a pilot centre to enhance this development.

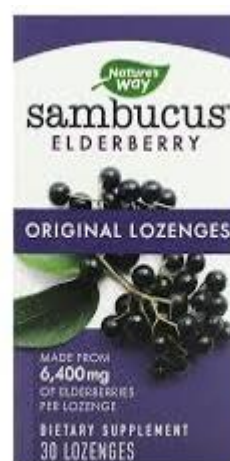
Objectives and results

1. Definition of flower and berry quality indicators, which relate growing conditions to flower and berry composition;
2. Implementation of flower and berry stabilization and storage processes with a view to preserving their bioactive components for a period longer than the normal harvesting of materials, thus ensuring the continuous supply of raw materials with strict food quality standards;
3. Design and development of new food products, based on elderberry flowers and berries;
4. Nutritional assessment of products to be developed;
5. Creation of a website, information dissemination networks and a partnership network with consumer associations, food companies and elderberry producers as a means of disseminating, communicating and valuing elderberry, at national and international level;
6. Creation of a pilot elderberry centre that should represent a nucleus of innovation across the entire elderberry value chain: from the plant to the creation of new value-added food products.

The results are made available through diverse technical (p.ex : Publicação Uaonline: Investigação do Departamento de Química: Centro-piloto do sabugueiro nasce para desenvolver produtos alimentares mais saudáveis – notícia no site da UA on-line - <http://uaonline.ua.pt/pub/detail.asp?lg=pt&c=54222>) and scientific publications. An impressive number of presentations and workshops and other events were organized. A PhD thesis was supported by the OG activities.

Lessons learned

Promotion of elderberry products in baskets: In January 2021, Inovterra, in partnership with some farmers and with the partner entities of the Operational Group, launched a distribution of baskets of vegetables and regional products at national level. This launch of product baskets made making it possible to include elderberry products in sales to the public in a different way and made it possible to publicize elderberry-based products, which were presented every week in the baskets. Also, beginning of cooperation with Galiza (Spain) due to common interests. Involvement between producers and commerce, for renewed products and presentations, as well as in marketing activities. Involvement of the agroindustry.



Figures 1 and 2. Elderberry plant, product made from Elderberry

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<https://youtu.be/SdjiiO15zKs>; <https://youtu.be/ZZAOQxeEazs>; <https://youtu.be/17Ep-wlLw3o>



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Mechanised cork extraction method

Introduction

Gosuber project, developed from 2018 to 2020, has been oriented to improve cork harvesting efficiency. The absence of mechanization in cork extraction work, or cork removal, is one of the main problems that affects subericulture, that is, forestry applied to cork oak forests.

Approach and main results

Cork harvesting continues to be carried out in the 21st century as it did more than two hundred years ago, manually, with the help of the axe and a leverage, which points towards a necessary modernization.

The conditions in which cork harvesting is carried out make this profession unattractive for new generations, due to the temporary nature of the work, the difficulty involved in handling the axe (it requires strength and skill), and the danger of the work (sometimes involves climbing the trees). As a consequence, specialized labor is scarce and aging, and in addition, they work with serious security deficiencies.

New procedures have been sought by changing the way that it is usually done, bringing new machinery on, and upgrading security and health practices, as well as introducing new complete logistic process through last technologies and adapted procedures. Main results have been materialized in a mechanical cork harvesting guide.

Lessons learned

One of the most important parts of the project, the mechanization of cork harvesting, has a long development path ahead. The introduction of electrical machinery in cork harvesting still requires a deep awareness effort regarding the occupational safety and health of the cork remover's work. Only with the professionalization of the sector, and at the hands of the administrations, would technological advances be possible that would make us forget about the axe. The technological evolution of the electric saw and the battery is already causing this change.

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Further information

<https://gosuber.es/>



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Quality cork guide

Introduction

Gosuber project, developed from 2018 to 2020, has been oriented to improve cork harvesting efficiency. Furthermore, at GOSUBER other uses of cork have been studied, apart from wine corking, the aeronautical industry, construction, and other minor uses, to improve the marketing and valuation of cork.

Currently, much of the economic value of cork lies in its capacity to manufacture wine stoppers but, given its exceptional physical-chemical properties, there are multiple possibilities for use in areas as diverse as the aeronautical industry or cosmetics. ; The resulting products provide a very high added value compared to traditional uses and represent a very significant economic potential for rural areas (creation of qualified work, stopping rural depopulation, industrialization of the economy, etc.) as well as the maintenance of the ecosystems of the cork oak forests. Main results have been materialized in a guide to new uses of cork whit the studies carried out and their applications.

Lessons learned

The valorization of cork, on the rise due to the general decline of cork oak forests and the advance in the technology of manufacturing technological wine stoppers (where almost all cork quality classifications are valid), complicates its use for applications outside of the wine market

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Mechanised resin extraction method

Introduction

Although the practices used in resin extraction have been improving in yield and quality, the extractive method remains the same: collecting the resin that emanates from a bare wood surface as a result of incisions, called picks, made repeatedly over time on the surface of the tree. With the development of mechanised extraction methods, the aim is to obtain a raw material with greater purity, less physical effort and skill in execution, and good yields

Approach and main results

The method tested in this OG is the so-called borehole at height. This method, which has existed for decades but has not yet been applied in Spain, has been tested and improved in this project. The methodology consists of drilling 3 simultaneous holes of 1.6 cm in diameter and 12 cm deep, with an inclination of 10 gr with tangential orientation (not radial), leaving a horizontal space between holes of 10 cm and a vertical space of 2 cm. For the borehole method, three extraction bags were used simultaneously, which were raised in height each time the picks were refreshed in an upward direction, with a periodicity of 14 days between picks. The results show that the borehole method produced 8.5 % more *P. pinaster* and 15 % more *P. radiata* than the other methods tested (traditional method and surface drilling method). The Borehole method is suitable for stands destined for chipping wood, and the yields obtained are very interesting, even without the application of stimulants. Stimulants have increased resin production by 70 % for traditional pica and circular notching, but only by 40 % for borehole. The high borehole productions stand out, especially in the non-stimulated trees, reaching productions of 1,796 g for *P. pinaster* and 1,162 g for *P. radiata*. The increase in production in 2022 compared to 2021 is very small for the borehole method, from which it can be deduced that the borehole wood penetration production system has a smaller cumulative effect per season and/or is less influenced by the different environmental conditions between seasons. For example, the production increases for Borehole, depending on the species and extraction technology, range between 8 and 10% in 2022, while for the traditional and circular notching system the increases are 34.5% and 30.22% respectively in 2022.

Lessons learned

The generation of innovation in resin extraction processes requires long-term trials and a large number of individual specimens (trees) studied. Resin production is affected by numerous variables, including climatic, edaphic, dasometric and, of course, human factors. This means that in order to extrapolate an innovation in this field to different scenarios, it requires longer study periods than those currently provided by the OG. On the other hand, the complexity of scientific and technical cooperation has become manifest. Good communication of the real interests of the parties is essential for the success of these processes. On the scientific side, data collection in the field, which is carried out by the tapping workers, as well as the execution of the work, is essential to scientist work. Without reliable data, all research results will be useless. On the other hand, the researchers developing the experimental designs must know and communicate frequently and closely with the tapping workers or the designs cannot be realistically implemented

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Wood-resin compatibility model. Mechanical wood characterization to assign a resistance class according to the UNE-EN 338 standard.

Introduction

The incorporation of complementary activities to the exploitation of timber can represent an improvement in the management and conservation of forests, as well as allowing the generation of regular economic activities that create added social value for the populations benefiting from different products. One of the complementary activities listed for Galicia in Decree 73/2020 of 24 April is the use of resin in three pine species (*Pinus pinaster* Ait., *Pinus radiata* D. Don and *Pinus nigra* Arnold) before the clear-felling.

Approach and main results

In this context, there is an interest in including tapping activity as an ecosystem service added to the management of Galician mountains, initially planted for timber use only. As a material of natural origin, wood presents a great deal of variability. The characterization and classification processes are presented with the aim of complying with the basic requirements established by regulations for the appropriate use of wood as a structural element, which consists, fundamentally, in knowing the properties of the material. In this sense, one of the proposals of the ACREMA Operative Group was to evaluate the influence of the resin activity on the quality of wood from a structural point of view. For this purpose, mechanical tests (static bending) were carried out on a total of 238 pieces of *Pinus pinaster* with structural dimensions, separated into two subsamples (resin-treated and control logs). Prior to the breakage (bending) tests, all the boards were visually graded according to the criteria established in the Spanish visual grading regulations for coniferous wood. During the visual grading process, the presence of some singularities that may affect the structural strength of the wood were analysed: knots, resin pockets, cracks, deformations. However, the number of rejected tapped boards is quite similar to the number of rejected boards from control logs. Structural strength values for all the material were obtained from the mechanical tests and it was possible to compare the structural quality of the wood from previously tapped and untapped logs. In general, the values obtained for the two samples are in the same order. Regarding the strength, the sample of boards from the control logs had a slightly (6 %) higher average value than the sample of boards from the tapped trees. The average values of the strength properties: modulus of elasticity, bending strength and density, showed no numerically significant differences between the tapped and control material from the two plots. The study concluded that the resin does not cause any loss in the mechanical

properties of the wood (strength and stiffness). With regard to the density parameter, however, an increase in the value is observed in the wood from tapped pieces, which could mean positive contributions from a structural point of view. The characteristic values of the strength properties of the tapped wood obtained are within the expected range for Spanish *Pinus pinaster* wood, which is nowadays accepted in the European standard that regulates the use of wood species for structural purposes (EN 1912).

Lessons learned

The use of resin in the Galician community presents a series of weaknesses that hinder the development of the sector, from the scarce availability of workers in the trade to the rejection of forest owners due to the possible effects of the use of resin on the quality of the wood, to the lack of confidence on the part of the manufacturing industry due to possible problems in the technical handling of the material.

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Further information

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<https://acrema.es/r4-asignacion-de-una-clase-resistente-a-la-madera-de-p-pinaster-resinada-con-fines-estructurales-segun-la-norma->



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Analytical techniques based on NIR technology for the characterisation of resins and their derivatives.

Introduction

The quality of the resin is a key factor in the competitiveness and viability of the resin sector, about which there is insufficient knowledge to date. Starting from the distillation of the resin by hydrodistillation or steam distillation to obtain its main components (rosin and turpentine), and through laboratory analytical techniques, we can determine important parameters that will vary depending on the resination method, the species or the climate, among others, and which will be decisive when classifying the resin according to its quality and, therefore, its final destination. A study has been carried out on the analysis of resins and rosins using NIRs technology (Near Infrared Spectroscopy), a non-destructive, simple and fast technique that would allow an initial classification of the resins based on their quality parameters, such as rosin and turpentine content, for example. This would allow a more detailed knowledge of the product for sale to the first transformation industry, directing the resin production to different sectors, depending on the needs demanded by the companies.

Approach and main results

The quality of the resin is a key factor in the competitiveness and viability of the resin sector, about which there is insufficient knowledge to date. Starting from the distillation of the resin by hydrodistillation or steam distillation to obtain its main components (rosin and turpentine), and through laboratory analytical techniques, we can determine important parameters that will vary depending on the resination method, the species or the climate, among others, and which will be decisive when classifying the resin according to its quality and, therefore, its final destination. A study has been carried out on the analysis of resins and rosins using NIRs technology (Near Infrared Spectroscopy), a non-destructive, simple and fast technique that would allow an initial classification of the resins based on their quality parameters, such as rosin and turpentine content, for example. This would allow a more detailed knowledge of the product for sale to the first transformation industry, directing the resin production to different sectors, depending on the needs demanded by the companies. The NIRs analysis has focused on the development of models to determine the % turpentine and % rosin of the starting resins and the acidity index of the rosins obtained. The first step of the working system in the development of a NIR prediction tool is calibration, which involves the analysis by classical (or laboratory)

technologies of a set of samples that are representative of the parameter of interest (called the calibration population). At the same time, these samples will be analysed by NIR, optimising the process so that quality spectra are obtained. The spectra will be confronted with data obtained by classical methodologies, constituting the working databases with which, using multivariate analysis software, prediction models will be developed. The second step is validation, the application of these models on samples not included in the calibration population, also analysed by classical methods, thus knowing the reference value of the parameter to be determined (known as the validation population). The statistical study of these results will determine the framework of application of the prediction models, restricting it to a classification system by categories, or it can be applied in quantitative analysis. Model development was studied considering a global data set, and also classifying the calibration population by method, species and both factors simultaneously. As expected, correlation values improve when variability is restricted. As an overall result it can be concluded that, although correlation coefficients of 0.8 have been obtained for some models, it is necessary to extend the calibration populations to be able to continue working and developing robust models that allow, if not quantification, a quick and easy classification of the resin. All this, together with the great versatility of commercial accessories for NIR equipment (portable and non-portable) would provide companies with a tool that not only allows product control, but also its commercialisation with a guarantee of traceability and quality.

Lessons learned

NIRs technology is a promising technique in the resin industry as a simple and fast way to classify resin. The models developed for the prediction of rosin % show better statistics than those developed for the prediction of turpentine content. This may be due to the method used to obtain principal components. It is necessary to extend the calibration populations in order to be able to continue working and developing robust models that allow, at least, a quick and simple classification of the resin.

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New cork uses guide

Introduction

Gosuber project, developed from 2018 to 2020, has been oriented to improve cork harvesting efficiency. An attempt has been made to establish a cork quality classification procedure.

Main results have been materialized in a guide, that collect detailed information about the studies carried out and their applications in cork quality classification.

Information technologies applied to subericulture are the immediate future of forest management of cork oak forests.

The possibility of establishing the different qualities of cork in the field through innovative technologies will lead to a democratization of cork sales standards.

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Further information

<https://gosuber.es/>





Establishing new business models with NWFP

Introduction

The project "sustainable bee forest" develops and implements a new forest management concept that improves the habitat of flower-pollinating insects during re- and afforestation from the very beginning while generating new sources of income from non-wood forest products. It is based in the state of Hesse in the middle of Germany, which is one of the most densely forested states in Germany. A quarter of the total forest area in Hesse is privately owned, and one third of this is small-scale private forest is owned by farmers. Because many of them are challenged with forest dieback in the face of climate change, the smallholder farmers are the main target group of the "sustainable bee forest" OG. By focusing on product innovation with NWFP, the OG aims at diversifying sources of income from forest management.

Business model with NWFP from bee forest

In addition to wood production, emphasis is placed on the production of honey and other non-wood forest products incl. berries and nuts in bee-friendly forest habitats. The OG conducts monitoring and evaluation studies and collaborated with the University of Göttingen to analyse the economic potential of honey as a non-wood forest product. Such research has been lacking. Yet a solid knowledge base is needed for knowledge transfer and persuasion of interested forest owners, managers, and administrations. A Master Thesis at University of Göttingen (2024) conducted an economic analysis of the non-wood forest product innovation from managed forests with bee-friendly species. It modelled the economic potential in two different settings:

1. Early succession phase in first years of stand development.
2. Comparable areas in standing forests with corresponding succession and in old-growth forests.

The analysis examined the economic potential of honey, berries, and nuts: income per hectare in different succession phases, and the economic potential in a so-called "combined forest use model", incl. wood, honey, and nuts. The results of this research are made available via the OG website and communicated by various means and activities, incl. outreach to small-scale forest owners.

Lessons learned

The marketing of monofloral (type) honey is economically interesting for professional beekeepers because it can be marketed nationwide at a high price. However, in order to produce such type honeys, large tracts of one flowering resource or tree species (monoculture) are required. This is in contradiction to the desired mixed forest of bee forest tree species. One solution could be to market a "bee forest honey" as an additional product alongside classic type honeys.

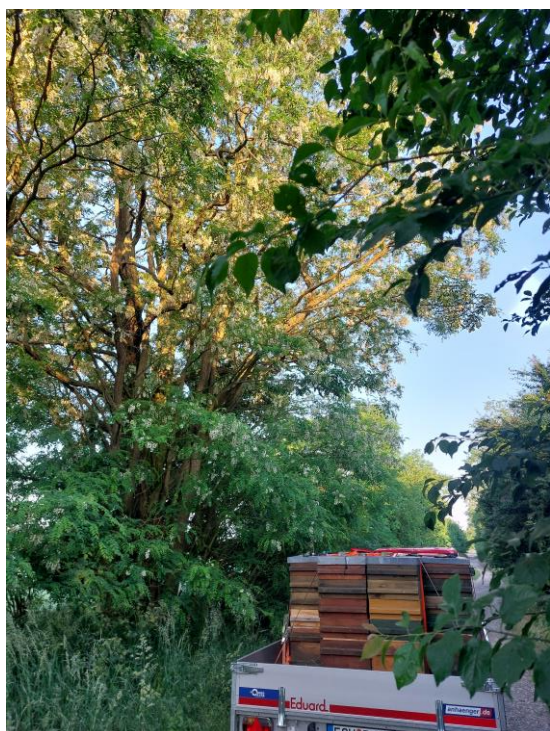


Figure 1: Honey from pollinating trees



Figure 2: Communication about NWFP from bee forest

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Further information

www.bienenwald-hessen.de





Interactive Pinus pinaster resin production simulator

Introduction

This innovation is a dynamic model to estimate the accumulated resin yield during the resin production season. Within the ACREMA GO, a decision support system has been developed which consists of two parts, one which is an interactive simulator with the production models and the other which is a web sig with the auxiliary variables and resin production maps.

Approach and main results

In southern Europe, especially in Spain and Portugal, maritime pine resin is one of the main non-timber forest products. After suffering a crisis at the end of the 20th century, it is currently a growing sector. In Spain, depending on the area, the management of pine forests is one of the pillars of the national bioeconomy. In addition to timber production, these forests may be oriented towards resin production only, or resin production as a complementary activity to timber production. In both cases, as in any sector, it is essential to have tools to manage and anticipate production, especially in the new context of the bioeconomy. The data used were obtained from the macroresination tests of the project itself, which were subsequently processed through machine learning algorithms assembled to develop the predictive models of resin production, specific for the different areas, methods and pastes. These models were implemented in a web tool accessible to all users that allows them to locate their plot, choose the methods and pastes they wish to use, enter the number of trees and the dasometric variables of their stand and obtain an estimate of the resin production of their plot. In addition, the production maps elaborated in the interactive application and based on the IFN IV P. pinaster stands, as well as the auxiliary climatic variables used in the adjustment of the models, can be consulted in the web sig. For this purpose, the maximum resin potential was defined as the estimated maximum production that a territory could produce according to the legal restrictions in force if all the Pinus pinaster stands were resined. We used the estimates of the largest stands and dasometric attributes of P. pinaster from the IV National Forest Inventory (IFN). For the Autonomous Regions of Galicia and Asturias, trees with a normal diameter equal to or greater than 25 cm were filtered out; in the case of the provinces of Castilla y León, the normal diameter was 20 cm. As normal diameter the value of the diameter class was used and as total height the value of the estimate of the mean height weighted according to the diameter class was used. With the data

analysed, maps were drawn up for each area of action and, depending on the extraction method and the stimulating pulp used, the maximum yields obtained were indicated.

Lessons learned

The results of this study make it possible to add the cumulative annual resin yield of maritime pine to the processes that the Bertalanffy-Richards equation is capable of modelling. Furthermore, the great versatility of these s will be of great use to the forest manager in optimising the annual harvesting season as well as for the scientific community.

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Methods for managing cork oak forests with platype attacks from the Sor region (process and technique)

Introduction

Cork oak forests (*Quercus suber*) are very complex and delicate ecosystems, characteristic of the Mediterranean Basin, with great economic, social and ecological value. The worsening of its health status and its relationship with biotic factors was verified: it is closely associated with complex patterns in which pests (e.g. *Platypus cylindrus*, *Coroebus undatus*) and diseases (e.g.: *Phytophthora spp*, *Biscogniauxia mediterranea*, *Botriosphaeria stevensii* and *Ophiostoma spp*) are determining factors for the death of cork oaks.

A population increase of the insect *Platypus cylindrus* (platype) was observed and, consequently, its damage to the cork oak. It is an endemic species that mainly attacked dead or very weakened trees and currently contributes to the mortality of thousands of green trees. The most likely hypothesis suggests the fact that started attacking healthy trees because of current more aggressive behaviour for having established new symbiosis relationships with fungi or bacteria, some of them do not endemic.

Project's development and results

The project objectives were:

1. Know the factors related to the spatial/temporal distribution of attacks platypus;
2. Know the bioecology of the platypus in the region;
3. Look for alternatives to existing means of control (biological and chemical);
4. Seek to increase the effectiveness of the technique for capturing adult insects using traps with chemical attractants currently sold.

The Tasks performed were: Identification of properties and characterization of plots with *Platypus* attacks; Evaluate the relationships between the occurrence of the platype and the different characteristics of the trees that allow a successful attack from the platypus; learn about the bioecology of the platypus in the region; field essays and technical experiments with several products and techniques, analysis of the results.

The plots were defined according to the presence of the pests, diseases and insects, contextualized within the regional picture. The fact that historical records reveal the strong presence of the plague throughout the region

allowed the simplification of the choice of properties that were eligible for enforceability of the proposed work. With this precondition, 3 properties were immediately identified with cork oak stands and with characteristics apparently suitable for testing accomplishment. 6 experimental plots were installed in the field with the aim of carry out a detailed study of its health evolution, with the evaluation of 16 variables during the entire duration of the project, as well as carrying out the tests foreseen in the remaining phases.

Partial results were obtained for the various tasks, related to the attack strategy of the platype: anticipating, plots determination, yeld records, cork extraction, observation of leaves and dry branches, presence of other biotic and abiotic agents, etc.



Figure 1. *Platypus cylindrus*



Figure 2. Damaged cork oak tree

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Further information

<https://www.aflosor.com/>

<https://inovacao.rederural.gov.pt/grupos-operacionais/13-projectos-grupos-operacionais/135-platisor-metodos-para-a-gestao-do-montado-de-sobro-com-ataques-de-platipo-da-regiao-do->



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Improving productivity and sustainability of black truffle plantations by microbiological handling of the rhizosphere

Introduction

Black truffle production is an expanding crop in Catalonia with high economical potential, especially in agricultural areas with low productivity. In this sense, black truffle cultivation is often developed on poor soils, with low production yields and where trees present nutritional deficiencies and serious phytosanitary problems. Another problem to be solved in truffle culture is crop irregularity, possibly due to suboptimal production conditions, both in the nursery and in the field. As a major difference from the cultivation of trees for biomass or for the cultivation of fruits, in this case we work with a much more complex interaction between the tree and the rhizosphere or interface zone between the root of the plant and the soil. However, the increase of monospecific plantations (generally holm oaks) can cause an increase in certain diseases and pests that decrease the production of truffles. Management of the rhizosphere can contribute to the general improvement of plant vigor and its tolerance to biotic factors without the need to use phytosanitary products. In this project we evaluated the capacity of different organic substances and rhizobacteria, some isolated from wild truffle trees described by Vilanova et al (2013) with the intention of improving the biotic and abiotic conditions of the rhizosphere, considering the presence and availability of nutrients, Development of the vegetative phase of truffle mycelium, vigor of the tree (nutritional status) and control of pathogens. The follow-up of the fungus response will be carried out in collaboration with IRTA, using the technology and results of the innovative pilot project, financed by the Department of Agriculture of the Generalitat de Catalunya in 2013 (File No. 56700362013). These techniques are based on quantitative PCR and allow us to determine the mycelium biomass of a fungal species, in this case *Tuber melanosporum*, in a soil sample (Parladé et al. 2013). The monitoring of the vigor of the tree will be carried out through foliar nutrient analysis. In order to correlate the bacterial activity generated in the rhizospheric soil by the introduction of bacterial strains and the effects on the plant and the fungus, initial and final counts of viable aerial mesophiles will be carried out by means of isolating in the appropriate selective media.

Lessons learned

The application of the different rizobacteria, organic compounds, and combinations of treatments in the first and second year of experimentation did not present effects on the concentration of *Tuber melanosporum* mycelium in the substrate of the plants produced in nursery. The treatments used, in isolation or combined, have no effect on a young plant growing in the nursery. The conditions of the nursery (substrate, irrigation, fertilization) and the fact of incorporating a can concentration of spores of the mycorrhizal fungus to obtain the mycorrhization of the plants are sufficiently developed, and the application of this compounds in the phase of Nursery does not represent any detectable improvement. In the plot of Granollers we find comparable results. None of the applied treatments, separately or in combination, have increased the concentration of truffle mycelium in the soil surrounding the treated plants. In a plot already established for years and that is already producing truffles, the incorporation of rizobacterial and organic compounds has no stimulating effect on the development of mycelium fungus. A plot established more than 12 years ago, the fungal composition of the rhizosphere of plants is sufficiently stabilized to be able to significantly modify the equilibrium established with contributions such as those proposed. In the case of Batea's newly established plot in which the treated plants had an age of 3 years, the effects of the incorporation of rizobacteria such as *Bacillus liqueniformis* or *Pseudomonas fluorescens*, as well as the incorporation of organic compounds of different origins, had a stimulating effect on the development of *Tuber melanosporum* mycelium. In young plants, in the phase of settling in their place of definitive plantation, with strong biotic and abiotic competition of the environment, the application of these products if it confers a positive effect on the development of the mycelium of truffle. In conclusion, the application of these products in young plantations in the phase of establishment would be recommended, and it would not be necessary in the phase of production of mycorrhizal plant in nursery or in plantations already adult in phase of production. In view of the results obtained, it can also be concluded that combinations of rizobacteria and organic compounds did not present the expected summation effect in a principle. The hypothesis that the combination of treatments with stimulating effects on the development of truffle mycelium would have a better behavior than the components separately has not been confirmed. More studies would be needed to design, with more data, these possible combinations. On the other hand, combinations of treatments, especially those that contained organic compounds, have had an effect on the bacterial populations of the soils of both plantations. And also, the fungus in the case of the Granollers plantation, consisting of adult plants in production. It is described in the literature that these bacteria can have a positive effect on the development of the plant, and indirectly on the production of truffles. The future monitoring of these parcels would allow to verify it. At the time, to continue collecting data from these experiments, would allow it to determine if the effects of the treatment persist in time or the need to repeat them periodically during the first phases of planting establishments should be considered. With regard to the improvement of the collection and accumulation of nutrients in plants, in all cases the detected effects were not consistent and did not allow to detect a treatment that was efficient in improving the content of nutrients in the plants. There are not enough data to extract solid conclusions.

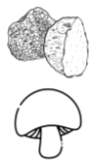
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Geolocation and monitoring of animals to identify possible incidents and improve the management of animals and pastures

Introduction

The project aims to provide the extensive livestock farming sector (cattle, horses and sheep) with new technological tools to obtain and manage as much data as possible from a herd with minimum involvement by the farmer. Geolocation and monitoring of animals uses various algorithms to analyse the information collected in order to identify possible incidents and improve the management of animals and pastures. This Operational Group, consisting of the Unió de Pagesos (Farmers' Union of Catalonia), the Institute of Agrifood Research and Technology (IRTA), Digitanimal, SL and the cooperatives Pirenaica Societat Cooperativa C. LTDA and Agrària Ramadera del Pallars de Sort, SCCL, focuses on exploring the full potential that these technologies can provide help to overcome the main challenges facing the sector:

1 – Improving the economic viability of farms.

- Adjustment of the devices to herd activity patterns to improve technical-health-financial management.
- Provision of the location and monitoring of the movements and condition of animals and herds.
- The task requiring the most labour is supervising the herd and monitoring the animals' health (behaviour, diseases, births, etc.). Reducing working hours is a key factor in lowering costs and increasing the financial viability of farms.

2 – Efficient and sustainable use of natural resources and the maintenance of biodiversity.

- Analysis of the grouped data related to the animals' location to determine grazing pressure, preserve the pasture's quality and ensure the sustainability of the silvopastoral system.

3 – Proximity of herds to wildlife.

- A third challenge is the fact that herds live in proximity to other wildlife. The technology for detecting wildlife attacks will be assessed, and patterns of behaviour to detect and document them will be established.
- Facilitate control of herds, management of technical-health and pasture data to improve the productivity and viability of extensive livestock farms by using geolocation systems and by monitoring animals using collars.

Characteristics of the technological tools:

- A position sensor that shows the location.
- A triaxial accelerometer, which shows the level of activity. -A surface temperature sensor.
- A low-consumption long-range communications module.
- A cloud server, and various databases and algorithms for extracting patterns and creating notifications.
- A long-life battery.

Lessons learned

In conclusion, it has been proved that this technology is an opportunity for extensive livestock farming, even though the following is necessary: Ensuring proper network to achieve the greatest emissivity of collars. Shepherds should know what type of network they got when purchasing collars (mobile network, Sigfox network, Lora network...). Antenna installers are recommended. They should be technicians (which may belong to the own public administration, if it already exists, or to the private sector) and would be in charge of the antenna maintenance and testing before animals reach the mountain and during the season.

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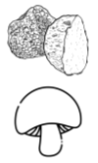
Further information

<https://www.youtube.com/watch?v=lqf-Sdv5Ods>

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Development of a system to remove TCA from cork stoppers using adsorbents and biosorbents

Introduction

The manufacture of stoppers is currently the application with the highest added value for cork as a raw material with 98% of the Catalan cork sector's revenue coming from the manufacture of corks for still wines and sparkling wines. The industry has a turnover of almost €230 million, has an export level of around 50% and employs more than 1200 people. Given that it is a high-quality product, the challenge is to remove sensory deviations in order to comply with requirements of the wineries and stave off the threat of alternative stoppers. These alternative stoppers have consolidated their position in the market, mainly due to the controversy generated around the presence of haloanisoles (like TCA) and other volatile compounds which may be present in the cork and affect the bouquet of the wine. This has forced the cork sector to implement technologies for the detection and/or removal of these aromatic compounds. There are currently systems to remove aromas in the market, but they are mainly aimed at cork granules, not bottle corks, given that they are 'aggressive' elimination systems that may affect the cellular structure of the material. The proposed system is based on the use of adsorbents and biosorbents with the aim of retaining the aromas extracted in the various cork production stages. The innovation developed in the project has an impact on productivity and sustainability levels both territorially and in the winemaking and cork industries in general. The objective of the project was to develop an innovative system to remove aromas from cork stoppers based on a combination of various adsorbent and biosorbent materials. Achieving this objective helps to improve the competitiveness of cork companies, foster the use of natural and renewable products such as cork stoppers and address the competition from alternative stoppers by reducing the problem of aromas associated with corks.

Lessons learned

The end result of the project is two aroma removal systems, one for the natural cork stopper manufacturing process and the other for the agglomerated cork stopper manufacturing process with two discs for sparkling wine in liquid and steam conditions. A mixture of natural biosorbents was obtained that captures 50-95% of haloanisoles under laboratory conditions. This capture system is based on adsorbent compounds with a greater affinity for aromas than cork, enabling an increase in their removal without supposing major changes to the systems currently used by the companies. The following practical recommendations may be drawn from the

project: - Recovered activated carbons are a good option for the removal of defective aromatic compounds present in corks. - The selected materials can be applied in both aqueous and dry environments. - The materials have a shelf life of more than six months. - Application of these compounds in company extraction systems improves their efficiency The following conclusions may be drawn from the project:

- There is significant potential for removing unwanted aromas in corks by using biosorbents at different points in the production process, adapted to the needs of each company.
- It is worth exploring the design of biosorbent containment prototypes to solve the challenge of biosorbent containment without limiting their adsorption properties

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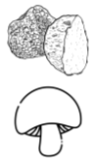
<https://www.icsuro.com/projectes/sistema-deliminacio-dhaloanisols-tca-i-altres-aromesdefectuoses/>

<https://www.icsuro.com/la-bioabsorcio-daromes-suro>

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Evolution of oxygen transfer in the various cork stopper manufacturing conditions. Effect of this parameter on still and sparkling wine

Introduction

One of the most significant variables that affect the evolution of wine in the bottle is the supply of oxygen through its stopper: the oxygen transfer rate). Cork stoppers are known to have an advantage over their synthetic alternatives in this respect due to their vegetal matrix. Corks enable the progressive ingress of oxygen into the bottle over time, preventing the oxidation and reduction processes that are characteristic of certain alternative stoppers. The project consisted in determining the variables in the cork stopper production process that affect oxygen transfer and obtaining information to modify the production procedure to adjust the oxygen transfer rate of the corks in accordance with the consensus values for each type of wine

Objectives

1. Assessment of oxygen transfer throughout the production process.
2. Application of control measures based on the values obtained in point 1.
3. Assessment of the effect of the oxygen transfer rate on the wine.
4. Preparation of a catalogue of cork stoppers with different transfer rates and their effects on the evolution of the wine.
5. Foster relations between the cork sector and the winemaking industry.

Lessons learned

- The oxygen permeability of the stopper in still and sparkling wines affects their chemical and sensory development.
- Different types of cork stoppers (natural one-piece, granular and cork discs) have different oxygen permeability characteristics.
- For each type of cork, there are factors in the production process that have key impact on the oxygen transfer ratio of different batches of corks.

- Use of stoppers with higher or lower oxygen permeability depends on the oxidative capacity of each wine, which in turn depends mainly on the grape variety.
- Determining the type of cork to be used is a key factor for wineries that want to control how their wines age and the oxygen transfer values of the corks should be known so as to favour the desired ageing.
-

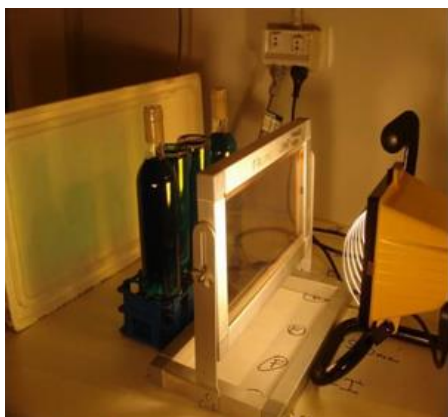
Figure 1: "Elaboration of wine (1)"



Figure 2: "Elaboration of wine (2)"



Figure 3: "Elaboration of wine (3)"



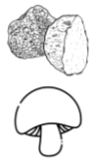
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Further information

<https://www.icsuro.com/projectes/determinacio-de-levolucio-de-la-permeabilitat-a-loxigen/>

Company contact, e-mail: teresa@jvigas.com





Diversification of edible wild mushroom cultivation with new native species

Introduction

The project was led by Bolet Ben Fet (TEB Verd SCCL). The operational group consists of: Bolets de Soca (Tresseras Multimèdia SL), the Catalan Mycology Society, the Wood and Furniture Guild and the Institute of Agrifood Research and Technology (IRTA). IRTA acted as a technology and research centre, and two lecturers from the University of Barcelona (UB) joined the team of researchers. A total of 120 strains belonging to 14 fungal species were isolated from the specimens collected in the field. A mixture of wheat, rye and sorghum grain in equal parts was designed with a water content adjusted to 50-60% and sterilised in the autoclave. It was tested successfully with 87 different strains of 11 fungal species for the production of the inoculum (seed). The small-scale trials were carried out using a substrate based on hardwood sawdust adapted to 60-65% humidity levels. An incubation temperature of 20-25°C was suitable for all the species. The project has made it possible to develop methods and protocols for the cultivation of eight edible fungal species from native strains. The cultivation protocols can be considered developed for: *Agrocybe aegerita*, *Fistulina hepatica*, *Lyphphyllum decastes*, *Meripilus giganteus*, *Pleurotus eryngii* and *Polyporus squamosus*. They were also developed for better known species including: *Ganoderma lucidum* and *Grifola frondosa*, but using native strains. Catalonia is a country with a strong mycological presence and tradition, but the cultivation of wild forest mushrooms focuses on a few species that are mostly of Asian origin; this is a pioneering initiative in this type of cultivation. Diversification into other species with closer links to local tradition would increase the diversity and current range of edible fungi. These new products would give local producers a competitive advantage and open up new opportunities for export. The main objective of this project was to incorporate new species of fungi which are mostly lignicolous and native to Catalonia in the cultivation of edible mushrooms in order to diversify production and improve the commercial range of our country's producers.

Lessons learned

1. A crop bank of 120 strains belonging to 14 edible fungal species native to Catalonia has been established. This collection of pure strains is available for future research and development work.
2. A viable seed production method has been established for 11 of the fungal species mentioned above.
3. The project has made it possible to develop methods and protocols for the cultivation of eight edible fungal species from native strains: *Agrocybe aegerita*, *Fistulina hepatica*, *Ganoderma lucidum*, *Grifola frondosa*,

Lyophyllum decastes, Meripilus giganteus, Pleurotus eryngii and Polyporus squamosus. Some of these species, such as: F. hepatica, L. decastes and P. squamosus have never been cultivated before.

4. Nutrient and cytotoxicity analyses for all the newly cultivated species are being developed.

5. The complete cultivation cycle has not yet been reached for Laetiporus sulphureus. No mushrooms have been obtained. Interest in the species has led to the start of a bachelor's degree final project at the University of Barcelona to continue the research.

Eight species of fungi were added to mushroom cultivation. Some of them, such as Fistulina hepatica, Lyophyllum decastes, Meripilus giganteus and Polyporus squamosus have never been cultivated before. Other more well-known strains, including: Agrocybe aegerita, Ganoderma lucidum, Grifola frondosa and Pleurotus eryngii, cultivated from native strains. The diversification of edible mushroom cultivation should continue in the long term in order to incorporate new products into the market. Cooperation between companies in the sector and research centres with support from government institutions proved to be an effective way of achieving these results.

Figure 1: "Wild mushrooms collected by workers"



Figure 2: "Wild Mushrooms"



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Further information

<https://www.irta.cat/ca/el-cultiu-dels-bolets-de-soca-autoctons-cami-de-ser-una-realitat/>

<https://www.boletbenfet.com/es/-:~:text=La%20Granja%20de%20Bolet%20Ben%20Fet%20es%20un%20centro%20especial>





Valorization of dried nuts with hard skin

Introduction

The OG had as Objective the valorization of dried nuts, diversifying their use. For the almonds and hazelnuts, to contribute to their long lasting, presentation, and conservation, making possible to attain distant markets. Almonds: to explore the potential of ground, flour, granulated and laminated. Also explore its processed value: fried, in jams, toasted, with meat or in liqueurs or other drinks. ground, flour, granulated and laminated. also explore its processed value: fried, in jams, toasted, with meat or in liqueurs. For the by-products such as the bark, explore their use as fertilizer, use in animal feed, as a source of bioactive compounds or as gum. For each of these objectives, tests and essays were made, according to the variability of the fruit, the time consuming, the cost and the real transport conditions. The humidity, microbial content, storage temperature in the different stages of product preparation were particularly sensitive aspects.

Hazelnuts: The intention was to potentiate this crop in Portugal by diversifying its use and presentation (indirectly the price) and achieving export. The physical-chemical characterization of the different varieties was carried out and good practices were established. For post-harvest, attention was paid to peeling, packaging and transportation, with special relevance for tropical countries.

Connection with the Project Valor+ (<https://valormais.cncfs.pt/>): The 'ValorMais' project aimed to promote the valorization of by-products from agricultural, agri-food and forestry sector through its characterization and quantification. In this sense, the OG co-promote the use and valorization of the so called "waste" (by-products) in a view of circular economy. The forest waste of other varieties such as eucalyptus, pine and quercus are also considered here in Valor+, building a platform to inform about the stock, use and commercial operators in this field.

Lessons learned

Several scientific articles were published, as a way to promote the results and the international discussion on these subjects. The cooperation between research institutions was productive, as in other OG. The essays are expected to go further, as well the efforts to achieve the effective advantages for producers. The foreign competition is an aspect to be studied, yet. The enlargement of the cooperation with other partners, beyond

the promoters of this OG, was an added value to better disseminate and promote the use of the all the products valences.

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Further information

<https://valnuts.cncfs.pt/projeto>

gruposoperacionais@gmail.com; [CNCFS](https://cncfs.org)



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Visor Mikogest

Introduction

One of the objectives of the operative group is to learn about and manage the regulation of the mycological resource using technological tools. Priority is given to guaranteeing sustainability in harvesting, traceability in the value chain and generating useful information for both the collector and the business sector. To this end, a Big Data collection and analysis system has been generated to provide the necessary information to guarantee the sustainability of both the activity and the habitats, offering precise knowledge of the production capacity of these habitats in real time (through estimates of the production in each place and time), and also processing precise parameters of the demand, commercialization and exploitation of the resource. Queries made on the Mycological Big Data database can be visualized through the mikogest viewer

Approach and main results

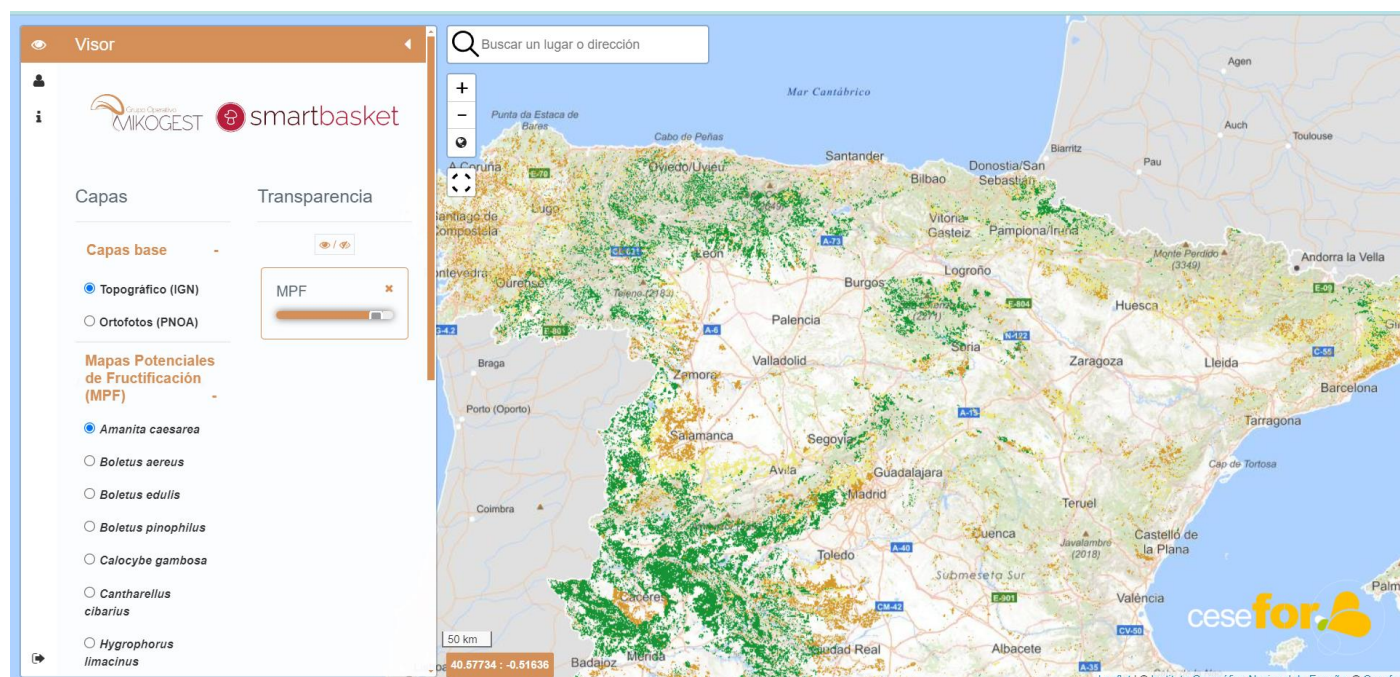
This viewer is based on the collection and integration of all existing data from the mycological sector for Big Data analysis, designed to allow us to address, in an effective and useful way, the large volume of existing data in the natural environment and also those collected through the apps generated within the project. Its purpose is to improve the management of our mushroom producing forests. This viewer displays the Potential Fruiting Maps (PPM) of the selected mushroom specie. This potential fruiting area is classified according to the legend in Optimum, Adequate and Marginal according to the main and secondary forest species, its age, climatological criteria, edaphology and fraction of covered area. Information can be obtained, among others, on: POTENTIAL FRUCTIFICATION AREA (ha), ANNUAL PRODUCTIVE CAPACITY, AVERAGE MARKET PRICES. Information can also be obtained on: POTENTIAL AND OBSERVED MYCOLOGICAL DIVERSITY OF EDIBLE SPECIES. For the 11 species for which the potential fruiting map has been obtained, the Optimum, Adequate and Marginal surface is shown. In addition, it also shows the potential annual production capacity in kg, estimated from adjusted production models based on habitat-dependent variables and stand characteristics. Observed diversity refers to the number of times that species is known to be present in the administrative unit of work. OBSERVED PRODUCTION OF EDIBLE SPECIES: for the target species of socioeconomic interest for which a fruiting potential map is available, the number of observations recorded in the database is shown, as well as the average production calculated in kg per hectare and the average yield in kg per hour. PRODUCTIVE CAPACITY OF EDIBLE SPECIES: in this case we can see the annual amount harvested during the previous season and the estimated productive capacity. An indicator of the sustainability of the resource is also included so that it will appear green when the species is harvested without compromising the resource and orange when the species may be

harvested with the risk of compromising its survival. FRUCTIFICATION PREDICTION: you can also see a prediction of fruiting production for the next few days for the target species. Thus, you can see whether an area has a very likely, likely, unlikely or improbable fruiting prediction for each of the 11 target species.

Lessons learned

The prediction models developed by the viewer require long series of data well distributed in time and territory. The development of the viewer itself is feasible for any computer expert. However, its implementation requires crossing several data layers, which are sometimes not available. The real complexity lies in the collection of this information needed to generate the viewer's outputs, such as fruiting potential maps or fruiting predictions

Figure1: Appearance of the website



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Further information

https://www.youtube.com/watch?v=dLQ732Zp_J8&ab_channel=FundacionCesefor
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