ANNUAL REVIEW 2020

RAIZ

Forest and Paper Research Institute


RAIZ
Forest and Paper Research Institute

annual review 2020

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KEY PERFORMANCE INDICATORS 2020

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RAIZ

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GLOBAL VISION 2020

JOÃO LÉ
Chairman

CARLOS DE PASCOAL NETO
General Director

2020 was and certainly will be one of the most striking years of our lives and of our organizations. The pandemic had and is having profound economic and social impacts that require a new look at the way we live, work, socialize, but it has also opened up new challenges and windows of opportunity for a sustainable change. RAIZ, as an Interface Center focused on research, development and innovation in the forest, paper and forest-based bioeconomy, is adapting to this new reality and, above all, contributing to this change.

Still far from guessing what 2020 would bring us, we implemented a new, ambitious five-year strategic plan, in which, essentially, we propose contributing for promoting:

(i) productivity, resilience and sustainability of the national forest, through the production of improved genetic materials, obtained by natural selection, biological solutions against forest pests and diseases, development and sharing of best silvicultural practices, as well as solutions and tools for forest management support;
(ii) competitiveness and sustainability of the pulp, paper and its derivatives industry, through the diversification and differentiation of products, as well as the implementation of circular economy principles and efficient use of resources;
(iii)a forest-based bioeconomy through an integrated biorefinery concept and the development of forest derived new bioproducts.

In the area of industrial process and products, we highlight the contributions to the optimization of wood and water consumption in the industrial process, the environmental performance of the pulp and paper products production facilities and the valorization of the generated waste, in a industrial symbiosis logic. From the perspective of the industrial product, differentiation opportunities were explored, taking advantage of eucalyptus fibers' characteristics, and new products were developed, one of which, a functional and innovative tissue product which has already reached the market. In the field of forest-based bioeconomics, technical and economic feasibility studies for the production of biocomposites, biofuels and new bioproducts were continued.

In the forest research and development area, the production of three new clones and improved seed stands out, as well as the preparation for the release of a new natural enemy in the fight against eucalyptus pests, the application of remote sensing for supporting forest management and the activities of forestry extension and knowledge transfer to third parties. In this area, the consolidation of the "e-globulus" platform, developed by **RAIZ**, deserves a particular highlight.

The achieved results originated 27 publications, 3 national patent applications and 3 international patent applications, as well as the granting of a national patent.

In the area of dissemination and public awareness concerning the relevance of forest and of a forest based bioeconomy, are highlighted the launch of the "forests.pt" platform, with the technical-scientific coordination of **RAIZ**, the start of the "Floresta do Saber" project, with the support from the Calouste Gulbenkian Foundation and, at the end of the year, the recognition of **RAIZ** as a UNESCO Club, as recent milestones in our history.

RAIZ's human resources structure was consolidated in 2020, with 25 new researchers hired under the highly qualified staff financing program for the National Network of Interface Centers.

As the year ends, we present a renewed and reinforced word of appreciation to all **RAIZ** employees, to all researchers in our network of academic partners and external R&D centers, as well as to all the staff of the industrial, forestry and corporate areas from The Navigator Company. Their contributions were decisive for the results achieved by RAIZ in this peculiar year of 2020.

A BIG THANK YOU TO ALL.

03

INPACTUS PROJECT

A step forward for a green, global, sustainable and competitive bioeconomy in Portugal, based on the eucalyptus pulp and paper industry.

The inpactus Project - Innovative Products and Technologies from Eucalyptus, started in February 2018 with an investment of around 15 M € (4 years), is in its third year of execution with the development of processes and products in the areas of Pulp, UWF Paper, Tissue and Biorefinery. The themes are distributed among 41 subprojects, with 26 PhDs in progress and with the participation of two Invited Navigator Chairs, at the University of Coimbra (Prof. Thadeus Maloney, Aalto University, Finland) and at the University of Aveiro (Prof. Falk Liebner, Boku University, Austria).

IN 2020:

- Definition and implementation start of an internal methodology for technical-economic evaluation and exploration plans;

- Application to the INOV C+ programme for enhancing the knowledge resulting from the inpactus project, materialization of the patented tool "impact assessment" and technology radar;

- *Floresta do Saber* application approved in the Sustainability Program of the Calouste Gulbenkian Foundation for publicizing the inpactus activities which have originated the RAIZ recognition as a UNESCO Club, by the National Commission of UNESCO, at the Ministry of Foreign Affairs;

- The technical-scientific execution suffered several constraints, due to the context of the Covid-19 pandemic, which affected the course of the planned works and some goals achievement. In 2021, a request for the project extension will be prepared by the Management teams, in close cooperation with the Technical-Scientific coordination.

Promoter

Co-promoter

Partners

MAIN DEVELOPMENTS IN 2020 IN THE RESEARCH AND DEVELOPMENT AREAS OF INPACTUS:

In the Pulp area progress has been made in the evaluation of enzymatic bleaching under conditions suitable for factory integration, in the evaluation of the suitability to cook wood mixtures and in processes development for increasing the absorption capability of pulps. An aerodynamic apparatus for non-wovens was designed and installed and its testing phase is currently being carried out. In the residues and effluents area, fly ashes pretreatments and their incorporation into mortars were evaluated, and tests in an anaerobic digestion continuous reactor were carried out for reducing COD and AOX.

In the UWF paper area stands out the application of a lignin derivative on paper for hydrophobization, the development, and its validation, of a method for characterizing the orientation of the fibers in the z direction of the paper, important for the diagnosis of the curl phenomena, the development of a starch cationization method, and the evaluation of paper as a support for fragrances and anti-oxidants, currently being evaluated as a possible support for sensors.

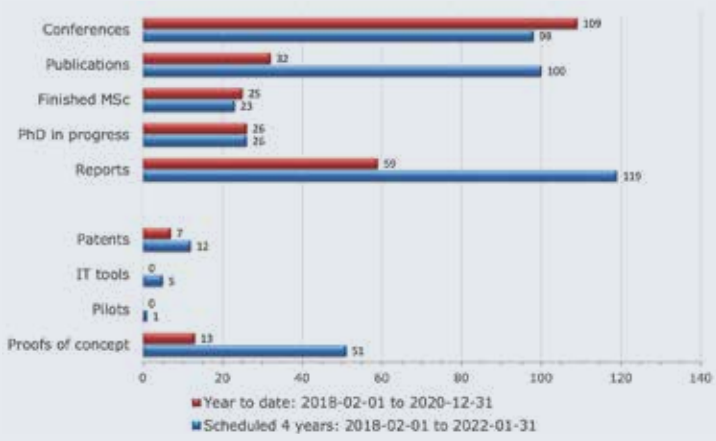
In the Tissue area it is highlighted the evaluation of the effect of different enzymes as refining aids and their impact on tissue properties, the development of laboratory embossing systems and progress on the development of a predictive optical system for tissue, the evaluation of impacts in the final stages for life cycle and tissue sustainability analysis, as well as the development of new products.

In the area of Bioproducts and Biorefineries the design of an integrated process for the extraction of bioactive compounds from forest biomass stands out. It is worth mentioning the biological activity, already tested in extracts, as anti-inflammatory and anti-senescent, which allows directing the studies towards formulations for topical application.

The scale-up of the production and separation of xylooligosaccharides from bleached eucalyptus pulp was started, with a final product being obtained for verifying its pre-biotic activity.

The study of polyols optimization from lignin for application in polyurethane foams was also completed, using an alternative process.

Finally, it is worth mentioning the synergy between residues valorization and the development of new products through the assessment of the potential of primary sludges for the production of sugars and bioethanol.



INPACTUS: *PERFORMANCE INDICATORS*

04

RESEARCH, DEVELOPMENT AND CONSULTING

DURING 2020, RAIZ'S INDUSTRIAL RESEARCH AND CONSULTANCY CENTERED ITS ACTIVITY ON SUPPORTING THE NAVIGATOR COMPANY'S INDUSTRIAL UNITS, FOCUSING ON THE OPTIMIZATION OF CORE BUSINESS PROCESSES AND PRODUCTS, NAMELY BLEACHED EUCALYPTUS PULP, PRINTING AND WRITING PAPER AND TISSUE PAPER, AND IN MINIMIZING THE ENVIRONMENTAL IMPACTS ASSOCIATED WITH PRODUCTION PROCESSES.

INDUSTRIAL PRODUCTS AND PROCESSES

HIGHLIGHTED TOPICS:

- Monitoring investment projects and procedural changes at the several Industrial Complexes;
- Optimization of raw material consumption, with special emphasis on the consumption of wood and process chemicals;
- Water consumption minimization at the different stages of the production processes;
- Quality improvements of bleached eucalyptus pulp, printing and writing paper and tissue paper;
- Product portfolio diversification, especially tissue papers;
- Search for solutions to minimize the amount of residues generated in the Industrial Complexes and for the valorization of these residues, under the Circular Economy principles;
- Knowledge consolidation and analysis of opportunities associated with the implementation of the biorefinery concept, based on the development of new products from eucalyptus, or using products or by-products already produced;
- Participation in national and European research projects, generating new knowledge and skills aligned with the Company's core business, aiming the development of new processes and / or products, in partnerships with Universities and Institutes, companies from different sectors of activity and suppliers.

WOOD AND IMPACT ON THE PROCESS

The search and research for viable wood supply alternatives is a goal of The Navigator Company. In 2020, **RAIZ** supported the Company by carrying out detailed laboratory studies, which make it possible to deepen the knowledge about the behavior and technological characteristics of different woods, both from the point of view of pulp production and from the point of view of their paper suitability, with RAIZ also following industrial tests with new sources of supply.

The model for predicting and measuring specific wood consumptions developed at **RAIZ** has been updated based on the most recent process information, in order to strengthen its capacity as a decision support tool.

REDUCING THE WATER USE IN THE PROCESS

The use of water at The Navigator Company continues to be one of the primary aspects of environmental performance and, in this context, **RAIZ** has maintained its focus and activity in this area through continuous technical support to the reduction measures in implementation, as well as through the feasibility assessment of measures that will continue to be part of the reduction plans.

In this activity, the beginning of the study on the reuse of bleaching filtrates in the washing of raw pulp is highlighted. In addition, a pre-feasibility and impact analysis of higher investment measures was carried out, such as the replacement of the current white pulp washing equipment for paper production by an equipment with a more rational use of water (such as washing presses).

MODELING, DECISION SUPPORT TOOL AND EVAPORATION OPTIMIZATION

The black liquor water evaporation capacity is often the limiting factor for the production capacity and a determining factor on the environmental performance of pulp mills. The ability to design, optimize the process and to validate alternative proposals through computer modeling is an added value for the performance and project evaluation for the factories.

In 2020, **RAIZ** together with the operational areas of Navigator's Industrial Complexes (Aveiro and Figueira da Foz) has developed current evaporation models, as well as future configurations of these facilities through the WinGEMs® process modeling software.

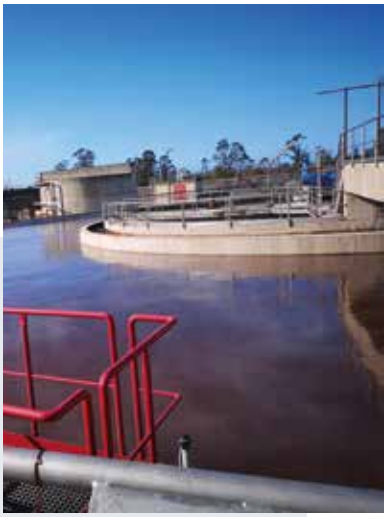
The developed models made it possible to estimate the area increases necessary to overcome the current bottlenecks at the two units, to study current procedural alternatives, as well as, the detailed comparison of solutions proposed by suppliers identifying critical points, which allowed the clarification and review of existing proposals, thus supporting the decision-making process.

Finally, it should be noted that these tools are now available to carry out any evaluation and process optimization through a simplified interface for the facilities' process engineering.

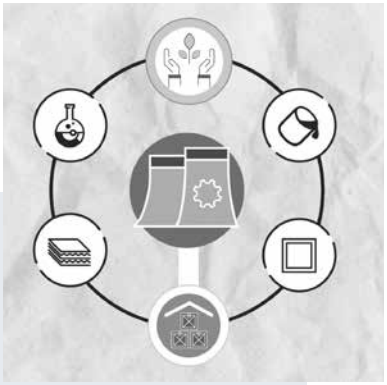
WWTP PERFORMANCE OPTIMIZATION

The increasing demands concerning the quality of discharged effluents led to a program of industrial tests concerning the operation of the Wastewater Treatment Station (WWTP) at the Aveiro Industrial Complex of Navigator, which aimed at optimizing its operation and the quality of its final effluent. The testing program outlined went through the test of using different dosages of nutrients, stabilizing the rest of the WWTP's operating conditions at reference values.

The tests carried out allowed a biodegradation increase, the removal of AOX and of sedimentability of biological sludges for optimal nitrogen dosage ratios (ratio between the organic load to be degraded and the nutrient), allowing improving this variable control according to the characteristics variation of the effluent to be treated.



INDUSTRIAL PRODUCTS AND PROCESSES



CIRCULAR ECONOMY

Within the circular economy context, **RAIZ**, together with Navigator's Aveiro Industrial Complex, tests were developed for the recovery of the fibrous component of a wide set of process residues that allowed the identification of the sources with the greatest recovery potential, and also the identification of the procedural conditions which optimize this incorporation. As a result of previous work, almost all of the larger residues fractions have been reincorporated, and the conditions have been created to be able to test on an industrial scale the reincorporation of all the fibrous residues generated.

PULP AND PAPER: INCREASED MECHANICAL STRENGTH, NEW PRODUCTS

In 2020, studies were continued in view of increasing the mechanical strength of paper products, confirming the positive effect of some new approaches at conditions simulating the manufacturing context, maximizing incorporation of short fiber and identifying the most appropriate conditions to proceed with demonstrations through industrial testing. Within the perspective of increasing the strength of the pulp product, the point of addition was selected and a comparative assessment of different approaches was carried out, demonstrating significant gains in the resistance properties.

The activity carried out allowed the identification of procedural conditions for the development of new pulp and paper products with differentiating characteristics and maximizing the use of eucalyptus fiber, standing as a support tool for performing industrial tests. Other wood species and their effect on the process and on the product when mixed with eucalyptus were also selected and evaluated, increasing the knowledge in this area for identifying opportunities and for supporting decision-making.

TISSUE: PRODUCT DIFFERENTIATION

As a result of the R&D activity and the team work carried out in close articulation with the tissue area of The Navigator Company, five industrial tests were carried out for new products and conditions adjustment, resulting, in one case, in two new products market launch, the Amoos Aquactive kitchen rolls and multiuses. The activity continues to expand the range of products adjusted to the current needs of the tissue paper market with differentiating solutions. RAIZ's transversal support to the Company's Tissue area was also reinforced, with a strong activity in the search for solutions, specialized technical opinions and support to new Company projects.

CONSORTIUM R&D PROJECTS

SHELLUTION (P2020)

Innovative project, resulting from a full involvement of the consortium stakeholders, Shellution - Development of ECO-innovative products by incorporating biogenic calcium carbonate ended in 2020, with the laboratory evaluation of paper properties of sheets incorporating calcium carbonate from eggshells, prepared under specific conditions by the partner Omya, with promising results obtained.

LIFE_NO WASTE PROGRAMA LIFE EU (H2020)

The application on the ground (1200 m2, Minas de S. Domingues, Mértola) of granules of ash and of secondary sludges stabilized by composting was carried out at the Setúbal Industrial Complex, consisting on the second pilot predicted within this project. A plan for soil, leachate and vegetation cover monitoring is underway, allowing the project to be concluded in 2021.

PAPERCHAIN (H2020)

The demonstration of the application of dregs, grits and carbonate sludges into construction materials was carried out with the execution of two pilots. A section of pavement was installed at Navigator Tissue Aveiro by the partner Megavia using bituminous with dregs or grits and prefabricated cement gantries containing carbonate sludges were installed at the SPRAL partner. The monitoring of mechanical properties and leachate started in 2020, with the final evaluation scheduled for 2021. Being a successful case of Circular Economy implementation and of synergies between Companies from different business areas, this project has been widely publicized, having been highlighted in the magazine My Planet from The Navigator Company - November edition entitled “Closing the circle of the paper chain”.

PROJETOS DE I&D EM CONSÓRCIO

WOODZYMES BBI (H2020)

Industrial applications of kraft lignin is one of the research lines of this European project, which started with the lignin isolation from the The Navigator Company industrial kraft liquor, followed by its fractionation using proprietary technology by Metgen, a partner of the consortium. The fractions were tested in polyurethane foams and resins for MDF, showing relevant results, which will be consolidated in 2021, the completion year of the project.

TOXAPP4NANOCELFI (FCT)

The project envisioning the evaluation of nanocellulose concerning its cytotoxic effects has demonstrated that, at the tests concentrations range and time of exposure, no harmful effects were revealed in cells of the human pulmonary epithelium. The project continues in 2021 with a genotoxicity assessment. Nanocelluloses have been mostly produced at **RAIZ** by methodologies already implemented.

BL2F (H2020)

BL2F - Black Liquor to Fuel by *Efficient HydroThermal Application integrated to Pulp Mill* is the European project, started in 2020, aiming to apply hydrothermal liquefaction technology, including separation of salts, for the production of aviation and navigation fuel from black liquor. During the project, it is planned to carry out tests in an industrial context with the developed pilot, as well as the assessment of environmental, social and economic impacts.

FOREST

The research and technical support and extension activities carried out at RAIZ cover a wide range of topics.

THE MAIN ONES INCLUDE:

• An understanding of the forest functioning in its productive and conservation dimensions, with emphasis on the study of interactions with water, carbon, soil fertility and biodiversity, offering practical solutions for better management and measures to mitigate impacts, creating better and more resilient plantations;
• Genetic improvement, with a view of making available new clones and seeds of higher quality. This theme is the result of a continued program of field testing, careful measurements and advanced statistical analysis with the purpose of a regular selection of the best individuals. The program also includes the incorporation of biotechnology tools and studies for improving plants propagation;
• Use of remote sensing technologies and development of information processing systems and processes in order to support a forest better monitoring and management decisions by companies and owners;
• Development of monitoring, prevention and control measures for the main pests and diseases of eucalyptus, including the study and testing of new natural enemies and the collaboration with specialists from all over the world in search for solutions.

RAIZ also provides a range of services and forest extension initiatives, both to The Navigator Company's operations in Portugal, Spain and Mozambique, and to several other initiatives to help forest producers and their associations, service providers and society and academia in general.

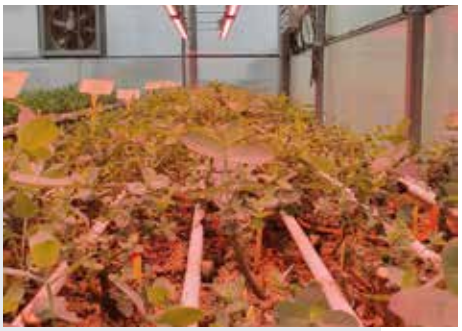
Finally, **RAIZ** has been actively involved in establishing or strengthening contacts and strategic partnerships with Universities and Research Institutions in Portugal and worldwide.

THREE NEW CLONES REINFORCE THE LIST OF IMPROVED PLANT OPTIONS

RAIZ continues its genetic improvement program, with the aim of testing and selecting new high-yielding eucalyptus clones in terms of pulp per hectare, and with improved resistance to extreme drought and temperature conditions.

In 2020 three new clones were transferred to large-scale production. The selection process, in addition to its performance in dozens of field tests, also included the performance of rooting tests in macro and mini-cuttings and the evaluation of its resistance to nursery and field diseases. The estimated genetic gain of a reforestation with these materials, in relation to undifferentiated plantations, is around 50%.

Due to their better rooting and rusticity, these clones will also allow an increase of the nursery's production capacity by about 10% and, consequently, reducing the costs per plant.



AN IMPROVED E. GLOBULUS SEED HAS BEEN DEVELOPED

In order to increase the supply of improved eucalyptus seeds to the market, **RAIZ** has continued to work on the study and maintenance of seed orchards. In 2020, approximately 1.1 kg of high quality seeds was delivered and the installation of 5 hectares of a new orchard was completed.

Studies were carried out throughout the year confirming the excellent initial growth of the orchard seed, comparable with commercial Navigator's clones. A Master thesis, in collaboration with FCUL, where the values of contamination and self-pollination rate and their impact on seed quality were studied, was successfully completed.

RISK ASSESSMENT STUDIES FOR THE RELEASE OF CLERUCHOIDES NOACKAE COMPLETED

In order to allow the release of a new natural enemy of the eucalyptus bug, a set of studies necessary to prepare the application for its introduction into nature was completed in 2020, in accordance with the European standard. This investigation showed that C. noackae does not represent a threat to the local fauna or will have other negative impacts, being consequently possible to be released. This is a project that has been developed in close collaboration with Navigator, Altri Florestal and the Instituto Superior de Agronomia.

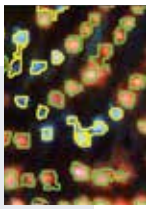
Authorization to be launched into nature is expected very soon by the national authority. In the future, this measure is expected to result in a 20% damage reduction in areas with bed bug wear.

THE ELECTRONIC PLATFORM E-GLOBULUS CONTINUES TO GROW

This is a free access platform, launched in 2019, dedicated to providing personalized technical indications on fertilization, land preparation, vegetation control and much more. It is a tool developed by **RAIZ**, for supporting a better management by owners, Forest Producers' Organizations and all of those who want to know how to conduct eucalyptus stands in the most sustainable and efficient possible way. In 2020 we had a total of 15,560 views and more than 3,000 users.

Also during 2020, several Novelties and News, new Thematic Dossiers and new features were created, with emphasis on the greater flexibility for importing data with the possibility of uploading property information via Kml and the creation of the "forestry technician" profile. The Portuguese patent application was finalized and the International Patent application for this platform was submitted.

e-globulus



REMOTE DETECTION FOR SUPPORTING A BETTER PEST CONTROL

RAIZ has been studying and developing proofs of concept in remote sensing, which make possible to speed up monitoring processes, alert systems and the operational planning of The Navigator Company and its employees. In 2020 we demonstrated that the use of drones can be very effective in identifying affected trees and quantifying the degree of damages caused by the foracanta pest. The work was published in the prestigious Remote Sensing magazine (Impact Factor = 4.51).

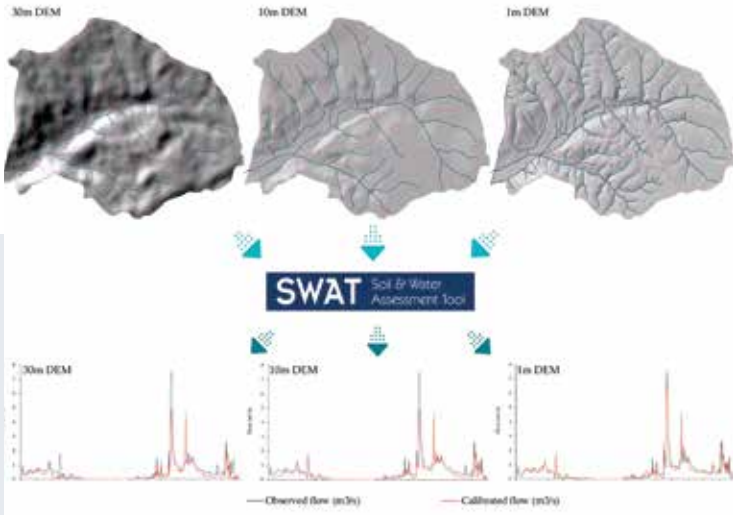
SUPPORTING INITIATIVES FOR PROMOTING AND EXTENDING THE THE NAVIGATOR COMPANY FOREST

RAIZ has maintained an extensive support program for the training and dissemination activities developed by Navigator with its Partners (viz Tec4Forest, Operacionais da Floresta) as well as for the technical support and consultancy activities to owners adhering to the Premium program (problem solving and forestry recommendations). In total, 24 field sessions were supported with Forest Operatives, four training sessions were held with Forest Associations and Certification Groups, 50 Premium processes, 30 problem solving processes, 1 Best Eucalyptus process (CELPA), 1 Replantar Program process. (CELPA) and 8 of the Clean and Aduba Program (CELPA), GIS information on 41 municipalities for the ForestSim project and various training courses in the Best Eucalyptus and + Partners programs.

In 2020, new information leaflets were reformulated and produced, with emphasis on the operational clones of Viveiros Aliança, intended to be distributed to owners and nurseries.

REMOTE SENSING IN MODELING THE HYDROLOGICAL RESPONSE IN EUCALYPT BASINS

In order to be able to improve the quality of eco-hydrological models, useful tools for supporting the planning and management of forest resources, we have shown that the use of remote sensing for detailed terrain mapping allows to significantly improve the quality of adjustment of the tested hydrological models, especially in the case of smooth topography basins. The results were recently published in a Special Issue on "Operationalization of Remote Sensing Solutions for Sustainable Forest Management", in the Remote Sensing magazine (doi: 10.3390 / rs12203287).



05

SERVICES

FORESTRY TECHNICAL SUPPORT

RAIZ's Technical Forestry Services team has developed several forestry activities and was strongly involved in the construction and development of new tools for supporting and reducing the risk associated with the various decision-making processes along The Navigator Company's forestry chain. The following activities are highlighted:

- Forest aptitude assessment, edaphoclimatic characterization and productivity estimations carried out in Portugal and Spain for supporting decision-making on land acquisition, forestry investment, selection of the forestry model and definition of the forestry project to be applied on a case-by-case basis;
- Implementation of a network of forest inventory plots in stands of E. globulus and E. nitens in Galicia. To increase the degree of knowledge concerning soils, climates, biotic and abiotic risks and their effects on forest productivity, thus providing an increased robustness to productivity estimates and reducing the risk associated with forest investment decision making;
- Technical support to RAIZ's forestry R&D projects, through the selection of areas and the setting of new field tests, RAIZ testing network monitoring and maintenance within the various R&D topics;
- The development, in collaboration with the forestry area of Navigator, of two new tools (heat maps), which can revolutionize the current methodologies used to guide land raising in Portugal. In this way, two heat maps were developed, one with a more strategic nature and guiding the commercial focus at the parish level, and another one aiming to provide the land raising team with a new commercial approach around the patrimony under Navigator management (to gain scale);
- Macro-assessment of forest aptitude and the creation of homogeneous macro regions of productivity under the heat map "Heritage Islands".

LABORATORY

RELEVANT TOPICS DURING 2020:

- Extension of the IPAC accreditation for physical, mechanical, optical and structural characterization tests for the "Tissue Paper and Tissue Products" matrix, proving the reliability, traceability and reproducibility of the results produced;
- The Laboratory promoted interlaboratory tests for the tissue matrix and for the white pulp matrix, with the remaining laboratories of The Navigator Company. After the statistical treatment, this tool made it possible to detect deviations and to correct trends;
- Benchmarking assessment of commercial products, namely pulp and tissue papers, allowing knowing the relative position of our strengths to better adjust the strategies to be implemented in the face of competition;
- Physical-mechanical characterization of long fiber for the production of UWCF paper and tissue, allowing the elaboration of an internal Specification Sheet in order to technically support the acquisition of this raw material;
- Support to the Industrial Management Teams in monitoring some environmental parameters, namely TOC and AOX in effluents and compliance with the company's residues control plan for landfills;
- Analysis, identification and characterization of impurities occurring in deposits from paper machines troubleshootings and in the produced paper;
- Development of a methodology for the evaluation of the presence of certain plastics in paper with waterproof characteristics, as well as the research of various types of plastics in tissue - Development of an analysis methodology by Py-GC / MS to assess the presence of ASA and AKD;
- FTIR analysis of additives used in the production of tissue paper for setting up a database;
- Analysis and characterization of non-fossil fuels for the production of energy from the company's biomass boilers.

06

SCALE-UP AND NEW POTENTIAL BUSINESSES IN THE BIOECONOMY

SCALE-UP AND TECHNICAL-ECONOMIC FEASIBILITY - BIOECONOMY

The biocomposites market (thermoplastics mixed with natural fibers) has shown consistent and robust growth rates. Industrial composites production groups, as well as pulp and paper companies, have been mentioned in publications and public reports as suppliers of these new materials.

During the first half of 2020, **RAIZ** has completed some equipment tests, consolidating the knowledge about the formulation and processing technologies.

The second semester focused on contacts with technology suppliers with the purpose of acquiring own equipment for installing a pilot unit at **RAIZ**, allowing to accelerate the development of a range of products and to simultaneously supply material to the injection industry, incorporating their feedback into the development process. This approach is intended to reduce the time-to-market for this product.

SCALE-UP AND TECHNICAL-ECONOMIC FEASIBILITY - BIOECONOMY

BIO ETANOL

The new European directive (RED II), which will regulate the incorporation of biofuels into road fuels in the member states, between 2021 - 2030, stipulates the increasing obligation to incorporate advanced fuels up to 3.5% in 2030. Cellulosic bioethanol, a product identical to the first generation biofuels (from agricultural crops) currently already being mixed with gasoline, has been considered by oil companies as a viable option, allowing using the physical structure already available.

At **RAIZ** and The Navigator Company, the production of cellulosic bioethanol from residual forest biomass was tested on an industrial pilot scale, using different technological concepts, having been analyzed the technical and economic feasibilities (with the conclusion of pre-engineering studies).

Also during 2020, together with Altri, the production of cellulosic bioethanol from pulp and paper industry residues (primary sludges from the WWTP) was explored, the sludges being a source of costs for the sector. In this joint work, the availability of sludges and its conversion into bioethanol (on a bench scale pilot) were evaluated and a conceptual study was carried out where the possibility of scaling an industrial unit for this purpose was technically and economically evaluated.

BACTERIAL CELLULOSE

There are bacteria that have the ability to convert sugars and other carbon sources into high-purity, nanometer-sized cellulose. In 2020, in a partnership with an external company and with the engineering group of The Navigator Company, the lay-out and the equipment needed to build an industrial unit were evaluated, in order to strengthen a business plan for the industrial production of bacterial cellulose.

CELLULOSIC SUGARS

Large companies in the chemical sector have been announcing and implementing a strategy for abandoning the use of chemicals of petrochemical origin, replacing them with equivalents from renewable sources (biochemicals). Many of the biochemical synthesis processes make use of sugar syrups as a raw material (syrups originating from cellulose and hemicellulose). The production of this type of syrups from forest biomass has been the object of study at **RAIZ**, and in 2020 a pre-assessment of concepts that could lead to its industrialization has started.

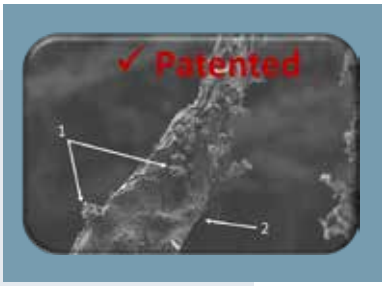
XYLO-OLIGOSACCHARIDES (XOS)

They are compounds that have prebiotic activities, favoring and improving intestinal functions, immunological and antimicrobial actions, and benefiting health. For the production of XOS, lignocellulosic materials can be used, being this an ongoing area of R&D at **RAIZ**, and for which throughout 2020 it was decided to start the scale-up tests, in view of conceptual studies for a hypothetical industrialization of the production concepts being developed.

07 TECHNOLOGICAL SCOUTING AND INDUSTRIAL PROPERTY

RAIZ's *technological scouting activity produced and provided, during 2020, relevant information regarding technologies, processes and products developed by Pulp and Paper companies, start-ups, universities and research centers, which are active in the Forest, Pulp and Paper, Tissue, Packaging and Biorefinery value chains.*

This activity consisted on the monthly publication of Newsletters, summarizing the main initiatives of different value chains players which were disclosed during each month. Another feature of RAIZ's technological scouting activity consists on on-demand reports, where relevant information on technologies, processes and products of interest are reported to different The Navigator Company and **RAIZ** departments, supporting different projects in the areas of product development, consultancy and technological and forestry research and development.



The results coming from **RAIZ** technological and forestry research and development activities continued, during 2020, to be the subject of patent applications, both nationally and internationally. RAIZ's portfolio of patent families increased, during the year 2020, with 3 national patent applications and 3 international patent applications submitted, in collaboration with Portuguese universities, RAIZ's partners in different technological research and development projects. A national patent was also granted, from a patent application submitted in 2018, within inpactus project's framework.

08

DISSEMINATION AND SOCIAL RESPONSIBILITY

__RAIZ__ is located in an absolutely unique space called Quinta de S. Francisco. In this place there are hundreds of monumental trees of the most varied species, some unique in the country and in Europe.

Quinta de S. Francisco proves to be an ideal natural space for knowledge dissemination about forest and its multiple functions, including the provision of resources to human beings. In this sense, RAIZ saw its application for the Floresta do Saber project approved. This project, which started in September, is co-financed by the Calouste Gulbenkian Foundation and aims at the dissemination and deepening of knowledge about forest, bioeconomics and sustainability, topics that are rarely addressed in current education programs in Portugal.

However, in 2020, dissemination activities and particularly the reception of visits were greatly affected as of mid-March, due to the contingency measures imposed due to the Covid-19 pandemic. During this year, **RAIZ** received 251 visitors, 234 of whom visited Quinta de S. Francisco, representing its lowest value of the last 5 years.

Also in the area of biodiversity dissemination a pamphlet was designed concerning the 30 most common species of birds at Quinta de S. Francisco. There was also the growth of the Quinta de S. Francisco herbarium, now with a quarter of a thousand specimens and more than a thousand duplicates, assuming itself as a historical-scientific record of disseminating the flora of this place.

03 NATIONAL AND INTERNATIONAL COOPERATION

COLLECTIVE ACTIONS

In 2020, RAIZ ended the e-globulus project, which was financed by the "SIAC - System of Incentives for Collective Actions" of Portugal 2020. With this project, RAIZ was able to set up and make available to the public a free online platform for knowledge transfer concerning eucalyptus forestry and the support to forestry management on a case-by-case basis.

The closing ceremony of the project and the public launch of the platform took place at RAIZ headquarters in February 2020 and was attended by the Innovation Agency, representing COMPETE, and several Stakeholders including CELPA - Associação da Indústria Papeleira, members of the academy associated to the sector (ISA and UTAD), forest service companies (Unimadeiras) and forest owners associations (AFBV).

The innovative character of this project has already allowed the submission of three patent applications (national, European and International).

Project Duration 01/11/2017 to 31/01/2020
Project Code 26785
Operation Code POCI-01-2046-FEDER-026785

COLLABORATIVE LABORATORIES

The Collaborative Laboratories initiative (CoLab), promoted by the Foundation for Science and Technology (FCT) and the National Innovation Agency (ANI), aims to implement research, development, innovation and technology transfer centers in Portugal, involving R&D centers and agents / entities from the economic and social fabric, focused on strategic themes for Portugal. Collaborative Laboratories are constituted as private non-profit associations or companies.

RAIZ INTEGRATES THE BOARD OF DIRECTORS OF THREE COLLECTIVE LABORATORIES (COLABS) RECOGNIZED IN 2019:

BioRef - Collaborative Laboratory for Biorefineries, led by the National Energy and Geology Laboratory (LNEG).

AlmaScience - Research and Development in Cellulose for Smart and Sustainable Applications, led by the National Press Casa da Moeda (INCM).

eCOLab - Collaborative Laboratory for the Circular Economy, led by the BLC3 - Campus of Technology and Innovation.

RAIZ also follows, through the associated member The Navigator Company, the ForestWISE - Collaborative Laboratory for a Forest and Fire Integrated Management.

Within the RAIZ interface with the Collaborative Laboratories in 2020, the approval of a three-year Mobilizing project promoted with the CoLab for Biorefinery (BioRef), called "Move2LowC - Biologically Based Fuels" can be highlighted, including the participation of 18 entities and with a total investment of 11,212,947.15 Euros. This mobilizing project aims the development of a biofuel for heavy goods and passenger air and road transport sectors.

Within the scope of COLAB AlmaScience, a team of Colab researchers was welcomed at RAIZ, to carry out scientific work at our infrastructures and for promoting projects with COLAB partners in the area of "smart paper".

INTERNATIONAL COOPERATION

RAIZ had the opportunity to integrate another European project financed by H2020, in the form of a reference consortium, with a Swedish leadership, in the area of Biofuels, and with a total investment of five million euros.

At the international level, RAIZ promoted and integrated a collaborative project that took the form of an international partnership with ALTRI and CSIRO Australia within the scope of sustainable forest management, namely issues related to soil and climate, efficient use of resources and mitigation of climate change effects.

RAIZ is involved in 27 national and international financed projects and in partnerships with Universities, Research and Development Centers and Companies, 5 of which have started in 2020.

PREPARED APPLICATIONS / SUBMITTED / APPROVED IN 2020

R&D CONSORTIUM FINANCING PROPOSALS	SUBMITTED	APPROVED	REJECTED	IN EVALUATION
Total	11	3	7	1

ONGOING PROJECTS IN 2020

INTERNATIONAL CONSORTIUM R&D PROJECT	NATIONAL CONSORTIUM R&D PROJECTS	INFRASTRUCTURE FINANCING	COLLABORATIVE LABORATORY	ONGOING
5	16	3	3	27

PROJECTS STARTED IN 2020

ACRONYM	DESCRIPTION	LEADING PROMOTER	COPROMOTORS
R3	Pilot Laboratory in Forest Based Biorefineries - RAIZ Reinforcement and Requalification	RAIZ	-
Move2LowC	Biologically Based Fuels	A4F, Algafuel, S.A.	IST, FEUP, Inst. Polit. de Portalegre, UMinho, UTAD, BIOTREND, , Fac. Ciências da Univ. de Lisboa, RAIZ, REDETECA, DouroGás, UNL | ITQBNOVA, PETROGAL, LNEG, BIOREF, SYSADVANCE, SOLVAY
PDPI_IA+INPACTUS: SP+XOS+ECB+FP	Patents registration	RAIZ	-
IDTecFor	Sustainable Planted Forest, the basis of a new bioeconomy: Consolidation of the human resources structure in research and knowledge transfer in RAIZ	RAIZ	-
BLF2	Black Liquor to Fuel by efficient Hydro Thermal application integrated to Pulp Mill	TAU -TAMPERE UNIVERSITY OF APPLIED SCIENCES (FI)	BRUNEL UNIVERSITY LONDON (UK), KARLSRUHER INSTITUT FUER TECHNOLOGIE (DE), SINTEF (NO), PAUL SCHERRER INSTITUT (CH), VTT Oy (FI), NVG+RAIZ (PT), VALMET (FI), NESTE (FI), RANIDO (CZ), LGI (FR)

10 EXTERNAL RECOGNITION AND CERTIFICATION

The Floresta do Saber, a project approved in September 2020 to be financed by the Sustainability Program of the Calouste Gulbenkian Foundation, intends to create a Forest Laboratory in the Forest, dedicated to Sustainability, to the Forest and to a Forest-based Bioeconomy, open to the Civil Society, a unique project in Portugal, which will make the Future Generations aware of Forest related issues.

FINANCED BY

FUNDAÇÃO CALOUSTE GULBENKIAN

UNESCO RECOGNITION

One of the achievements of Floresta do Saber, already in its initial phase, was the accreditation of **RAIZ** as a UNESCO Club (United Nations Educational, Scientific and Cutural Organization), by the Portuguese Ministry of Foreign Affairs, in December 2020. This status recognizes that RAIZ with the development of Floresta do Saber is in line with the missions of promoting Education, Science and Knowledge, Patrimony Conservation and Promotion, Cultural Heritage and the Sustainable Development Goals (Sustainability SDGs) subscribed by UNESCO.

Membro da Rede de Associações e Clubes para a UNESCO

RAIZ, INTERFACE CENTER

In 2018, RAIZ was recognized as a Technological Interface Center. This recognition, and the corresponding framework into the National Research and Development Infrastructure network, allowed RAIZ to apply for funding sources to reinforce skills and infrastructures.

In 2018, **RAIZ** also had access to the FITEC multiannual financing program (Basic financing granted by ANI - Agência Nacional de Inovação). In 2019, an application was submitted for the strengthening of its technical infrastructures, namely the expansion of the Central Laboratory and the construction of a new Pilot Laboratory dedicated to the Biorefinery area (Pilot Laboratory in Forest Based Biorefineries - Reinforcement and Requalification of **RAIZ** - R3). This project was approved and contracted in 2020. In 2020, RAIZ also applied for a support line for the hiring of Highly Qualified Resources, which was also approved and contracted in the same year, which will allow hiring, between 2020 and 2021, 25 Human Resources Masters and PhDs.

CIT Centro Interface

11 GOVERNANCE

GENERAL SHAREHOLDERS ASSEMBLY

CHAIRMAN
ANTÓNIO PEDRO GOMES
PAULA NETO ALVES

SECRETARY
ANTÓNIO ALEXANDRE DE ALMEIDA E NORONHA DA CUNHA REIS

BOARD OF DIRECTORS

CHAIRMAN
JOÃO PAULO CABETE GONÇALVES LÉ

GENERAL EXECUTIVE DIRECTOR
CARLOS DE PASCOAL NETO

MEMBERS
ADRIANO AUGUSTO DA SILVA SILVEIRA
JOÃO PAULO ARAÚJO OLIVEIRA
NUNO MIGUEL MOREIRA DE ARAÚJO SANTOS

AUDIT COUNCIL

KPMG & ASSOCIADOS, SROC
REPRESENTED BY;
PAULO ALEXANDRE MARTINS QUINTAS PAIXÃO (ROC)

SCIENTIFIC COMMITTEE

CHAIRMAN
JÚLIO PEDROSA

MEMBERS
MARGARIDA TOMÉ
CARLOS FIOLHAIS
CLEMENTE PEDRO NUNES
FILIPE DUARTE SANTOS
JOÃO COUTINHO MENDES
FRANCISCO GÍRIO

EXECUTIVE BOARD

GENERAL DIRECTOR
CARLOS DE PASCOAL NETO

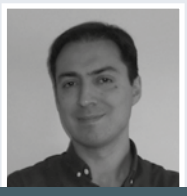
ADMINISTRATIVE AND TECHNICAL SUPPORT DIRECTOR
LEONOR GUEDES

TECHNOLOGICAL RESEARCH AND CONSULTING DIRECTOR
RICARDO JORGE

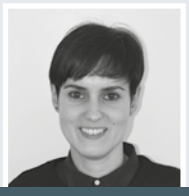
FORESTRY RESEARCH AND CONSULTING DIRECTOR
NUNO BORRALHO

EXECUTIVE TEAM

GENERAL DIRECTOR
Carlos de Pascoal Neto

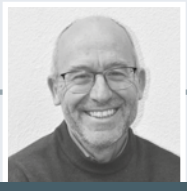


DEMONSTRATION, SCALE-UP, NEW BUSINESSES
Alexandre Gaspar



TECHNOLOGICAL SCOUTING
Mariana Oliveira

TECHNOLOGICAL RESEARCH AND CONSULTING
Ricardo Jorge



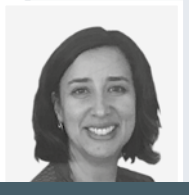
FORESTRY RESEARCH AND CONSULTING
Nuno Borralho

ADMINISTRATIVE AND TECHNICAL SUPPORT
Leonor Guedes

OUTREACH AND STRATEGIC PROJECTS
Cristina Marques

GENETIC R&D AND FORESTRY CONSULTING
Daniela Ferreira

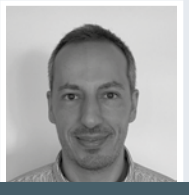
SILVICULTURE RESEARCH
Sérgio Fabres



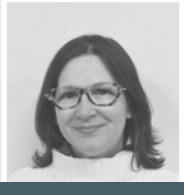
TECHNOLOGICAL RESEARCH
Paula Pinto

TECHNOLOGICAL CONSULTING
Luís Machado

ADMINISTRATIVE SUPPORT
Leonor Guedes



FIELD TECHNICAL SUPPORT
Cláudio Teixeira



SERVICES AND R&D LABORATORIES
Manuela Marques

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PERSONNEL

*The year of 2020 will be engraved in the memory of all **RAIZ** employees as well as in the history of the country and the world. The pandemic caused by SARS-CoV-2 paralyzed the world and changed the lives of all the inhabitants of this planet.*

The pandemic brought great changes, challenges to companies and organizations, which had in a record time to adapt their ways of operation with numerous measures. Some of these measures, such as laboratory working in shifts and teleworking, had an impact on the professional and personal lives of each employee.

However, despite the physical distance, the reinforcement of on-line meetings with the teams and permanent contacts allowed the maintenance of a more fragile and subtle but inclusive and involving network, which ensured the continuity of the work throughout the year.

The maintenance of the Christmas meeting, also online, was one of the moments for reinforcing the team's unity globally, thanks to the personal and collective efforts of all **RAIZ** employees, **RAIZ's** strategic objectives and goals for 2020 were essentially achieved, despite all the difficulties.

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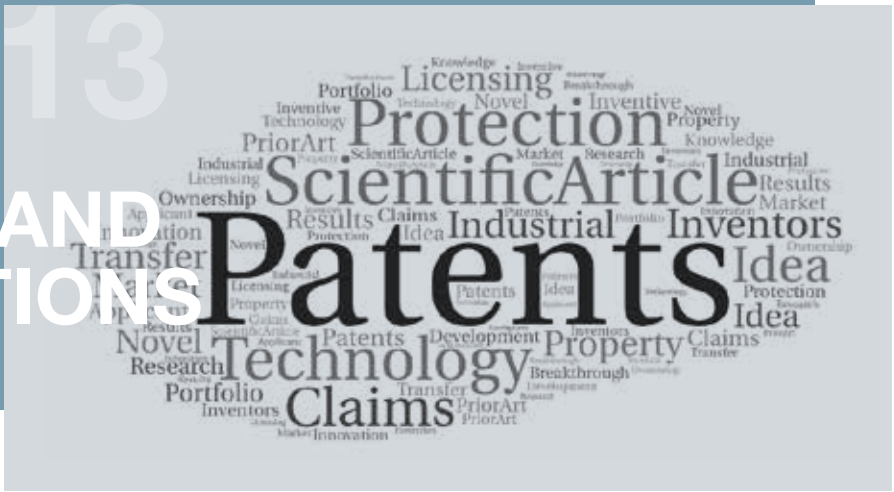
PATENTS AND PUBLICATIONS

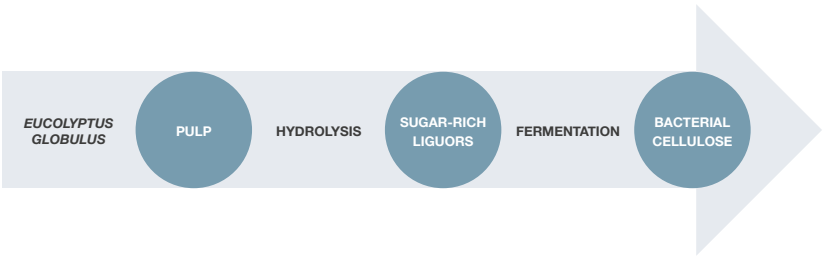


*During 2020 the **RAIZ** patent portfolio was increased both nationally and internationally. The results of technological research and development projects, in collaboration with different partners, were the target of 3 national patent applications and 3 international patent applications, with the grant of a national patent.*

One of the national patent applications considered a security paper composed of polymeric complexes of luminescent lanthanides, allowing two procedures to guarantee security / counterfeit detection: either through the emission of light by the lanthanide in the presence of ultraviolet light; either through its opposite effect when in contact with copper or nickel solutions.

It was also considered, for a national patent application, a production process of xylooligosaccharides (XOS), prebiotics with application as food additives, from Eucalyptus globulus kraft pulp and through a simple acid hydrolysis, in a single and direct step and at moderate operating conditions.

The third submitted national patent application describes a bacterial cellulose production process, which does not require any detoxification step and without potentiating any inhibitory effect on cellulose production, using Eucalyptus globulus lignocellulosic biomass sugar-rich liquors.



IN **2020**, **RAIZ** PRODUCED A TOTAL OF **27 PUBLICATIONS**, OF WHICH:

> 2 ORAL COMMUNICATIONS
> 15 ARTICLE PUBLICATIONS
> 6 POSTERS
> 3 TECHNICAL ARTICLES AND A REVIEW ARTICLE

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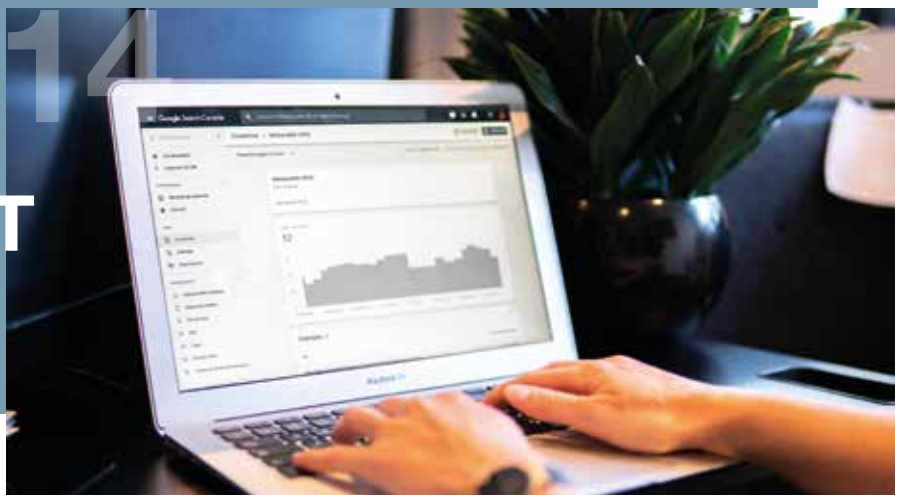
RELEVANT FACTS



RELEVANT FACTS OCCURRED AFTER THE END OF THE YEAR

As of the date of issue of this report, there have been no subsequent events that could be disclosed in these financial statements.

FUTURE PROSPECTS

No significant changes in the Company's activity are expected for 2021.

BUSINESS CARRIED OUT BETWEEN THE COMPANY AND ITS DIRECTORS

No business was carried out between the Company and its Directors.

PROPOSED IMPLEMENTATION OF RESULTS

The Direction of **RAIZ** - Forest and Paper Research Institute, proposes to its partners that the net result of the 2020 financial year, in the amount of € 99,081 to be taken € 94,127 as to retained earnings account and € 4,954 is earmarked for constituting legal reserves.

BOARD OF DIRECTORS

João Paulo Cabete Lé
Carlos de Pascoal Neto
Adriano Augusto da Silva Silveira
João Paulo Araújo Oliveira
Nuno Miguel Moreira de Araújo Santo

annual review 2020

FINANCIAL STATEMENTS

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DECEMBER 31, 2020

FINANCIAL STATEMENTS

BALANCE

Amount in €	Note	2020	2019
ASSET			
NON-CURRENT ASSETS			
Tangible fixed assets	7	1 832 836	2 034 873
Intangible assets	8	10 351	10 633
Financial investments - equity method	9	2 170 258	2 000 640
Financial investments - other	9	5 000	5 000
Other financial investments	11	18 787	30 629
Deferred income tax assets	12	77 000	131 069
		4 114 231	**4 212 844**
CURRENT ASSETS			
Costumers	13	745 172	1 487 962
State and other public entities	14	57 358	160 708
Other receivables	13	12 666 483	10 375 422
Cash and bank deposits	5	62 636	266 919
		13 531 648	**12 291 011**
TOTAL ASSETS		**17 645 880**	**16 503 855**
SHAREHOLDER'S EQUITY AND LIABILITIES			
SHAREHOLDER'S EQUITY			
Funds	15	9 000 000	9 000 000
Results carried forward	15	254 128	247 343
Adjustments/Other equity changes	15	942 635	385 744
		10 196 763	**9 633 086**
Net profits		99 081	(17 946)
TOTAL SHAREHOLDER'S EQUITY		**10 295 845**	**9 615 140**
LIABILITIES			
NON-CURRENT LIABILITIES			
Responsibilities for post-employment benefits	17	171 306	0
Liabilities by deferred taxes	12	425 150	5 480
		596 456	**5 480**
CURRENT LIABILITIES			
Suppliers	16	547 295	1 029 863
State and other public entities	14	129 488	142 816
Other payables	16	2 435 754	2 243 831
Deferrals	18	3 641 042	3 466 725
		6 753 579	**6 883 234**
TOTAL LIABILITIES		**7 350 035**	**6 888 715**
TOTAL SHAREHOLDER'S EQUITY AND LIABILITIES		**17 645 880**	**16 503 855**

FINANCIAL STATEMENTS

INCOME STATEMENTS

AMOUNT IN €	Note	2020	2019
Sales and rendered services	19	4 536 937	4 474 129
Operational subsidies	20	1 994 727	1 857 250
Profit/(loss) incomes imputed from subsidiaries, associates and joint ventures	-	15 618	644
Supplies and external services	21	(2 309 385)	(2 363 928)
Staff costs	22	(3 916 865)	(3 762 633)
Other income	23	10 824	41 811
Other expensives	24	(23 347)	(40 593)
INCOME BEFORE DEPRECIATION, FINANCING EXPENSES AND TAXES		**308 509**	**206 680**
(Expenses) / reversals of depreciation and amortization	7	(181 824)	(130 384)
TRADING INCOME (BEFORE FINANCING EXPENSES AND TAXES)		**126 685**	**76 296**
Interest and similar income obtained	25	36 311	39 067
Similar interest and expenses incurred	25	(19 868)	(4 345)
RESULT BEFORE TAXES		**143 127**	**111 017**
Income tax	12	(44 046)	(128 964)
NET PROFIT		**99 081**	**(17 946)**

ECONOMIC AND NON-ECONOMIC ACTIVITIES

	Economic	Non Economic	Sums
COSTS			**6.451.290,00 €**
Current Activities	3.710.046,86 €		
Financed Projects		2.559.419,14 €	
Depreciations	181.824,00 €		
INCOMES			**6.594.417,00 €**
Services Rendered to Clients	4.536.937,00 €		
Interests and similar Incomes	36.311,00 €		
Other incomes	26.442,00 €		
Subsidies		1.994.727,00 €	
BALANCE	**707.819,14 €**	**-564.692,14 €**	**143.127,00 €**

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RAIZ

PART OF
THE NAVIGATOR
COMPANY

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