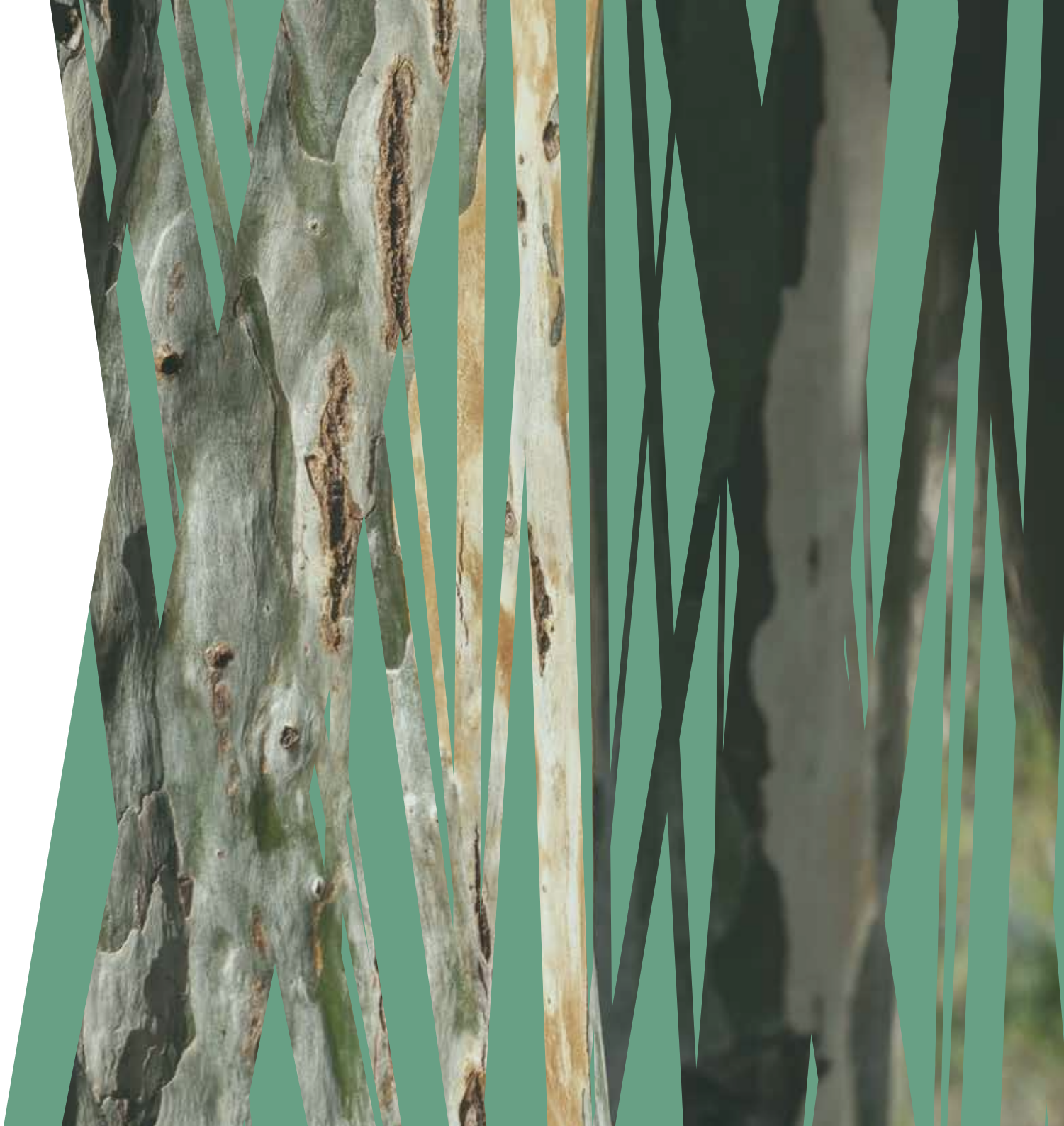
2018 ANNUAL REVIEW

RAIZ
Forest and Paper Research Institute



RAIZ - FOREST AND PAPER RESEARCH INSTITUTE, PROMOTING A GREENER, GLOBAL, SUSTAINABLE AND COMPETITIVE BIOECONOMY BASED ON THE PORTUGUESE EUCALYPTUS PULP-AND-PAPER INDUSTRY.

TABLE OF CONTENTS

KEY PERFORMANCE INDICATORS

PROJECT DELIVERABLES

100

PUBLICATIONS

41

NEW POTENTIAL BUSINESSES

2

PRIVATE FUNDING

6.3 MILLION EUROS

PATENTS (APPLICATIONS)

3

PUBLIC FUNDING

1.4 MILLION EUROS

PROOFS OF CONCEPT

127

OUTREACH INITIATIVES (PEOPLE INVOLVED)

1805

2018 OVERVIEW

Adriano Silveira
Board of Directors Chairman

Carlos Pascoal Neto
Executive Board, General Director

2018 was a great year to our Institute! Highly qualified new people, new facilities, new projects and results with impact on our customers and shareholders.

Inpactus, a **RAIZ** flagship project focused on new innovative products and technologies from eucalyptus, promoted by **The Navigator Company** was launched early this year, together with the Universities of Aveiro and Coimbra, as co-promoters. New projects on forestry were approved for funding, including the i-Plant project, focused on new genetic materials and innovative systems for cloning eucalyptus. These new projects, most of them involving national and international cooperation, are bringing to **RAIZ** new researchers, equipments, and facilities, strengthening our skills and developing new areas of competence.

Within the context of a circular Bioeconomy, our industrial processes and products team has been focused on new paper properties and applications, new biorefining approaches and on the upgrading of solid residues. Consulting activity involved the optimization of wood and water use at pulp mills, and the support to the industrial start-up of new cooking and oxygen delignification technologies. The forestry team, while developing new knowledge on forest ecosystems, has been particularly focused on our tree improvement program, the better understanding of nutrient cycles and improvement of fertilization processes, new control measures against pests and diseases and new smart technologies supporting management decisions.

Technical support was provided to **The Navigator Company** forestry operations in Portugal, Spain and Mozambique, as well as to private associations of forest growers and private and public bodies. Our central laboratory has been particularly active in supporting the industrial, commercial and forestry operational areas of our main shareholder, **The Navigator Company**.

Two potential new biobased businesses were proposed, based on R&D results: essential oils from eucalyptus leaves and bioethanol from biomass residues. A third new business proposal is already at a pilot scaling stage. The scouting and industrial property support has been quite active in 2018 with 3 new patents applications being filled.

The economic impact of **RAIZ** activity has been addressed through the development and test of a new management tool.
We were particularly committed with our social responsibility, namely through science outreach and environmental education activities addressed to schools, using our natural heritage, the arboretum of Quinta de São Francisco.

As a corollary of these efforts and achievements, **RAIZ** was recognized as an Interface Centre by the Portuguese Ministry of Economy and European Business Innovation Centre by the European Business Network, EC, Brussels.

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INPACTUS

A STEP FORWARD TO A GREENER, GLOBAL, SUSTAINABLE AND COMPETITIVE BIOECONOMY IN PORTUGAL, BASED ON EUCALYPTUS PULP-AND-PAPER INDUSTRY

"Inpactus - Innovative Products and Technologies from Eucalyptus" is a Research & Development Project promoted by **The Navigator Company**, **RAIZ**, the Universities of Coimbra (UC) and Aveiro (UA) (Consortium). The project is supported by Structural Funds managed by the Portuguese program Portugal 2020 (COMPETE 2020 nº 246/EIXO II/2017, number 21874).

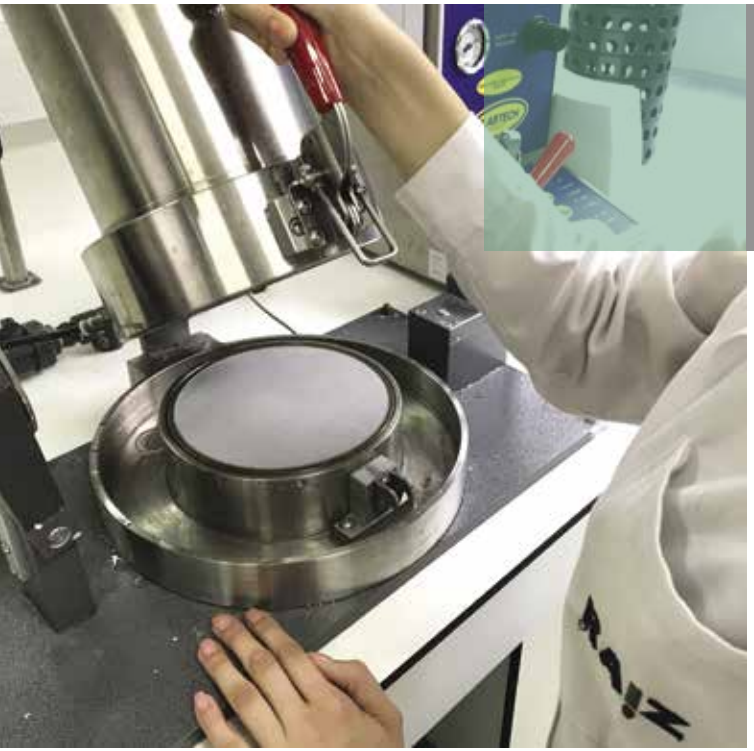
Inpactus, aims the development of new solutions, such as cellulosic pulps with innovative features, new paper products with different specificities and functions, tissue paper with innovative properties, new bioproducts, biofuels and other materials obtained from the deconstruction and conversion of forest biomass and by-products from the pulp industry.

During 2018, OECD in its report "Stimulating knowledge transfer: challenges and policy responses", recognized inpactus as an exemplary success story of University-Company cooperation, through the creation of a multipolar and delocalized Centre of Excellence, focused on knowledge and innovation on eucalyptus products and technologies.

This project is structured in activities that will be developed over a 4 year period, involving a global investment of up to € 14.6 million (including 13.3 M€ investment from European Structural Funds). The project will thus bring a set of socio-economic impacts relevant to the national economy, promoting job creation, innovation in products and technologies in a relevant field for the country, valuing endogenous resources and sustainable industrial solutions.

To know more visit the website: **www.inpactus.pt**.

Cofinanciado por:
COMPETE 2020
PORTUGAL 2020
UNIÃO EUROPEIA
Fundo Europeu de Desenvolvimento Regional



RESEARCH, DEVELOPMENT AND CONSULTING

INDUSTRIAL PROCESSES AND PRODUCTS

RAIZ Technological R&D and Consulting activities develop scientific knowledge and state of the art technologies covering all pulp & paper industry value chain, wood and raw materials, pulp production, printing and writing paper and tissue paper, as well as biorefineries and bioproducts.

During 2018, the Technological R&D main activities included:

- Technological evaluation and characterization (chemical and morphological) of wood and forest products as raw materials for the production of cellulosic pulp, as well as for new applications, namely within the context of a biorefinery;

- Optimization of pulping and bleaching processes, effluent treatment and process residues and by-products upgrading, within the context of a circular economy;

- Development of new biomass deconstruction processes within the context of biorefineries of the future;

- Development of new applications for pulp, by using cellulosic fibers as reinforcement elements in thermoplastic biocomposites, or by the fractionation of its components into cellulose (micro- or nano-fibrillated) and hemicelluloses, and looking for new applications for these materials/products;

- Pulp beating evaluation, interaction of different components in “wet end chemistry and paper properties and development of new surface treatments, both for uncoated woodfree products and tissue;

- Fractionation, conversion (chemical, thermochemical, biological) and separation of biomass components, to develop products like bioactive compounds from bark and wood, new materials and bioproducts from cellulose, hemicelluloses, sugars and lignin as well as biofuels obtained by (bio)(thermo)chemical conversion of biomass and biomass components

Technological Consulting activities cover the pulp and paper processes, environment and energy, aiming to find solutions for operations otimization, allowing to face new industrial, economic and regulation challenges, serving **The Navigator Company** as well the pulp-and-paper sector. With this expertise, **RAIZ** is also a partner of National and European pulp-and-paper sector for the development of environmental regulation within the context of BREF or ecological labels.

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MAJOR HIGHLIGHTS

TISSUE PRODUCTS EVALUATION

Tissue R&D at **RAIZ** is growing up and is gaining increased relevance for the Company tissue business. Besides benchmarking and critical analysis of commercial products, product innovation and advanced methods for tissue evaluation were developed. Along with strength and absorbency, softness is a key consumer attribute for tissue paper products. A panel tissue implementation and correlation of perceived softness with physical measurements through panel tests was successfully achieved.

ENHANCING PULP AND PAPER STRENGTH PROPERTIES

Technological R&D is developing projects to enhance pulp and paper strength properties and evaluating different processes to produce micro fibrillated cellulose, not only as a strength additive for paper production, but also for the development of different paper characteristics.

Within this context, a patent application was filled, dealing with the use of nano and micro cellulose fibrils for strength development and filler retention during papermaking. This research work was a co-winner of the Blue Sky Young Researchers and Innovation Award – Europe 2018 (CEPI).

Blue Sky Young Researchers and Innovation Award | Europe - 2018

CEL SMART SENSE

CELLULOSE BASED ELECTRONIC PLATFORMS FOR BIODETECTION
2016 - 2018

DEVELOPING NEW PAPER APPLICATIONS

RAIZ, **The Navigator Company** and i3N - Institute for Nanostructures, Nanomodelling and Nanofabrication (Faculdade de Ciências e Tecnologia / Universidade Nova de Lisboa) have successfully concluded the Project CelSmartSense (2016-2018) – cellulose-based electronic platforms for biodetection. A cellulosic matrix suitable for microfluidics and printed electronics was developed by this team and a patent application on this topic was filled.

CIRCULAR ECONOMY

In spite of the high residues recover and reutilization rate (84%) at **The Navigator Company**, some inorganic materials resulting from pulp and paper processes still end up in landfills. Within the scope of a Circular Economy, these residues have been worked up as raw-materials for the construction sector in two projects: Proteus (funded by PT2020) and Paperchain (funded by H2020). A circular economy model was established considering the production of precast eco-concrete and eco-bitumen for road construction application. The model evaluation is concluded and the demo work is being prepared.

MAJOR HIGHLIGHTS

WATER USE REDUCTION

RAIZ technological consulting area, in straight collaboration with Setúbal mill, carried on, from the previous year, the support to an extensive water use reduction plan. Studies, evaluation and execution of reduction measures were carried out, resulting in a 6,5% reduction considering the project reference year.

During 2018, this program was also extended to Aveiro mill where all the balances and identification of potential water use reduction measures were performed.

THE NAVIGATOR COMPANY FIGUEIRA DA FOZ PULP MILL OPTIMIZATION PROJECT STARTUP

During 2018, Figueira da Foz pulp mill started an optimization project that increased production up to 650 000 ADt/yr and installed, for the first time in **The Navigator Company**, a LoSolids cooking and O_2 delignification technology.

RAIZ Technological Consulting team was involved in the project performing specific studies, before and after project implementation. Process and quality variables were closely monitored, working side by side with the industrial team. During the start-up phase all the knowledge gathered was of great value to overcome and troubleshoot unforeseen events.

BIOREFINERY AND BIOPRODUCTS

Pre-Competitive Research Program “Lignin refinery towards high-value applications” held by RISE-BIOECONOMY has started. **The Navigator Company** takes part of the Consortium board through **RAIZ**. The work front includes the following topics: lignin separation, chemical modification and characterization. So far, the main progresses are the comparative performance of acidified eucalyptus black liquor through filtration and a process development to improve it. Developing radically new, sustainable and techno-economically feasible pulping technologies for industrial wood and agro-based lignocellulose raw materials based on natural deep eutectic solvents, is the main goal of the BBI Project PROVIDES - Processes for value added fibres by innovative deep eutectic solvents. **The Navigator Company** participates in the project through **RAIZ** and has been contributing for properties evaluation of the lignin produced by the newly delignification process developed in the consortium.

WOOD RESOURCES

A model and an IT tool were developed for evaluating the impact of having different wood mixes in mills performances by estimating future operational consumptions and by verifying if different processes maximum capacities are reached at each mill in different scenarios.

In a context of increased diversification of wood sources, this type of approach is essential to optimize the overall wood supply, as well as per mill, in the near future.

RESEARCH, DEVELOPMENT AND CONSULTING
FORESTRY

Forest research and consulting activities at **RAIZ** span across a wide range of topics. Key ones include:

- A better understanding of the functioning of forest ecosystems in all its dimensions (trees and vegetation, water, soil and climate), while delivering practical solutions for better, more resilient plantations.

- The follow up of **RAIZ's** Tree Improvement Program, with the continuing development and application of Biotechnology tools and novel Plant Propagation Strategies.

- Better understanding of the nutrient cycles in forestry and improvement in fertilization guidelines, based on alternative mineral and organic fertilizer sources and less intensive soil cultivation practices, leading to lower costs and improved environmental impacts.

- Clever processes to gather and process information and systems in place to support better management decisions.

- Development of more effective control measures against pests and diseases.

- Finally, **RAIZ** provides a range of services and outreach initiatives, firstly in support of **The Navigator Company** operations in Portugal, Spain and Mozambique, but very much so in helping forest growers and theirs associations, several service providers and society and academia in general.

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MAJOR HIGHLIGHTS

PRODUCING MINI-CUTTINGS THROUGH WINTER

A study on best mini-cuttings propagation systems for winter production was carried by **RAIZ** in its nursery facilities. The study demonstrated it was economically viable to produce cuttings through winter. Appropriate protocols for best stock plant nutrition, pest control and climatic conditions inside the glasshouse (viz Vapor Pressure Deficits and minimum temperatures) were established. Next year the company is expected to start its first winter clonal production line.

REMOTE SENSING TECHNOLOGIES IN SUPPORT OF THE BEST FOREST MANAGEMENT

RAIZ continues to explore the possibilities that arise from remote sensing information technology. Examples include forest inventory applications based on Terrestrial Laser Scanning and the estimation of fire severity indices based on Satellite Image, the latter in support of post-fire mitigation efforts. Furthermore, **RAIZ** is part of a large H2020 project (MySustainableForest), aiming to demonstrate the advantage of incorporating EO based information into the daily decision making, protocols and operations across the silvicultural chain.

NEW WEAPONS AGAINST MAJOR EUCALYPTUS PESTS

Three new species of parasitoids of the Eucalyptus weevil and one of the Bronze bug were authorized by ICNF to be imported and studied in **RAIZ** lab. They include Cirrospilus sp., Euderus sp., Anagonia sp. and Cleruchoides noackae. All are being maintained under strict quarantine conditions, and studies to demonstrate their efficacy and risks, before they can be authorized and released into the wild.

The insecticide EPIKTM was approved for use against the bronze bug. This insecticide is efficient in controlling this pest and it is recognized as having low impact on beneficial insects, such as honey bees. More stringent toxicological studies are under way, as part of a long term monitoring program.

MAJOR HIGHLIGHTS

LARGE GENETIC ANALYSIS OF EUCALYPTUS GENETIC TRIALS HAS BEEN COMPLETED

A genetic analysis (BLUP) combining datasets from **RAIZ** and ALTRI breeding programs was recently completed. The analysis is the most comprehensive carried out so far. It brought together more than 240,000 genotypes for growth and survival tested across more than 260 trials belonging to two of the most advanced and long lasting tree breeding programs in the world. The analysis permitted a more robust comparison between elite individual, clones and families from the two populations, tested across a wide range of site conditions and genetic backgrounds.

THE IMPORTANCE OF HAVING FARMERS AND FARMER'S ASSOCIATIONS MANAGING WELL THEIR PLANTATIONS

RAIZ is actively involved in several tech support initiatives, often in association with CELPA and **The Navigator Company** outreach programs. Key target groups include Certification Groups, farmers and Forest Owner's Associations, Regional Extension Officers and Forest Managers.

A detailed study on the impact of forest management in Central Portugal was conducted. It showed that appropriate management practices by forest growers, as minimum soil preparation efforts and a timely coppice and control of vegetation, had a huge impact on productivity of plantations. Managed plots yielded up to 2.5 times more wood than unmanaged stands, while significantly reducing fire risks.

EXPANDING HORIZONS FOR FOREST PLANTATIONS

A number of **RAIZ** projects have been devoted to study the potential of new plantations outside Portugal, including new forest projects in Iberia and overseas. The studies in Northern Spain focused on understanding the relationship between growth and vitality of eucalypt plantations across the complex array of soils and climatic conditions present. In Mozambique, **RAIZ** provided tech support to the company's forest plantations program, including the development of an ambitious Forest Extension Programs, contributions for the company's Forest Management Plan, the development of new site index maps for eucalyptus production, based on soil and climate information, the estimation of carbon stocks and carbon balances and the publication of a local "Handbook for field evaluation of nutritional diagnosis for Eucalyptus urophylla and E. urograndis"

SERVICES

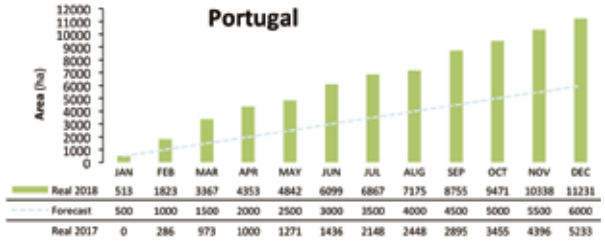
LAND EVALUATION

The forest support services team of **RAIZ** developed multiple activities that served as support for the decision-making of different clients.

The forest support services team of **RAIZ** developed multiple activities that served as support for the decision-making of different clients. In 2018, the edaphoclimatic characterization continued to be an important activity, with the characterization of 11.300 ha in Portugal and 2.800 ha in Galicia.

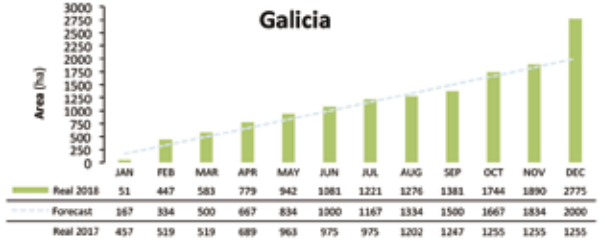
This activity associates estimates of productivity for the future forest and risks of occurrence of biotic and abiotic factors that occur that may compromise the success of the plantation and the normal growth of eucalyptus. Thus, it is intended to boost local productivity and minimize the risks associated with the forestry investment decision, support the forestry project and the macro-planning of the forestry operations.

The team was also heavily involved in technical support to **RAIZ** R&D projects, through the installation of new field trials, monitoring trials, expert evaluations of pests and forest diseases. There were also several training sessions about edaphoclimatic characterization.



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Real 2018	513	1823	3367	4353	4842	6099	6867	7175	8755	9471	10338	11231
Forecast	500	1000	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000
Real 2017	0	286	973	1000	1271	1436	2148	2448	2895	3455	4396	5233

AREA EVALUATED IN PORTUGAL IN 2018



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Real 2018	51	447	583	779	942	1081	1221	1276	1381	1744	1890	2775
Forecast	167	334	500	667	834	1000	1167	1334	1500	1667	1834	2000
Real 2017	457	519	519	689	963	975	975	1202	1247	1255	1255	1255

AREA EVALUATED IN GALIZA IN 2018

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LABORATORY

RAIZ has unique research facilities available for scientific work and provides services to the pulp-and-paper sector in particular to **The Navigator Company** mills and its different departments.

A wide variety of situations are dealt at the laboratories such as troubleshooting, product benchmarking, product performance improvement, and new products development. RAIZ has the necessary equipment for standardized tests and state of the art advanced characterizations. Standard or more advanced chemical, physical and printing tests are also performed.

RAIZ Laboratory, during 2018, issued 47684 results corresponding to different matrices, such as soils, plant material, wood, liquors, pulp, paper, tissue, raw materials for pulp and paper, process samples, solid waste, process waters and liquid effluents.

Evaluation of soil and plant material was performed supporting the Company forest area investment decisions and responding to forest research projects needs.

Characterization of wood samples was carried out to select new suppliers, as well as to characterize the imported wood supplied to pulp mills. Properties of the biomass to be fed to mills boilers were characterized at RAIZ Laboratories.

The evaluation of non-process elements, NPE, on liquor and lime from the evaporation and causticizing plants was also carried out.

RAIZ laboratory has also performed tissue benchmarking tests to support the research team and the new business area of **The Navigator Company**.

The characterization of the samples corresponding to the landfill monitoring plan of the four plants of **The Navigator Company** was carried out to ensure compliance with the environmental licensing.

SERVICES

NEW POTENTIAL BIOECONOMY BUSINESSES

BIO COMPOSITES

Blending natural fibers with fossil based plastics is a recent but growing market, which addresses the concerns regarding non-biodegradable plastic usage / its reduction and may bring, as well, performance improvements in certain fields. Throughout last years **RAIZ** and **The Navigator Company** have been testing at lab scale these blends & its properties. During 2018 the industrial scale-up was addressed and studied, several trials at industrial equipment providers were performed (mainly at foreign countries) in order to choose the best configuration and equipment towards an industrial scale-up. With the material produced, several injection and molding tests were carried out at Portuguese industrial partners, to assess the materials and evaluate market acceptance.

ESSENTIAL OILS

Eucalyptus essential oils are used at fragrances, cosmetics, disinfectants and at the pharmaceutical industry. A few decades ago Portugal was one of the largest producers of Eucalyptus Globulus essentials oils, one with the highest market procurement. **RAIZ** assessed through last years the possibility to perform a pre-extraction of the oil (with high value) over biomass being currently burned at the biomass boilers, delivering afterwards that biomass back to the boiler circuit, to be burned and produce energy. From the business point of view this approach revealed to be interesting and currently, with a key industrial partner, the studies for an industrial unit are finalized and construction works are foreseeing to start in 2019.

BIOETHANOL

Cellulosic bioethanol has been a subject of interest within **RAIZ** and currently a new EU legislation decree established that advanced biofuels (such as cellulosic bioethanol), have to be blended in road fuels, on growing percentages, throughout the next decade, up to 3,5%. All the knowledge build up at **RAIZ** across the previous years is now being used on discussions with technology providers and on the assessment for the construction of a cellulosic bioethanol plant at Portugal, a partnership with other industrial group.

TECHNOLOGICAL SCOUTING & IP

ON-DEMAND TECHNOLOGICAL SCOUTING REPORTS WERE ISSUED SUPPORTING DIFFERENT NVG DEPARTMENTS, AND RAIZ R&D AND CONSULTING ACTIVITIES, BY PROVIDING INFORMATION ON RELEVANT SPECIFIC TECHNOLOGIES, PRODUCTS AND PROCESSES.

During 2018 monthly regular Technological Scouting outputs were delivered, where processes, technologies and products developments released by companies, universities and research centers with activities in the Forest, Pulp and Paper and Biorefinery value chains, at national and international levels, were disclosed and analyzed. Quarterly, these Technological Scouting outputs consisted on published patents by companies, universities and research centers carrying out their activities in the previously referred domains. Different analyses, with respect to the jurisdictions chosen for protection and the technological areas representative of the inventions developed, were also made available.

On-demand Technological Scouting reports were issued supporting different NVG Departments and **RAIZ** R&D and Consulting activities, by providing information on relevant specific technologies, products and processes.

Three Patent Applications were filled to the Portuguese Patent Office concerning processes and products developed under the R&D activities carried out by **RAIZ**, as well as in collaboration with Universities and Research Centers partners. One Patent Application and one Utility Model Application were filled to the Portuguese Patent Office concerning products developed by the **The Navigator Company** different opertional areas. Derived International applications were prepared and filled, at the European Patent Office and at the Spain and France National Offices.

OUTREACH & SOCIAL RESPONSABILITY

PRESERVATION OF CULTURAL AND NATURAL HERITAGE

Ensuring the preservation of Europe's largest centenary eucalyptus arboretum, hundreds of monumental trees, from both native and exotic species and the protection of more than 400 species of plants found at **Quinta de São Francisco** is one of the responsibilities of **RAIZ** as inheritor of Dr. Jaime de Magalhães Lima's* legacy.

In 2018 several interventions were carried out, in order to reduce forest fire hazards, namely through regular maintenance actions that reduced the density of shrubs, the construction of the south hydrant network and the creation of a group of volunteers, constituted by **RAIZ** employees trained to defend this place from forest fires. At the same time, invasive species control actions continued, either by mechanical or chemical means, in areas not previously subjected to control.

Biodiversity was increased directly with the introduction of new species in the gardens and by planting dozens of deciduous trees in the valley, improving these areas. A reforestation plan for the old south technological showcase was also outlined (in collaboration with Navigator Forest Portugal), which foresees for this area the establishment of a small Mediterranean native forest.

DISCLOSURE AND ENVIRONMENTAL EDUCATION

Quinta de S. Francisco received 1805 visitors in 2018, which represents an increase of more than 400% over the previous year and, in parallel, developed several actions in schools to raise forest and environment awareness. In order to explain the importance of sustainable forests, biodiversity and nature conservation, to children often visiting us, the game "Give the Forest a Hand" was developed.

Last year, the disclosure of our heritage was also made through two profusely illustrated leaflets, as well as 15 chronicles and news about scientific, cultural or historical curiosities related to the forest and biodiversity, which appear regularly on the intranet and also on **RAIZ** website. At the same time, **Quinta de S. Francisco** herbarium, increased to 200 specimens, assuming itself as an historical-scientific register of the existing flora.

TEAMBUILDING AND SOCIAL RELATIONS WITH THE LOCAL COMMUNITY

The concern with the environment and nature conservation is one of the principles that permeates **RAIZ**, which is the reason why a teambuilding nature walk was organized and open to all **RAIZ** employees and relatives into one of the best preserved areas of Bocage of our country, Baixo Vouga Lagunar. **RAIZ** and **Quinta de S. Francisco** also welcomed more than 600 colleagues from Setúbal site, during the Industrial Challenges training program.

The development of partnerships with local schools continued as **RAIZ** offered dozens of trees and shrubs to the Agrupamento de Escolas de Eixo, during the International Day of Forests. Also during 2018, **Quinta de S. Francisco** hosted for the second time, a cross country running event, which brought together more than 400 students, teachers and other members from the local community.

* Creator and former owner of Quinta de S. Francisco

IMPACT EVALUATION

The impact of research, development and technology has a key importance in **RAIZ** strategy. As part of the implementation of the strategy in 2018, **RAIZ** developed and created its own model and tool, with a patent submitted. The assessment model includes:

- Project pre-assessment, to pre-assess merit and potential/ expected economic impact; should demonstrate the ability of the planned research program/consultancy and demo projects to achieve the desired high impacts with a final decision go/no go validated by Board Directors;

- Project evaluation, to evaluate merit and real economic impact; to validate deviations and obtain justifications;

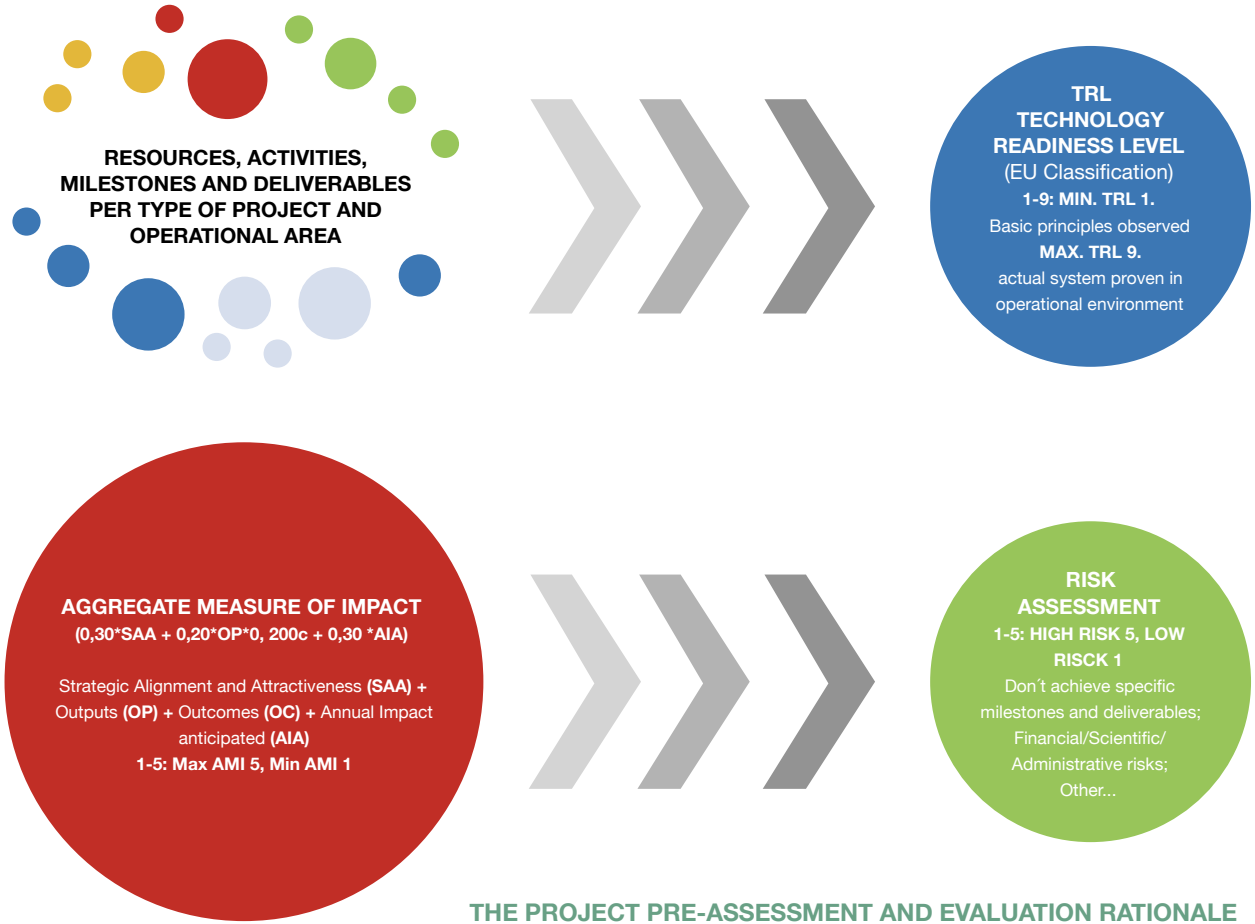
- Scorecard, to score the current performance and growth per indicator annually, KPI's to scoring and monitoring performance with a set of KPI's covering elements of the organization; easy to combine with results assessed by different innovative certifications.

- Impact Assessment activity, to evaluate activity long term impact, every 4-5 years.

RAIZ Impact Assessment is a MULTI-LEVEL, DYNAMIC, and ADAPTABLE methodology, using new metrics and indicators; a user-friendly tool to be applied to several Organisations.

RAIZ Impact Assessment is a tool to measure the value created by R&D able to capture economic and social value, also intangible assets, anticipating and measuring efficiency and effectiveness.

This tool was patented and tested with ongoing projects and activities at **RAIZ** on 2018 and will be fully implemented in 2019.



THE PROJECT PRE-ASSESSMENT AND EVALUATION RATIONALE

R&D INFRASTRUCTURE

NEW R&D AND SERVICES EQUIPMENTS

TISSUE LABORATORY

Tissue Testing of paper is indispensable for paper quality control and new paper evaluation. The equipment for characterization of Tissue paper (Tensile properties (dry and wet), Thickness, Water absorption capacity, TSA, Klemm) was acquired and installed at the new conditioned environment laboratory at **RAIZ**.

The new analytical equipment for biorefinery research within inpactus was installed at **RAIZ** laboratories at Creative Science Park, Aveiro.

LIQUID CHROMATOGRAPHY MASS SPECTROMETRY (LC-MS)

Liquid chromatography mass spectrometry (LC-MS) system is used to identify, characterize and quantify unknown and known compounds within complex matrices, including monomer structures of lignin, wood extractives and environmental compounds.

This system enable us to streamline our workflow and obtain more information from every run, from high throughput sample screening to discovering trace levels of unknowns.

HIGH PRESSURE LIQUID CHROMATOGRAPHY – HPLC

This Liquid Chromatography with several detectors provides flexibility to accomplish all applications from method development to routine analysis in biorefinery compounds, pulp and paper liquid samples and environmental samples.

GPC/SEC SYSTEM

This system provides **RAIZ** the possibility of obtaining an accurate molecular weight of the compounds under analysis. It comprises a newly developed Vial sampler, for higher unattended sample throughput. The Multicolumn Thermostat provides accurate temperature control to minimize detector noise and baseline drift. The electronically updated Isocratic Pump achieves extra flow precision and a new Refractive Index Detector provides precise results. This equipment is very useful to analyze the molecular weight distribution and the structural properties of lignin, as an important step to understand their behavior in wood pulps.

GAS CHROMATOGRAPHY

This system allows the laboratory to boost its productivity, as it tolerates the analysis of dirtier matrices like black liquors, with minimum cleanup, using the system's robust injector technology. It additionally makes possible to detect trace concentrations with smaller injection amounts and minimum pre concentration results, using enhanced detector sensitivity and micro-volume technology.

TISSUE LABORATORY

CREATIVE SCIENCE PARK (PCI)

At our R&D and Services Laboratory, Eixo, new equipments were installed, including:

IONIC CHROMATOGRAPHY SYSTEM

This equipment allows quantifying the majority of the anions in waters, wastewaters and process samples such white green and black liquor. The IC is also suitable to quantify sugar monomers existent in bark, wood, pulp and black liquors.

TOTAL ORGANIC CARBON ANALYZER

The equipment allows the quantification of organic carbon in samples such waters, wastewaters and process liquid samples. The measuring principle is based on the high temperature digestion of the sample in an air / O_2 stream at 850 °C. Totally bound carbon is converted into CO_2 which is quantitatively determined by a NDIR detector. An elemental macro analyser suitable for testing high sample weights is especially important when testing hetereogeneous samples, such as soil and plant material and wood.

ELEMENTAL MACRO ANALYSER

Suitable for testing high sample weights, particularly important when testing hetereogeneous samples, such as soil and plant material and wood.

SEM/EDS

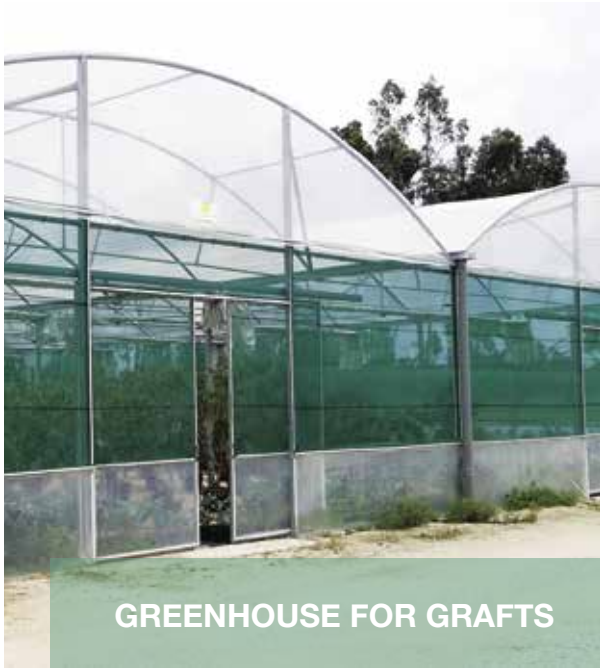
Tabletop Scanning Electron Microscopy (SEM) integrates easyness of use, optimized imaging, and high-image quality. SEM images show simple contrasts between organic-based and metallic-based materials instantly providing a great deal of information about the area being inspected. At the same time, Energy Dispersive X-Ray Spectroscopy (EDS), can be used to obtain semi-quantitative elemental results about very specific locations within the area of interest. For **RAIZ** this is an important technique for paper matrix analysis (fiber and fillers) and also for defects / impurities characterization.

CALORIMETER

This equipment is widely used for both routine and occasional calorific tests. It uses the time-tested Parr 1108 style oxygen bomb and oval bucket in a compact calorimeter, producing reliable results with good repeatability.

NEW CAPABILITIES IN GENOMIC STUDIES

RAIZ biotechnology lab is responsible for a number of genotyping services, namely in support of tag control in the clonal nursery, orchard's seed quality assessment and several other studies on gene diversity and gene flow. In 2018, **RAIZ** increased by 50% the capabilities of its lab, with the arrival of a new DNA fragment analyzer.



GREENHOUSE FOR GRAFTS

ORCHARD - MINI CUTTINGS

NATIONAL AND INTERNATIONAL COOPERATION

RAIZ works with Universities and several Research Institutes at national and international levels. Participation in networks and consortia allows our researchers and research fellows to exchange knowledge between teams and also access state of the art techniques and research methods.

PORTUGUESE INTERFACE CENTERS ANNUAL PUBLIC FINANCING PROGRAM

With the new challenges and opportunities for the coming years, **RAIZ** intends to strengthen and consolidate its structure, the efficiency and effectiveness of its activity, pursuing a strategic plan organized in 12 major technological and structuring innovation objectives, involving national and international cooperation.

The background of this strategic plan is the vision of the pulp and paper factory of the future - to gradually evolve towards a true forest-based biorefinery. So **RAIZ** applied for a multiannual financing and the project was approved with an incentive of 2.3 M€ for the next three years

WOODZYMES NEW PROJECT

WoodZymes - Extremozymes for wood based building blocks: From pulp mill to board and insulation products is the new BBI project which has started in 2018. This project is a H2020 Research & Innovation Action funded by the “Bio-Based Industries” Joint Undertaking (www.bbi-europe.eu), and coordinated by CIB Group of Biotechnology for Lignocellulosic Biomass. Both **RAIZ** and **The Navigator Company** are in the Consortium. The final aim is to establish at least one new bio-based value chain by validating one of the applications envisaged in the project: fibreboards, polyurethane products and paper products. To know more visit the website: **www.woodzymes.eu**.

WOODZYMES

National Projects	International Projects	FCT	Demonstration	Operational Groups	Base Funding
5	5	3	2	2	1

NEW FORESTRY PROJECTS

Six new external research projects, mostly in collaboration with key national Universities and other forest companies have been approved. They include:

- iPLANT - Identify new genetic materials tolerant to adverse climatic factors (frost and drought). Proof of Concept for innovative systems for cloning eucalypts;
- R3Forest - Using exotic biomass for post-fire recovery: Reuse, Regenerate and Reforest;
- Topdevil - Study how bats and bird species can affect the populations of the weevil, its parasitoid;
- WildGum II - Understanding the processes of E. globulus naturalization in Portugal;
- GO-FITOGLOBULUS - Solutions to control damage caused by Gonypterus;
- GO-IEPE Management tools to assist eucalyptus plantations, taking into consideration site conditions, type of operations and costs.

EXTERNAL RECOGNITION AND CERTIFICATION

RAIZ was recognized as an European Business Innovation Centre by European Business & Innovation Centres Network (EBN) during December 2018.

This is the only worldwide European Commission's certification of innovation recognizing organizations which implement innovation procedures, processes and good practices. The Business Innovation Center has certified about 150 companies in Europe, with five of them located in Portugal.

This certification places **RAIZ** at a level of excellence in entrepreneurship, innovation, technology and knowledge fields, becoming part of a core of worldwide elite organizations, recognized by the European Commission with the mission to increase regional and national innovation ecosystems in the field of forestry and bioeconomy.

RAIZ was recognized as an Interface Center in the subcategory of Valorization and Technology Transfer Center, by the Ministry of Economy, with publication in Diário da República, 2nd series - N. 227 - November 24, 2017.

The recognition of **RAIZ** as an Interface Center, through the INTERFACE Program, follows from the relevant role played by this Research Institute in transfering technology to Companies, including certification processes, quality improvement, efficiency improvements in production, support for innovation activities, access to technologies in development and training of human resources.

eubic certified by ebn

CIT Centro Interface

RAIZ Forest and Paper Research Institute

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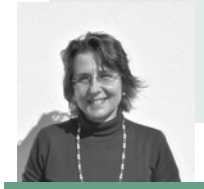

COMMUNICATION & STRATEGIC PROJ.
Cristina Marques

GENETIC & BIOTECHNOLOGY R&D
Nuno Borralho

SILVICULTURE R&D
Sérgio Fabres

FORESTRY CONSULTING
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ADMINISTRATIVE SUPPORT
Leonor Guedes

FIELD TECHNICAL SUPPORT
Cláudio Teixeira

SERVICES AND R&D LABORATORIES
Manuela Marques

PERSONNEL

The recruitment program was pursued aiming:
- To strengthen and consolidate the structure of permanent human resources, privileging hiring doctorates and masters degrees;
- To complete the framework of new competences of **RAIZ**, namely in the areas of new paper materials, process efficiency, tissue paper, industrial digitization, communication and dissemination of knowledge, and internationalization.

The advanced training through doctoral programs in partnership with **RAIZ** associated Universities, was reinforced, particularly with the new PhD program in Biorefineries and Bioproducts, jointly offered by the Universities of Aveiro and Coimbra.

HAPPY PEOPLE AT WORK, IS AN IMPORTANT ISSUE AT RAIZ!

WE TAKE IT SERIOUSLY!

PERMANTE STAFF

52

RESEARCH FELLOWS

41

PHD

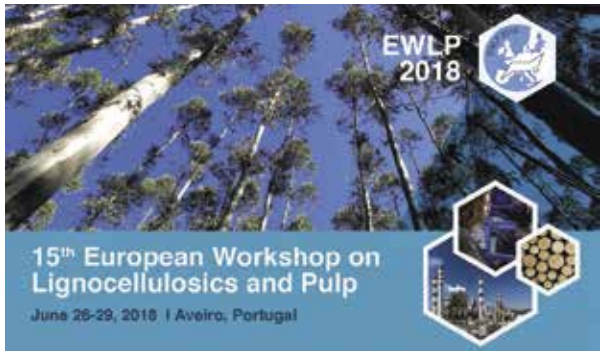
21

MSC

47

RAIZ
Forest and Paper Research Institute

SEMMINARS AND CONFERENCES



RAIZ joint-organized the **15th European Workshop on Lignocellulosics and Pulp (EWLP 2018)**, at Aveiro, Portugal, 20 years after the 5th EWLP, which was organized as well at this location..

The Conference, involving about 200 participants, occurs every two years, in a different European city, being a reference for researchers and students for the high standard presentations in the field of lignocellulosics and pulp.

RAIZ was also involved in organizing the **2018 NutriPLANTA Conference**, at Faculdade de Ciências, Universidade de Lisboa, under the main theme of "Innovating Plant Nutrition". The symposium established a forum to discuss the multiple aspects of plant nutrition and its consequences.

RAIZ held the **TECNICELPA SEMINAR** on the subject "Biorefinery in the Pulp and Paper Industry: new products and applications".

High standard presentations were made by **RAIZ** technicians regarding the biorefinery state of the art for the pulp-and-paper industry, detailing potential products, namely new cellulosic materials, lignin-based products, biofuels, and materials produced from pulp residues within a Circular Economy approach.

PUBLICATIONS & PATENTS

3 BOOKS AND BOOK CHAPTERS

6 OTHER PUBLICATIONS

3 PATENTS

4 PAPERS

36 CONFERENCES PROCEEDINGS

PATENTS 3 PUBLICATIONS 41

PUBLICATIONS HIGHLIGHTS

Catarina Gonçalves, RAIZ Forestry Researcher, won the Best Poster Presentation, titled "Monitoring and Control of a new Eucalyptus pest, the bronze bug, Thaumastocoris peregrinus", at the XXIV International Forest, Pulp and Paper Conference - TECNICELPA 2018, which took place in Aveiro on the 11th and 12th October. This event was attended by approximately 300 scientists, producers, technicians, and companies from various countries, from the forest, pulp, and paper areas.

CATARINA GONÇALVES

Paula Pinto and **Inês Mota**, Research and Technological Development coworkers at RAIZ are the co-authors of the book «An Integrated Approach for Added-Value Products from Lignocellulosic Biorefineries». This book has just been published internationally. It gathers 25 years of research developments and includes the work developed in two projects promoted by **The Navigator Company** and **RAIZ:** BioBlocks and Integrated Biorefinery in the Pulp and Paper Industry.

PAULA PINTO AND INÊS MOTA

Sara Monteiro, Science and Technology Manager/inpactus, launched the book "The Quadruple Innovation Helix Nexus: A Smart Growth Model, Quantitative Empirical Validation and Operationalization for OECD Countries" at Palgrave Macmillan (Nature). In co-authoring with 15 International Authors, this work introduces for the first time in the economic literature an "intelligent" mathematical model to represent the interaction of the four innovation helices (State, Industry, Academia and Civil Society) and their impact in economic growth in OECD countries. The book was endorsed by OECD, UNESCO, Chicago and George Washington Universities.

SARA MONTEIRO

FINANCIAL STATEMENTS

Amount in €	Note	2018	2017
ASSET			
Non-current assets			
Tangible fixed assets	7	1 599 342	1 338 895
Intangible assets		2 193	7 693
Other financial investments		4 706	217
		1 606 241	**1 346 804**
CURRENT ASSETS			
Costumers	10	846 051	1 896 012
State and other public entities	11	2 089	390
Other receivables	10	11 104 608	5 623 129
Cash and bank deposits	5	233 016	507 654
		12 185 764	8 027 185
TOTAL ASSETS		**13 792 005**	**9 373 989**
SHAREHOLDER'S EQUITY AND LIABILITIES			
Shareholder's equity			
Funds	12	7 000 000	7 000 000
Results carried forward		168 232	191 993
Other equity changes		95 882	(102 502)
		7 264 114	7 089 491
Net profits		**59 501**	**(22 796)**
TOTAL SHAREHOLDER'S EQUITY		**7 323 615**	**7 066 696**
Liabilities			
Non-current liabilities			
Responsibilities for post-employment benefits	14	97 534	-
Liabilities by deferred taxes	9	3 321	31 974
		100 855	**31 974**
Current liabilities			
Suppliers	14	133 830	409 438
State and other public entities	14	254 469	90 693
Other payables	14	560 143	965 289
Deferrals	14	5 419 092	809 900
		6 367 534	**2 275 320**
Total liabilities		**6 468 389**	**2 307 294**
Total shareholder's equity and liabilities		**13 792 005**	**9 373 990**

RAIZ
Forest and Paper Research Institute

FINANCIAL STATEMENTS

Amount in €	Note	2018	2017
Sales and rendered services	16	4 680 035	4 093 410
Operational subsidies	17	585 294	312 614
Supplies and external services	18	(1 918 668)	(2 704 337)
Staff costs	19	(3 350 680)	(1 595 955)
Other income	20	131 324	4 519
Other expensives	21	(23 630)	(34 040)
Income before depreciation, financing expenses and taxes		103 675	76 211
(Expenses) / reversals of depreciation and amortization	7	(151 758)	(85 543)
Trading income (before financing expenses and taxes)		(48 083)	(9 332)
Interest and similar income obtained	22	41 475	17 697
Similar interest and expenses incurred	22	(793)	(2 293)
Result before taxes		(7 401)	6 072
Income tax	9	66 902	(28 867)
Net profit		**66 902**	**(22 795)**

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RAIZ

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