2015 Activities Plan

CITAB

Compiled and edited by

CITAB's BOARD

This Activity Plan is in strict agreement with the 2015-2020 Strategic Programme

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1 Introduction

CITAB's mission is to create opportunities and technological development and reduce environmental impacts via better use of natural resources for stakeholders in Agri-food and Forestry chains. CITAB adopts a multi-disciplinary approach to produce research outputs of excellence and continues to strive to improve and promote integrated research initiatives both nationally and internationally. CITAB uses an international benchmarking criteria and undertakes ground-breaking national and international research.

After a previous consolidation of research strategies in previous years, internationalisation and improving critical mass this Activity Plan define the framework for the 1st year of the 2015-2020 Strategic Programme. This step, in general terms, aims to contribute to an increasing quality of research outputs in the agri-food and forestry sector needs and to reduce environmental impacts caused by these sectors via better use of natural resources and technological development a gradually and common request by private sector.

This 2015 Plan will focus into two thematic lines and five tasks previously defined in 2014 and presented in the Strategic Programme. These lines, designated by ***Sustainability of Agri-food and Forestry Ecosystems in a changing environment*** and ***Technology & innovation in Agri-food and Forestry chains*** meet CITAB's vision to provide scientific, technological and innovative knowledge based on multidisciplinarity and complementarity to meet stakeholder needs and challenges in agri-food and forestry value chains.

This Plan is the result of the exchange of opinions among the task members but arises as well from frequent interactions with stakeholders, after analysing their needs to better understand the principle problems/constraints they face. However, it gathers also the concerns from contacts with the national and international scientific community since CITAB defines a clear policy for promoting their activities and to exchange contributions with scientists in other Centres. We have to stress the role CITAB's newsletter and dedicated press officer and several workshops establish a close contact of CITAB's activities with the actual and potential international stakeholders and partners. The objective is to boost sector competitiveness and sustainability, contribute to the national economy, increase agricultural ecosystem efficiency, lead to more efficient and sustainable exploitation of natural resources and allow development of new integrated opportunities to improve the provision of ecosystem services.

Besides research, outreach activities are important as well in 2015 to ensure that CITAB researchers work together to divulge the centre's activities and capture the interest of potential young scientists in regional secondary schools. Besides the local community and state and private organizations are also a target of CITAB, to demonstrate that the research carried out in the Centre has application at different levels of the society, and has important impacts on the socio-economic life and in the environment. CITAB wants to prosecute the concept of "open laboratory" to high schools students (e.g."Ciência Viva" programme), and media attention, especially on "hot topics" such as climate change and greenhouse emissions, and its influence in agriculture, shortage and quality

of water, forest fires and biodiversity and sustainable management of agri-forest ecosystems.

2015 is a crucial year to apply for Horizon 2020 projects, and CITAB's Direction considered it a priority in both strands, promoting the development of consortia.

2 Major Objectives

The objectives for 2015 are close related with the implementation of the 2015-2020 Strategic Programme (SP). This Programme is focused in resolving societal and private sector (such as small and medium enterprises or SMEs) problems related with agriculture and forestry production chains and their impact on the natural environment. This will be done by balancing scientific excellence with benefits and consequences across multiple dimensions that embrace environmental science and socioeconomic needs. The SP will be based on a multidisciplinary approach that addresses both benchmark science and the human dimension of issues.

In SP the research is structured into two thematic strands (SP): i) Sustainability of Agri-food and Forestry Ecosystems in a changing environment and ii) Technology & innovation in Agri-food and Forestry chains for a more competitive bio economy. The first thematic area has two tasks a) Integrated monitoring of climate and environmental impacts: adaptation and mitigation strategies and b) Conservation strategies and ecological modelling: recovering and improving sustainability in Agri-food and Forestry ecosystems and ecosystem services. The second thematic area comprises three tasks a) Technological innovation and processes; b) Bio-based products and waste research and c) Towards valorization of agro-food co-products

The first thematic strand (TS) will address how impacts affect agri-food and forestry chains systems as well as the biodiversity and ecosystems they house to develop effective measures that contribute to sustainable strategy development, planning and decision making. The TS will bring together researchers in a multidisciplinary environment to develop tools and methodologies that assess how impacts from agriculture, forestry, climate change and land use change affect ecosystems and biodiversity by testing innovative monitoring techniques and developing spatially appropriate dynamic models to develop and implement regional adaptation & mitigation strategies and support decision making processes. Results will allow key stakeholders to develop optimal management strategies to guarantee sustainability and competitiveness in agri-food and forestry chains environments subject to change from various types of impacts. Findings will be fundamental to decision making and planning processes to develop regional strategies. The SP will increase regional valorization and competitiveness in agriculture and forestry production chains by reducing costs and risks, thereby simultaneously contributing to improved ecosystem sustainability and provision of ecosystem services by reducing impacts.

Based on a sound knowledge of regional, national and international top trends on agro-food industry stakeholder profiles and needs and regional agri-food, forestry and socioeconomic characteristics, the second TS will develop a sequential model to strengthen sector competitiveness by using innovation to improve the range of products on offer. This sequential model will focus on R&D innovative technologies and processes to valorise products and optimise processes in the recycling, reuse & recovery of raw materials in agri-food and forestry chains. Apart from boosting competitiveness via

innovative R&D, the second TS programme will provide positive feedback into the first TS by reducing impacts on the natural environment and natural resources in agri food and forest systems resulting from these sectors. The overall objective of this far reaching SP is to serve as a model for the development of sustainable yet competitive agri-food and forestry chains practises. However, R&D initiatives from each strand will have the potential to serve as pilot projects for agri-food and forestry chains and environmental issues where there is a need to boost competitiveness, empower stakeholders and SMEs, sustain livelihoods, promote responsible stewardship of the natural environment and the services it supplies and implement integrated management policies.

More specifically CITAB intends in 2015 to attain specific targets:

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- Continuation of the FCT funded International Doctoral Programme "Agrichains – from farm to fork"

- Submitting syllabi for new international doctoral programmes with national and international research centres, universities and stakeholders.

- Development of and participation in Horizon 2020 proposals in key areas that are compatible with the Thematic Strands of the 2015-2020 Strategic Programme.

- Development of planned, strategic outreach activities aimed to capture the interest of young scientists, media and to show the application of the research in various sectors of activity, with a priority on ecosystem services.

3 Activities

The presented TS and respective tasks arise from the SP 2015-2020, and their definition was based on the natural and rational identification of two research topics, taking into account national and regional needs to boost capacity and fill gaps in science. The TS were previous validated in 2014 by CITAB's Stakeholder Committee, the Scientific Advisory Committee, and Scientific Council.

Sustainability of Agri-food and Forestry Ecosystems in a changing environment

1. Integrated monitoring of climate and environmental impacts: adaptation and mitigation strategies;
2. Conservation strategies and ecological modelling: recovering and improving sustainability in Agri-food and Forestry ecosystems and ecosystem services.

Technology & innovation in Agri-food and Forestry chains for a more competitive bio economy

1. Technological innovation and processes;
2. Bio-based products and waste research;
3. Towards valorization of agro-food co-products

3.1. Sustainability of Agri-food and Forestry Ecosystems in a changing environment

The TS will address how impacts affect agri-food and forestry chains systems as well as biodiversity and ecosystems they house to develop effective measures that contribute to sustainable strategy development, planning and decision making.

Recent-past climate and environmental change, accompanied by the development of new analytical and modelling technologies, highlight the urgent need to meet societal challenges and create a new paradigm in planning and sustainable management strategies. Task 1.1 will develop integrated monitoring systems with stakeholders, based on climatic, environmental, biological and chemical elements, complemented with innovative engineering solutions, to develop cost-effective, environmentally sustainable and eco-innovative adaptation and mitigation measures. Task 1.1 will be highly interdisciplinary, using different field, laboratory and computational techniques using advanced analysis, scaling and modelling tools and testing novel potential indicators of environmental change. The 3 aims of task 1.1 are (i) to develop and apply new analytical technologies; (ii) to understand climatic and environmental forcing on target terrestrial and aquatic systems under current conditions; (iii) to assess climate and environmental change impacts under future scenarios in order to develop, test and implement appropriate mitigation and adaptation measures, such as restoring riparian galleries to mitigate CC impacts (e.g. temperature regulation, carbon sequestration, prevention of erosion, biodiversity) or cultivar re-planning to adapt to projected changes in bioclimatic conditions (e.g. zonation of important crops). Results will that guarantee sustainability

in AFFPC activities and their co-products and will contribute to maintain, or restore, quality in associated ecosystems, thereby contributing towards sustainability in the provision of natural resources and ecosystem services. Results from this task will bring important added-values not only to science and environment, but to key socio-economic sectors.

The TS addresses the complexity of this topic and the necessity for focused multidisciplinary research, in collaboration with stakeholders, to address the balance between a demand for a sustainable AFFPC and environmental change caused by anthropogenic intervention and their environmental impacts.

3.1.1. TASK 1.1 - Integrated monitoring of climate and environmental impacts: adaptation and mitigation strategies

In agreement with the strategic plan (Pest) of the CITAB we aim at developing innovative techniques for monitoring agro-forestry and environmental systems that may represent an important added-value for several socioeconomic sectors and for a wide range of shareholders. Through multidisciplinary interchange within and among tasks we also aim to achieve more integrated approaches. Furthermore, new datasets will be created and applied for this purpose. Our goal for 2015 is to bring all these new perspectives together so as to potentiate a better assessment of the likely impacts of a changing climate and environment on our target systems, also enabling the development of suitable, timely and cost-effective adaptation and mitigation measures. The present task can be subdivided into specific topics of research. Their main goals will be succinctly described in the following lines.

3.1.1.1. Dataset production

A collection, compilation, treatment (error identification/correction) and exploratory analysis of climate, agro-forestry and environmental datasets will be undertaken within this task. The accuracy and reliability of climate change assessments, analysis of agro-forestry and environmental systems, flood and drought modelling, water resources planning, determination of rainfall-runoff relationship and river flow estimation models are strongly dependent on the quality of the data used. However, several factors, such as the data collection method and the quality of the instruments/sensors, may significantly affect the homogeneity of the records. For this reason, data records will also be tested for their reliability and homogeneity prior to their use.

3.1.1.2. Climate variability and change

Climate variability, irregularity and, more prominently, climate and weather extremes will continue being an important area of research within the CITAB. This is mostly owing

to their strong socioeconomic implications on agro-forestry and environmental systems, as well as on their corresponding socioeconomic sectors. Driving mechanisms of climate variability and change in Portugal are far from being properly understood. Further research on this topic is essential not only to assess the reliability of the existing climate change projections over Portugal, but also to improve the consistency of the upcoming projections.

Besides the compilation and treatment of new instrumental datasets from different sources (e.g. weather stations and remote sensing), additional information will be retrieved from different proxies, namely from wood samples growing in Portugal. Tree rings have been used as a biological archive to study past environmental conditions. Although the tree-ring width is the anatomical variable traditionally used in dendrochronology, other anatomical features have been used to derive signals with a higher temporal resolution. Among these are the wood density components measured by x-ray microdensitometry, which allow us assessing not only the tree-ring width, but also the features of the wood cells. In fact, dendroclimatology plays a key role in the reconstruction of past climates, particularly useful when instrumental records are not available. Although the study of past climates in Portugal is still emergent, it is indeed critical for a better understanding of the climatic forcings in the country. Only an accurate representation of these forcings by the climate models will allow reliable climate change projections.

3.1.1.3. Climate vs. agriculture

Viticulture and oliviculture are two main lines of research at the CITAB/UTAD. These two crops play a key role in the national economy. Portugal is the 11th wine producer and the 10th wine exporter in the world. With a vineyard area of over 230 kha and a yearly wine production of about 6 Mhl, Portuguese wines are known worldwide. Approximately half of the total Portuguese wine production is exported, which represents nearly 2% of national exports income. Portugal also has one of the largest olive tree areas in the World (360 kha), producing 1 Mhl of olive oil every year. As such, these two crops have a high impact on local and national economies, including on the UNESCO word heritage Douro region, with direct links to the CITAB/UTAD. Nonetheless, other economically relevant crops will also be target in some specific aspects, such as chestnut-tree, almond-tree, cherry-tree and berries.

It is known that these crops are strongly influenced by atmospheric factors. Under the Portuguese typical Mediterranean conditions, the irregularity in yields is mostly attributed to inter-annual atmospheric variability. Despite being well adapted to the typical Mediterranean conditions, these crops have a high exposure to water and heat stresses, at least in some development stages. In fact, the typically warm-dry summers critically limits crop physiology, mainly due to summertime low water availability accompanied by heat stress. In addition, extreme weather events potentially occurring

throughout the year, such as hail and frost, can be quite damaging for crops in general. Given the strong climatic influence in these crops, climate change can further threaten the sustainability of the agricultural sector in Portugal. As such, one of the main objectives at CITAB/UTAD is to enhance the state-of-the-art understanding of the responses of the crops to climate, environmental stresses and water availability. The mechanisms underlying the physiological and agronomic processes will be an important object of research. The outcomes from these studies will deliver general guidelines to stakeholders.

We will use crop models for short-term prediction of crop parameters, as well as for long-term assessment of climate change impacts on crops. The CITAB team aims to calibrate and validate simulation models for predicting vineyard and olive orchard yields under the typical Portuguese growth conditions. In order to achieve a high model performance, sub-models to deal with the main biotic and abiotic hazards will also be included in the modelling solution. The model outputs will be used as a predictive tool for winegrape and olive oil production in Portugal, also as a management tool to improve the viticultural chain. In order to assess climate change impacts on these sectors over the next decades, crop models/sub-models will be driven by an ensemble of Earth model simulations of anthropogenic climate change (under CMIP5 and RCP-IPCC emission scenarios).

The modelling outputs will allow the timely implementation of adequate climate change adaptation measures and the development of mitigation strategies. Additionally, CITAB/UTAD researchers jointly work on developing and applying short-term adaptation measures, as the first protection strategy against climate change. These studies focus on:

- Irrigation strategies;
- Sunscreens for leaf protection;
- Soil tillage;
- Crop microclimate;
- Varietal and rootstock decisions;
- Mycorrhizal associations;
- Technological advances;
- Land use and allocation changes.

This research will foster resource-efficient economic growth and the safeguarding of agricultural jobs in this economically very important sector in Portugal.

3.1.1.4. Climate vs. aquatic and forestry systems

We will develop modelling and decision support skills for the management and planning of water resources at the river basin scale in Mediterranean ecological environments, for different scenarios of global change (e.g. climate, the land use land cover, conflicts).

The Portuguese rural fire database (PRFD) will be updated. The characterization of the fire regime will be complemented, in particular the relationship with environmental variables (weather, geographic, socio-economic, etc.) for various current and future scenarios of change, for the development of adaptation and mitigation strategies.

We also aim to overcome the limitations of single-level approaches to assess the diversity of human stressors in the aquatic ecosystems (acting at different scales) and the extraordinary complexity of ecosystems. Therefore, the investigation for 2015 will be based on the development and use of toxicity mechanisms (e.g. signaling pathways and gene networks implicated in toxic and adaptive responses) in aquatic animals, related to emerging compounds where there is little or no information on toxic effects. We want as well to go further in the research about ecological integrity in aquatic ecosystems based on the simultaneous use of several indicators at various levels of biological organization (molecular, biochemical, cellular, physiological, population and community level) including indicators of ecosystem function (decomposition), bringing together procedures that, up until now, have been developed and applied in isolation.

Concerning the research on the disturbance in aquatic ecosystems, it is intended to perform laboratory tests using model aquatic species to test effects of aquatic contaminants, including emerging compounds. Aiming to identify signalling pathways and gene networks implicated in toxic and adaptive responses; develop new biomarkers of effect and/or exposure and to apply them on biomonitoring programs. It is also intend to compile biological data at sub-individual levels (molecular, biochemical, cellular, physiological) using two aquatic communities, fish and invertebrates, to establish base line values at different pollution gradients, and identify potential variations due to climate and environmental impacts.

3.1.1.5. Climate vs. health co-benefits

Mitigation and adaptation of climate change has generated several policy documents with lifestyle recommendations, many of which present socio-economic challenges. However, there is current evidence and potential co-benefits of alternative practices, and environmental strategies that minimize the effects of climate change and improve health and well-being. In that context, important synergies for agricultural production, climate adaptation and mitigation, as well as other livelihood and environmental objectives, can be done by a climate-smart agricultural landscapes approach also in order to optimize health co-benefits. Therefore, it is necessary to measure and monitor the multiple health co-benefits of interventions designed to establish climate-smart agricultural landscapes.

3.1.2. Task 1.2. Conservation strategies and ecological modelling: recovering and improving sustainability in agri- food and forestry ecosystems and ecosystem services

Effective integrated management measures to recover and maintain sustainable AFFPC, ecosystems and natural resources must be based on sound science to provide information on how impacts from different sources and spatiotemporal levels drive both present day and future patterns of change. This is essential for informed decision making and planning. Anthropogenic activities across various levels of Agri-food and forestry production chains have direct and indirect impacts on biodiversity, ecosystems and ecosystem services. Effective integrated management measures to recover and maintain sustainable Agri-food and forestry production chains, ecosystems and natural resources must be based on sound scientific findings to provide information on how impacts from different sources and spatiotemporal levels drive both present day and future patterns of change. This is essential for both private and public sector stakeholders to make informed decisions. Task 1.2 uses a multidisciplinary R&D approach, linking data outputs from monitoring and characterization of systems to modelling methods. Model output will be used to develop accurate decision support tools for public and private sector stakeholder management and planning.

The tasks within this TS contribute towards guaranteeing sustainability in AFFPC, thereby maintaining sector competitiveness and ecosystem services that support this sector, society and the natural environment. The TS is based on expert holistic understanding and study of processes that do or will potentially affect systems and is highly multidisciplinary in order to fully capture the innate complexity of the interactions shaping systems, using established and innovative methods and technologies and develop models that provide stakeholders with information that allows them to plan and manage their needs accordingly.

For 2015 this task will address how impacts affect agri-food and forestry chains systems, biodiversity, ecosystems and ecosystem services and develop effective measures that contribute to sustainable strategy development, planning and decision making. The task will establish the interaction between the researchers belonging to the 2 tasks, through multidisciplinary participation to: a) develop tools and methodologies that assess how impacts from agriculture, forestry, climate change and land use change affect ecosystems and biodiversity; b) by testing innovative monitoring techniques and by developing dynamic spatially and temporally accurate mathematical models to develop and implement regional adaptation & mitigation strategies related to the disturbance of ecosystems (e.g. inland waters, increase of CO2 emissions, effects of energy consumption, soil loss and nutrient cycle disruption); c) to support decision making processes in order to maintain ecosystem services. All of these elements are also central to key strategic EU Horizon 2020 areas; TS research will closely follow these areas; e) To monitoring how natural and cultural marine and coastal environments provide

demonstrable and distinctive physical, mental and social health benefits to urban visitors. In agreement with the strategic plan (Pest) we want to overcome the limitations of single-level approaches to assess the diversity of human stressors in the aquatic ecosystems (acting at different scales) and the extraordinary complexity of ecosystems. Therefore the investigation for 2015 will be based on the development and use of toxicity mechanisms (e.g. signaling pathways and gene networks implicated in toxic and adaptive responses) in aquatic animals, related to emerging compounds where there is little or no information on toxic effects. We want as well to go further in the research about ecological integrity in aquatic ecosystems based on the simultaneous use of several indicators at various levels of biological organization (molecular, biochemical, cellular, physiological, population and community level) including indicators of ecosystem function (decomposition), bringing together procedures that, up until now, have been developed and applied in isolation.

Specific Objectives

This task is based on multiple processes and it will be developed different technologies to provide stakeholders with information that allows them to plan and manage their needs accordingly. Following in this task are examples of specific activities that will be carried out in 2015 that will contribute to maximize ecosystem services. Of course that CITAB members establish integration between these areas towards a further more holistic approach.

- Development, test and use of spatiotemporal dynamic predictive analytical and decision support tools for the management and planning of water resources at the river basin scale in Mediterranean ecological environments, for different scenarios of global change (e.g., climate, the land use land cover, conflicts).
- To quantify the response of large-fire activity to environmental and human drivers
- To quantify and model carbon emissions from wildfires
- To model tree regeneration from bioclimatic, site and fire history variables
- To assess fuel-treatment effectiveness under distinct spatial configurations
- Calibration, validation and use of rainfall-runoff models with embedded ecological tools;
- To establish a large-fire database, including environmental (weather, fuel, topography) and human-related variables (road network, population density, urbanization, fire suppression effort);
- Large-fire database analysis, e.g. using boosted regression trees;

- Establish and analyse a fire database with the associated fire weather conditions and estimated carbon emissions;
- Analysis of the tree regeneration database (sourced from the National Forest Inventory) using generalized linear models;
- Experimental lab-scale trials of fire spread under alternative fuel-treatment spatial patterns;
- Comparison of the experimental results with the predictions from fire-modelling tools.
- Identification of main groups of the flora and fauna that contribute for providing ecosystem services in "Douro Demarcated Region" vineyards. Development of habitat management strategies aimed at enhancing conservation biological control of insect pests of vineyards
- Contribute to a better understanding of the water cycle at basin scale and of the role of natural and human pressures for an environmentally sustainable use of the water resources as well as for support conservation and recovery strategies.
- Contribute to a better understanding of large-fire patterns and the relative role of its drivers;
- Development of a straightforward dynamic model to estimate fire-related carbon emissions;
- Advance the understanding of tree regeneration patterns in relation to environmental constraints.
- Contribute to a better understanding of the spatial patterns in fuel treatments that optimize fire spread disruption and lead to effective wildfire control;
- Restoration of the ecological functions of impacted systems, particularly under climate change scenarios which are likely to include extreme hydrological events (droughts and floods), leading to soil loss and nutrient leaching. In this field the research will be directed to various activities, but that must be integrated.
- Protection of banks to decrease fluvial erosion and habitat restoration (namely by applying soil engineering techniques): recover of riparian galleries, improvement and validation of environmental flows, control of exotic species (e.g. the bivalve *Corbicula fluminea*) and protection of endangered fish species.
- Contribute to the management of northern catchments in close cooperation with river board authorities.

- To identify MCES marine and coastal ecosystem services) that link the environmental contribution to health and social and economic well-being, and develop appropriate indicators. 2) To elaborate recommendations of best practices in the management of MCES that promotion of health and wellness.

3.2. Technology and innovation in Agro-food and Forestry chains for a more competitive bioeconomy

The TS is strictly linked to Research and Innovation Strategies for Smart Specialisation (RIS3) policy. It will develop new innovative approaches and uses to develop and apply updated processes and technologies to agro-forestry resources (crops and food products, biological materials and agri-food residues). The TS aims to give an economic added-value to the agri-forestry ecosystems, and agri-food and forestry products and co-products to boost regional and national economic growth. Since this TS will develop and apply updated processes and technologies to agro-forestry resources (crops and food products, biological materials and agri-food residues), looking also for an economic added-value to the agri-forestry ecosystems, and agri-food and forestry products and co-products, boosting regional and national economic growth. These objectives imply the direct involvement of sector stakeholders throughout the three vertically structured tasks based on multidisciplinary research with researchers from CITAB´s three groups (EI, BE, SAC).

3.2.1. Task 2.1 - Innovative technologies and processes

This task focuses on the economic growth, optimization and development of innovative technological inputs to assure more competitive agri-food and forestry production chains. Oriented by recent and updated EU agro-forestry policy, task 2.1 will develop innovative approaches and methods to stimulate the development of new production methods. The major objective will be to increment food and forestry crop productivity, reduce agricultural practice management costs and increase profit by developing technical studies at different but interconnected levels.

In agreement with the strategic plan (Pest) of the CITAB our goal for 2015 is to bring all these innovative and knowledge-intensive approaches for agriculture and forestry production and processing chains together have evolved to increase productivity ratio while ensuring sustainable resources use and alleviate stress on the environment.

The present task can be subdivided into specific topics of research.

(i) increase the productivity and yield of crops and forestry resources through physiological and best management tools

Identification of the patterns of wood density components and growth traits of softwood species (*Pinus sylvestris*, *Pinus pinaster* and *Pinus nigra*) through alternative methods to x-rays.

1. Developing new technique for measure the wood density profiles (softwoods) by the analysis of the RGB components of the wood image.
2. Computing the wood density components and growth traits by the RGB components analysis.

(ii) produce new technological applications, including management software prediction, spectral imaging applied to food crops and forestry in order to predict maturation stages, growth rates, harvest periods, water and cycle nutrients or fertilizers management, disease or plague occurrences, among others parameters

Developing methods to evaluate physical and anatomical wood properties regarding quality assessment and suitable uses.

1. Expedite method to evaluate the wood density (at annual ring level) for heartwood and sapwood, by image analysis.

2. Identification and quantification of the different hardwood tissues (fibers, vessels and parenchyma) by image analysis, based on the transverse dimensions of the cells.

Smart agriculture sensor based approaches for agro-forestry production.

1. Development and implementation of a remote and portable Geo-referenced (GPS) sensing station. The range of sensors to be installed is: Temperature, Radiation, Pressure, RH, UV (image based/sensor), CO2, Soil Moisture, Leaf wetness, Pest Accounting (image based).

2. Specification of a UV-Visible characterization portable equipment.

Evaluation of the grapes maturation profile based on the evolution of their oenological parameters over time.

1. Grape images and reference values database construction.

2. Development and testing of predictive models for oenological parameter estimation.

3. Model assessment for different varieties, growing conditions and harvest year.

4. Development of prototype for *in situ* testing.

Mechanical and fracture behaviour of bio-based materials and structures

1. Study of the influence of storage protocol over the in vitro mechanical properties of cortical bone.

2. Identification of elastic properties of cortical tissue of long bones through inverse methods, which combine experimental data (statically indeterminate tests) with optimization techniques. The experimental tests will be performed at the diaphysis scale, and will be instrumented with Bragg sensors embedded in optical fibres and with digital image correlation.

3. Experimental and analytical characterization of the effect of strain rate and temperature on the fracture behavior of wood in mode I and mode II.

4. Identification of cohesive laws for the fracture behavior of wood in mixed mode I / II, through the MMB test ("bending mixed-mode") and digital image correlation.

5. Development of identification methods of fracture constitutive laws of cortical bone, under mode I (DCB test), mode II (ENF test) and mixed-mode I/II (MMB test).

6. Development of characterization methods of the in situ mechanical and fracture properties of wood bonded joints by using digital image correlation and Bragg sensors in optical fiber.

7. Experimental identification and computational modeling of wood compression failure in the material symmetry directions, at the meso-mechanical and micromechanical scales.

8. Computer modeling (using the finite elements method) of the nonlinear behavior of doweled timber connections, based on the Hill criterion of plasticity.

9. Use of acoustic spectroscopy and mechanical spectroscopy for the identification of the viscoelastic behavior of wood.

(iii) identify key intervention points in resources to optimize production and thus identify potentially suitable species, varieties and rootstocks

Evaluation of the phytochemical and nutritional composition of agro-food products and co-products in close collaboration with key stakeholders. The plant materials evaluated will be addressed to identify the most promising extracts concerning biological activities in vitro. These materials will be further tested through dietary intervention trials towards the assessment of their capacity to modify pathophysiological biomarkers, therefore, retrieving information on their impact on the health status *in vivo*.

(iv) characterize vegetation and quality assessment to optimize physiological responses to climate conditions. Finding will show us how to produce with innovative methods, providing optimized solutions for current and future stakeholders by boosting

competitiveness and income. This will contribute to sustainable economic income for regional stakeholders which obviously extend findings to national level.

3.2.2. Task 2.2 - Bio-based products and waste research

This task will answer questions arising from Task 2.1 findings by studying the potential of agri-food and forestry residues (AFFR), native flora and aromatic and medicinal plants (AMP) to develop new products with high bio-based value. Researchers from BE and SAC will develop processes to create products with both biological and innovative industrial value. This task will study the use of AFFR for the production of materials with industrial applications such as transformation and structural characterization studies (BE) and physical and chemical property studies (BE and SAC).

The study of AFFR and AMP applications will be supported by the extraction, purification and isolation of highly bioactive compounds (SAC) using updated and case-to-case protocols to assess biochemical and biological activity and toxicologically and phytotherapeutically validate extracts, fractions or compounds. Findings will be used to produce and characterize extracts or compounds for the next set of experiments which will include assessment of potential as biopesticides to combat plant and crop pathogens in integrated production or biological agriculture (SAC and EI); evaluation of antibacterial activity; anti-aging, anti-inflammatory, anti-cancer, anti-ischemic and neuroprotective properties (SAC).

The final area of the task will determine the safety of extracts/fractions and validate their pharmacological/nutraceutical properties. The toxicological/pharmacological properties of extracts and fractions will be assessed using appropriate in vitro (biochemical and cellular) methods. The findings from this task will directly contribute to Task 2.3 research development.

3.2.3. Task 2.3 - Towards valorisation of agro-food co-products

This task focuses on the economic growth, optimization and development of innovative technological inputs to assure more competitive agri-food and forestry production chains. Oriented by recent and updated EU agro-forestry policy, task 2.1 will develop innovative approaches and methods to stimulate the development of new production methods. The major objective will be to increment food and forestry crop productivity, reduce agricultural practice management costs and increase profit by developing technical studies at different but interconnected levels (BE, SAC).

For 2015 the main research will look for an Evaluation of the phytochemical and nutritional composition of agro-food products and co-products in close collaboration with key stakeholders. The plant materials evaluated will be addressed to identify the most promising extracts concerning biological activities in vitro. These materials will be further tested through dietary intervention trials towards the assessment of their

capacity to modify pathophysiological biomarkers, therefore, retrieving information on their impact on the health status in vivo.

Specific objectives

This task includes an integrated and multidisciplinary approach to Quality and Innovation in the food sector with intervention on different strategic points of the food production sector, with particular emphasis to consumer's perception of quality.

The research goals of this project line have a particular emphasis on the northeastern food sectors, as these are the main industrial/producers with which the research groups involved in this project collaborate actively and have joint research and innovation projects. Specific actions arise from the project (INNOVFOOD - INNOVation in the FOOD sector through the valorization of food and agro-food by-products). Following are discriminated actions concerning to this task and this project:

- Spectrophotometric determination of the phenolic contents, namely total phenols, flavonoids, ortho-diphenols, and anthocyanins;
- Spectrophotometric determination of the antioxidant activity through distinct methodologies (ABTS, DPPH, e FRAP);
- Profiling of phytochemical contents in distinct matrices by HPLC-DAD-MSn;
- Quantification of content in bioactive compounds by HPLC-DAD;
- Isolation of phytochemical compounds by preparative-HPLC;
- Application of vibrational spectroscopy to the study of valuable matrices, and development of prediction models resorting to this methodology.
- Identification of valuable agro-food products and co-products representing potentially valuable source of bioactive phytochemicals and nutrients;
- Obtaining of hydro-alcoholic rich extracts, concerning bioactive compounds, isolation of valuable phytochemicals, and evaluation of their biological activity in vitro;
- Application of the isolated compounds toward the development of added-value commodities;
- Assessment of the biological effects of natural and purified products by metabolomic approaches;
- Toxicity and pharmacokinetic evaluation and modulation will be performed in order to present validated and consolidated data to stakeholders, other key researchers and competent authorities for approval and recognition of co-products;

3 Dissemination & Image

CITAB will continue to promote its Cycle of Conferences on transversal themes under development within CITAB's areas of expertise. Target audiences will include the academic community, actual and potential key stakeholders and the private sector. Contributions and keynote talks will be given by CITAB and consortium members and invited experts.

CITAB will increase the outreach activities for secondary schools through a yearly program of talks aimed to promote science and research activities, and to engage the students in the Unit activities as early as possible in their academic studies. The objective is also to project the Center at a national and international level in order to gather more fellowships for research activities, which is a priority for both strands.

The most crucial event is the organization of the 10th Iberian and 7th Iberoamerican Conference on Environmental Contamination and Toxicology - CICTA. This event conferences, using the motto Environmental Sustainability, looks for Insights to the future of research of ecotoxicology and environmental contamination. It will highlight top scientific approaches, encouraging the debate on issues related to pollution and environmental toxicology within an Iberoamerican context. It will also project the investigation carried out in CITAB.

We must refer also I the outreach activities, such as the production of a movie related to the conservation of coastal lagoons. Other outreach activities will comprise Dia Aberto da UTAD, Ciência Viva and Biodiversidade and seminars promoted by local/regional entities.

Besides, CITAB members will be involved in several activities to spread the results obtained in the Centre:

- Participation in national FELASA (Federation of Laboratory Animal Science Associations) B and C training program;
- Participation in International Laboratory Animal Science congresses
- Participation in the European meeting of pathology
- Invited Conference in the 'Phytochemical Society of Europe' Congress (Murcia, Spain);
- Dissemination article in the magazine 'Grain legumes';
- Workshop of the project INNOFOOD.
- 10th Iberian and 7th Iberoamerican Conference on Environmental Contamination and Toxicology - CICTA
- 8th International Symposium on Irrigation of Horticultural Crops

- Agriculture and Climate Change: adapting crops to increased uncertainty
- European Geosciences Union, General Assembly 2015
- European Meteorological Society, General Assembly 2015
- Physical activity and exposure to nature: mutual benefits and threats for greater gain in health promotion.
- Techniques in bioproductivity and photosynthesis under field conditions
- Understanding the Connections between Nature and Ecosystem Services and Human Health

CITAB will consolidate its communication office, which is responsible for the divulgation of the Unit and its researchers' activities on different levels and for different target audiences, from the general public, partners and institutions to stakeholders and industry. CITAB is expecting an increasing level of awareness for CITAB activities and its impact on society, reaching more and more different sectors of the scientific community, students and the population.

4 Cooperation

4.1 Internal

CITAB continues to promote internal cooperation with ExCo members meeting and encouraging dialogue with CITAB researchers who make suggestions on actual and potential activities which are transmitted to the Board. This dialogue helps to define adequate policies for the center.

Regular meetings (4 times a year) between working group coordinators and ExCo members are meeting on a monthly basis to discuss, organize and implement research, outreach and dissemination activities, solve problems and promote integration.

The development and teaching of advanced courses and the international Doctoral Program AGRI-CHAINS will promote greater internal cohesion as CITAB members work together to develop syllabi based on areas with high levels of expertise and critical mass.

4.2 National

CITAB continues to aim for increasing cooperation with national research centres via joint applications for funding, MSc and PhD thesis supervision, and FCT sponsored projects have been a good occasion to establish contacts with other organizations.

4.3 International

CITAB will expand cooperative research work initiatives, through funding initiatives such as the Horizon 2020 programme. At the international level these projects are also a good possibility to establish contacts with other international research centres. Since in 2015 members of both strands are involved in three applications, the links established will create in the future the conditions for a more intense cooperation in the European context.

CITAB researchers will continue to actively participate in international conferences, management, scientific meetings and technical visits develop contact with important foreign researchers and acquire expertise through visits to foreign (mobility).

4.4 Anchor Institutes

Biosystems Engineering
Cooperative Wine Institute (ICV), France
Dept of Biokinetics, Sport and Leisure Sciences, University of Pretoria, Pretoria, South Africa
Institut de Mécanique et d'Ingénierie de Bordeaux, France
Instituto de Ciencias de la Vid y del Vino, Spain
Istituto Dalle Molle di Studi sull'Intelligenza Artificiale University of Manno, Switzerland (IDSIA)
Polytechnic University of Madrid (UPM), Spain
SOING, Italy
INRA, Orleans (Unité Amélioration Génétique et Physiologie Forestières)

Universidad Complutense de Madrid, Spain
INSA de Lyon, LaMCos, France
University of Southampton , UK
École Nationale Supérieure des Mines de Saint Étienne, France
Technical University of Munich, Germany
Universidad de La Rioja, Spain
University of Exeter – United Kingdom
University of Navarra (UPNA), Spain
Symington Estates
UAVision
Ecointegrity
Botany Department, U.of Salamanca, Spain
Center for Genome Regulation, U. de Chile, Chile
Center for Macroecology, Evolution and Climate Department of Biology, U. of Copenhagen, Denmark
Centro Ibérico de Restauração Fluvial (CIREF), Spain.
Department of Biology and Botanical Garden, Fribourg, Switzerland
Euskal Herrido Unibertsitatea U.del Pais Vasco, Bilbao, Spain
Institute of Ecosystem Study, National Research Council, Verbania Pallanz, Italy
Lehrstuhl für Aquatische Systembiologie, Technische Universität München, Germany
Universidad Complutense de Madrid, Spain
Universidade de Castilla la Mancha, Toledo, Spain
Universidade Estadual de Paraíba, (UEPB), Brasil
Universidade Federal de Minas Gerais (UFMG), Brasil
University of Dronten, ALMERE Holland
University of Santiago de Compostela, Spain
University of Wageningen, Holland
Sustainable Agro-food Chains
Biotechnical Faculty of University of Slovenia
Indian Institute of Technology, India
Institute for Geophysics and Meteorology, Uf Cologne, Germany
ISVV, Bordeaux, France
Laboratory of Plant Raw Materials Processing and Agricultural Storage, U of Szczecin, Poland
University of California, Davis, USA
University of Copenhagen, Denmark
University of Crete, Greece
University of Reading, United Kingdom
University of Verona, Italy
University of Santiago de Compostela, Spain.
University of Salamanca, Spain
Technische Universität Dresden, Germany
Department of Plant Sciences, University of California, USA
UMR Ecophysiologie et Génomique Fonctionnelle de la Vigne, UBordeaux - France
CENTRO DE INVESTIGACIÓN FORESTAL, SPAIN
Centre for Forestry and Climate Change, UK

Department of Applied Physics, U of Santiago de Compostela, Spain
INRA - Centre de Bordeaux / UMR TCEM, France
Escuela Politécnica Superior, Soil Science and Agricultural Chemistry, U Santiago de Compostela, Spain
Institute for Crop and Soil Science, Federal Research Centre for Cultivated Crops, Germany

4.5 Stakeholders

Biosystems Engineering

Stakeholders listed for BE 2014 research activities include Iberia HealthCare Systems, Instituto de Ciencias de la Vid y del Vino (Spain), Symington Estates, UAVision, Instituto dos Vinhos do Douro e do Porto, I P (IVDP, IP), Grupo Avanza and the Douro Alliance.

Ecointegrity

For 2015 the company of electricity EDP established already an intense program at the environmental level with CITAB members involved in monitoring and rehabilitation of aquatic and terrestrial ecosystems. Besides, EI researcher have strong ties with key public stakeholders such as CCDR – Norte, LABELEC - Energias de Portugal (EDP group), the National Forest Authority (AFN), the National Civil Protection Authority, the Agência Portuguesa do Ambiente (APA) and North Region Water Authority, Vila Real Municipal Council, Mira Municipal Council, Figueira da Foz Municipal Council. Associação para o Desenvolvimento da Viticultura Duriense (ADVID), Associação de Agricultores para Produção Integrada de Frutos de Montanha (AAPIM).

Private stakeholders include Águas do Algarve S.A., forestry industry end users (Grupo Portucel, Soporcel), SME's (Gestão Integrada de Fogos Florestais, S.A,) and organizations dealing with environmental impact assessment and ecosystem rehabilitation and renewable energy sources (PROFICO Ambiente, Prosistemas, Ecosfera, Energia Verde and Energiekontor – Parques Eólicos Unipessoal, Lda). Sogevinus Quintas S.A, Companhia Geral da Agricultura das Vinhas do Alto Douro, S.A. (Real Companhia Velha).

Sustainable Agro-food Chains

Research activities within this group will continue via close cooperation with stakeholders from different sectors of the agro-food industry. Links with stakeholders include joint participation in projects, transfer of know-how transfer, dissemination of results, development of new products and developing technological solutions.

Listed stakeholders for 2014 are: The "Amândio Galhano" Viniculture Station (EVAG) of the Comissão de Viticultura da Região dos Vinhos Verdes (CVRVV), Associação para o Desenvolvimento da Viticultura Duriense (ADVID), Associação dos Olivicultores de Trás-os-Montes e Alto Douro (AOTAD), BioBaga – Estarreja, Mirtilusa - Sociedade de Produtores Horto-Frutícolas - Sever do Vouga, Regiefrutas, Sogrape, Unidade de Investigação e Desenvolvimento - Departamento de Alimentação e Nutrição - Instituto Nacional de Saúde Doutor Ricardo Jorge, Frulact- Gemunde, Maia – Portugal, NEIKER-Tecnalia Centro de Derio, Queijos Lagos e Sabores e Ambientes Serra da Estrela, Associação Nacional de Criadores de Ovinos da Serra da Estrela (ANCOSE).

5 Human resources

CITAB will maintain the number of MSc, PhD and postdoctoral students carrying out their studies at the Centre. We continue to actively encourage foreign students and researchers, in particular from Brazil, China and India, to carry out their studies at the centre.

6 Summary of metrics of scientific production for 2015

Expected scientific production for 2015:

Item	2015
Books	15
ISI Publications	108
Publications in national journals	30
Oral communications in international conferences	150
Oral communications in national conferences	60
Reports	70
Organisation of seminars and conferences	6
Doctoral theses	3
Masters theses	10
Patents	2

7 Budget

Item	%	2015
Human Resources		
Missions		
Consultants		
Aquisition of Goods & Services		
Patents registration		
Adaptation of buildings and facilities		
Overheads		
Equipament		
Total		

CITAB