

ACTIVITY PLAN 2024



*Planned Activities projected under the ongoing
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CITAB's Scientific Council on 20 December 2023*



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PRODUCTIVITY METRICS*Expected scientific production for 2024:*

<i>ITEM</i>	<i>2024</i>
<i>Publications</i>	
<i>SCOPUS Publications</i>	250
<i>Technical Publications</i>	10
<i>Books/Book Chapters</i>	5
<i>Communications</i>	
<i>Communications at international conferences</i>	200
<i>Communications at national conferences</i>	100
<i>Organization of events</i>	10
<i>Training</i>	
<i>Advanced training</i>	10
<i>Doctoral thesis</i>	15
<i>Master thesis</i>	40
<i>Patents</i>	1

RESEARCH ACTIVITIES

Thematic Strand 1- Sustainability of Agri-Food and Forestry Ecosystems in a Changing Environment

Thematic Strand 1 aims to develop novel frameworks to understand, estimate, and mitigate possible drawbacks in agroecosystems impacted by both local and global environmental changes. Specifically, it will focus on socio-ecological challenges, involving the development of value-added tools for fundamental and applied environmental research (Task 1.1) in the scope for harmonising production with the sustainability development goals (Task 1.2).

Task 1.1 - Integrated monitoring of climate and environmental impacts: adaptation and mitigation strategies

In Task 1.1, the interdisciplinary approach to studying ecosystems uses complementary techniques (such as fieldwork, laboratory experiments, computational analysis, advanced tools, and modelling) to understand the impact of climate and environmental factors on ecosystems. Specifically, land use change and future climate change scenarios are applied to envision suitable measures for mitigation and adaptation. Overall, Task 1.1 aims to enhance our understanding of production agroecosystems and develop strategies for its sustainable management. In brief, Task 1.1 aims to achieve the following sub-tasks:

Climate Change and Agroclimatic Modelling:

- Enhance climate change projections by utilizing CMIP6 and other emerging datasets at global, European-wide, and regional scales.
- Develop new or composite agroclimatic indices that are validated with weather station data and state-of-the-art remote sensing tools. These indices will increase accuracy in evaluations of drought exposure, vulnerability, and risks in specific regions, as well as evaluate plant water stress and optimize crop irrigation under different climate change projections.
- Assess the available water resources in target regions and evaluate their long-term sustainability under climate change projections. This will involve coupling hydrological modelling with climate and crop modelling, ultimately leading to more informed decisions in different agrarian value chains.
- Investigate the impact of meso and microclimatic conditions on water dynamics and survival strategies of grapevines using plant-based measurement techniques.
- Conduct innovative meso- and micro-climatic characterization of wine regions and their vineyards (pre-selected living labs) through a cascade of climate model simulations,

under current and future climates, to support decision-making for climate change adaptation and risk reduction in Portuguese and European viticulture.

- Collaborate with the Portuguese Weather Service to research the atmospheric mechanisms driving sub-hourly heavy precipitation events, including hailfall. This research aims to improve the weather forecast performance for these events, reducing the potential risks they pose to crops.
- Develop crop modelling applications to forecast agronomic parameters based on environmental factors, including medium-range and seasonal forecasts.
- Collaborate with the Portuguese Weather Service to model and forecast ozone concentration and its potential implications on crops.
- Apply new methodologies, such as downscaling and bias correction approaches, or Machine Learning approaches, to provide stakeholders and decision-makers with more accurate climate projections and enhanced uncertainty assessment.

Water Management and Ecosystem Services:

- Assess the ecosystem services provided by natural environments and their importance for sustainable development. Additionally, we aim to explore the concept of “payment for environmental services” as a means to foster the conservation of water resources.
- Develop hydrologic and hydrodynamic models to understand the water flow processes in aquatic ecosystems.
- Assess the impact of wildfires in afforested catchments on aquatic ecosystems, and develop strategies for soil loss control and ecosystem restoration.
- Investigate the consequences of land use and land cover change scenarios in catchments on water resources.
- Develop spatiotemporal river models to better understand the dynamics and behaviour of river systems.
- Implement river restoration plans designed to enhance the ecological health of rivers and their associated ecosystems.
- Develop an integrative landscape management approach, based on Nature-based Solutions (NbS) principles, to support biodiversity conservation, ensuring critical ecosystem services (ES) and sustainable development for the Atlantic and Mediterranean regions. This innovative participatory approach embraces the inherent value of nature and promotes the use of NbS as a cornerstone for achieving conservation goals and fostering sustainable development in urban and rural areas.
- Deepen the study of multi-resistant bacteria in aquatic systems through an eco-health approach focused on a holistic understanding of environmental and public health interactions.
- Assess the potential consequences of tailing dam breaks on water resources and develop mitigation strategies.
- Evaluate the vulnerability of groundwater to pollution and develop measures to protect its quality.
- Explore land use and land cover change scenarios in catchments and their consequences on water resources.

- Study spatiotemporal river modelling, tailing dam break, vulnerability of groundwater to pollution, and water quality predictions in river basins.

Ecotoxicological Studies:

- Implement experimental protocols to investigate the biological effects of pesticides, microplastics, other environmental contaminants and natural products in different organisms.
- Toxicological studies will be conducted on animal models and animals of zootechnical interest to minimize management costs.

Climate-Smart Agricultural Practices:

- Follow up the agroecosystem monitorization to gather data aiming to understand the impact of climate on agrobiodiversity (e.g. agroecosystem, cultures, functional biodiversity).
- Implement and evaluate climate-smart agricultural practices as an adaptation strategy to climate change. This may include crop diversification, living covers, agroecological strategies, and smart irrigation to improve water management and use.
- Conduct crop phenotyping to select and use local or drought-resistant varieties as strategies for adapting crops to climate constraints.
- Monitor field trials and crop development using thermal and multispectral images. This will involve developing prediction models and assessing the impact of climate conditions and management practices on crop development and agroecosystem productivity.
- Continuously monitor agroecosystems to gather data on the impact of climate on agrobiodiversity, agroecosystems, cultures, and functional biodiversity.

Genetic Diversity, Selection and Adaptation:

- Conduct molecular characterization of Portuguese wheat and rye landraces to obtain a comprehensive understanding of their genetic diversity, population structure, and potential traits of interest. This study aims to contribute to the conservation and breeding of locally adapted wheat and rye varieties.
- Exploit varietal diversity and molecular approaches for grapevine adaptation to climate change.

Vineyard and Fruit Crop Resilience and Adaptation:

- Evaluate the effect of deficit irrigation and water stress management on the physiological and agronomic performance of vineyards and olive trees.
- Identify and define specific physiological adaptation responses and biochemical markers that correlate with increased tolerance to climate stressors, such as temperature

fluctuations, and drought, namely applied to the identification of *Vitis vinifera* varieties with enhanced resilience to climate change.

- Design pre-harvest strategies that can increase the profitability and sustainability of grapevine and fruit crop yields using novel environmentally sustainable products, such as new biofungicides or biostimulants compared to market options.
- Study the effect of different substances, such as macroalgae extracts, on the molecular mechanisms involved in cherry cracking. This research aims to explore the relationship between cracking fruit, the expression patterns of genes related to cell wall modification, and the biosynthesis of cuticular waxes.
- Implement an operational toolbox of sustainable agroecological practices tailored to local vineyards' specificities. This aims to the resilience of Mediterranean vineyards to climate change and diseases, reduce the use of agrochemicals, and boost local circular agriculture.

Industrial Hemp and Crop Performance:

- Compare the performance of industrial hemp varieties and other crops utilized for natural fibre production to understand how they can withstand and adapt to the challenges imposed by climate change.

Task 1.2 – Sustainability in agri-food and forestry ecosystems

Task 1.2 encompasses multivariate analysis and modelling to tackle the impacts of habitat and land use change on terrestrial and aquatic environments, as well as on ecosystem services. Research will focus on techniques/methods for biological conservation, pest control and biodiversity enhancement. Recent methods (e.g. novel hyperspectral image, computational intelligence techniques, and decision spatial support systems) will be developed and implemented to increase efficiency and system resilience. This will also facilitate the engagement of stakeholders to protect and enhance ecosystem services (water and soil quality, soil biodiversity, and regulation of temperature). Spatiotemporal dynamic predictions will be used to understand how natural (e.g. seasonality, precipitation, and energy flow) and/or anthropogenic (e.g. fertilizer application in agricultural systems, discharge of effluents, and changes in crop type) changes affect ecosystem integrity. In summary, Task 1.2 aims to contribute with the following sub-tasks:

Crop Protection and Assessment:

- Physiological and biochemical analysis of red and white wine grapes grown under Mediterranean climate.
- Impact assessment of new grapevine protection formulations on leaves metagenomic profiles.

- Molecular assessment of cowpea (*Vigna unguiculata* L.) and other *Vigna* species diversity for screening water deficit and salt stress resilient genotypes.
- Development and implementation of methodologies for root growth evaluation in cowpeas.
- Ongoing studies combining Cytogenetics, Molecular Genetics, and/or *in vitro* culture to evaluate toxicity caused by exposure to synthetic herbicides and the abiotic stress response in cereals, grapevine, or pine species of high economic value to Portugal.
- Deepen the characterization of intra-varietal genetic diversity in chestnuts.

Agroecology and Sustainable Farming:

- Development and evaluation of biofertilizer formulations or biostimulants in crop protection and productivity, reducing the depletion of natural resources.
- Development of crop management agroecological strategies for sustainable, fair, and safe weed management in vineyards and custard apple orchards under different farming methods.
- Evaluation of the impact of biofertilizer and management agroecological strategies on soil microbial biodiversity and functional groups.
- Developing crop ecophysiology and phenological studies using advanced phenotyping tools, and employing soil and plant-based sensors (remote sensing) to assess agri-food systems sustainability and the impact of different management strategies.
- Identify chemical profiles of honey from different Portuguese regions.

Fire Prevention and Ecosystem Restoration:

- Evaluate fire weather indices for fuel moisture content.
- Establish relationships between fire weather and fire behaviour for improved fire danger rating in the Mediterranean basin.
- Participation in the Interreg REFLORESTA Project focusing on technological and social innovation for fire prevention and ecosystem recovery.
- Involvement in activities related to the impact of fires on aquatic ecosystems, soil vulnerability, reforestation, and ecosystem restoration.
- Assessment of the effect of pre-fire management on post-fire forest resilience.

Complex System Modelling and Biodiversity Management:

- Development of bottom-based approaches to tackle the impact of new pests and manage endangered populations.
- Understanding the importance of crop management and intercropping strategies for promoting biodiversity.
- Incidence studies of *Gnomoniopsis smithogilvyi*, the causal agent of brown rot in chestnuts, using cultural and molecular approaches.

- Screening of potential antagonistic against phytopathogenic fungi from chestnut (*Castanea sativa*) tissues and selection and characterization of the best isolates.
- Increasing knowledge of pollinator communities in natural and semi-natural communities.
- Research on the impacts of invasive species on biodiversity and linking regular monitoring schemes with ecological science.

Morphoclimatic and Chemical Analysis of Macrophytes:

- Analyse morphological, thermopluviometric, and chemical variables associated with tracheophytes and algae.
- Describe the territorialisation process and potential migrations of plants.

Applied Ecology & Territorial Sustainability:

- Founding a research team in Applied Ecology and Territorial Sustainability with a focus on Ecosystem Services. Establishing the LEAST laboratory will contribute to addressing gaps in understanding Ecosystem Services valuation, emphasizing economic and social valuation in scenarios of global change.

Thematic Strand 2 -Technology in Agro-food and Forestry chains for a more competitive bioeconomy

Aligned with RIS3 policy, this Thematic Strand explores innovative approaches to develop and update processes and technologies for crop and food products, biological materials, and agri-food residues. The Thematic Strand 2 aims to provide added value to agri-forestry ecosystems, agri-food and forestry products and co-products, boosting regional and national economic growth. This Strand actively engages sector stakeholders in two vertically structured tasks that apply multidisciplinary research.

Task 2.1 – Innovative technologies and processes

Task 2.1 focuses on a major unit objective - optimization and development of innovative technology for more competitive agri-food and forestry production chains. This task optimizes solutions for current and future stakeholders, enhancing competitiveness and income through improved productivity of food and forestry crops, decreased management costs and increased profits. To meet these objectives this task research will focus on (i) the development of physiological and best management tools; (ii) the production of novel technological applications, including predictive management software and spectral imaging applied to crop and forestry parameters (e.g. maturation stages, growth rates, harvest periods, water and cycle nutrients, fertilizer management, and pests and diseases); (iii) identification of key intervention points to optimize production and identify suitable species, varieties, and rootstocks; and (iv) characterization of vegetation and quality to optimize physiological responses to climate conditions. This will contribute to sustainable economic income for regional stakeholders, but findings extend to the national level. Therefore, Task 2.1 aims to achieve the following specific research topics:

- Establishment of an imaging acquisition system for root architecture characterization using cowpea as crop model.
- The combination of innovative Plant Cytogenetics, in vitro culture, Molecular Genetics and/or biochemical analyses will be used to evaluate the: (i) impact of less harmful synthetic commercial herbicides in the cell division and vegetative growth of grapevine; and (ii) the genetic variability and quality of wheat flour quality of old Portuguese landraces.
- Understanding vine response through the development of rationale adaptation strategies, specifically using leaf protector/biofertilizer agents on grapevines growing

under water stress, strong light and high temperature. Assessment of soil management practices to increase water use efficiency and water conservation in Mediterranean vineyards.

- Effective dimensionality reduction methodologies for hyperspectral images of grapes in non-invasive determination of oenological parameters.
- Apply methodologies of deep learning for non-invasive determination of oenological parameters based on hyperspectral images of grapes.
- Identify almond cultivars using machine learning classifiers applied to UAV-based multispectral data.
- High-resolution multispectral data acquired from an unmanned aerial vehicle (UAV) is used to estimate vegetation indices (VIs) and tree structure parameters to obtain cultivar identification using machine learning classifiers.
- Decision support systems for smart irrigation based on thermal images and ground sensors.
- Development of new resin extraction processes with the incorporation of new technologies and methodologies to make the activity more profitable, environmentally friendly and attractive to young people.

Task 2.2 - Valorisation of bio-based products and co-products

Task 2.2 studies the potential of agri-food and forestry residues (AFFR), native flora and aromatic and medicinal plants (AMP) to develop new high bio-based value products. This task will develop processes to create products with biological and innovative industrial value. AFFR and AMP application studies will be supported by the extraction, purification and isolation of highly bioactive compounds using updated and case-to-case protocols to assess biochemical and biological activity, and toxicological and phytotherapeutic properties will be evaluated. Finally, the safety of extracts/fractions and validated pharmacological/nutraceutical properties will be assessed. More specifically, Task 2.2 aims to achieve the following specific research topics:

- Develop strategies for recycling and valorising agri-food residues.
- Assess nutraceutical, therapeutical, and toxicological properties of bio-based products throughout *in vitro* and *in vivo* models.
- Development of a set of experimental protocols to investigate the effects of plant bioactive compounds in diverse model organisms, providing insights into the dynamics of physiological, biochemical and behavioural responses.

- Chemical, bioactive and/or nutritional characterization of rockrose (*Cistus ladanifer* L.) products to enhance rockrose production and management.
- Prospect the health benefits of several endemic *Thymus* species, aiming for their valorisation and preservation through sustainable cropping.
- Screening of phytochemicals for potential photo-protective, anti-ageing and anti-melanoma application.
- To elucidate the properties and bioactive compounds present in almond by-products and establish their correlation with health benefits; this study aims to assess the potential antimicrobial activity, as well as the in vitro and in vivo antifungal activity of their extracts.

COOPERATION

Although CITAB's applied research is of utmost relevance for the national and regional agrarian value chains, the internationalization of our research is a major goal that will be continuously persecuted. In 2024, the Centre will strengthen its internationalization through the promotion of scientific collaboration with other international R&D units, namely by its engagement in European projects (e.g. Horizon Europe and PRIMA), as well as its integration or consolidation in international research networks.

The CITAB's position as a research provider for private and public stakeholders and decision-makers will also be enhanced, with the establishment of several new contracts with industry and within the scope of our 12 Specialized Laboratories (<https://www.citab.utad.pt/the-centre/citab-labs>), such as the Fluvial and Terrestrial Ecology Lab (LEFT), Phytochemicals Lab, or Forest Products Lab (LPF). Projects with the industry will continue to represent an important source of funding for the Unit.

The integration of CITAB in the Associated Laboratory Inov4Agro will also foster collaboration with researchers from GreenUPorto (University of Porto), promoting synergies, upscaling our research and potentiating internationalization. This strategic partnership will also reinforce capacity building and knowledge transfer to stakeholders and policymakers.

DISSEMINATION, COMMUNICATION & OUTREACH

In 2024, CITAB will continue its active work of transferring the generated knowledge to a diverse audience, including academia and stakeholders from the public and private sectors and the general public. The commitment to excellence is evident in the initiatives planned for 2024, underscoring CITAB's role as a hub for intellectual exchange. Through the planned activities, CITAB continues to advance knowledge in agriculture, forestry, and the environment, driving innovation and addressing contemporary challenges for sustainable development. Accordingly, the main planned actions are:

- The “**CITAB Stakeholders Day**”. On this day, CITAB welcomes its stakeholders, including the “Stakeholders Committee”, and allows them to openly discuss or even bring new challenges to the CITAB researchers, tuning our research with the private sector needs. Visits to the labs will also be organized. The members of the External Advisory Committee are also invited to participate in this event, which is an opportunity to evaluate the latest developments of the Unit.
- The “**CITAB/Inov4Agro Open Day**”. This event is co-organized with GreenUPorto under the framework of the Associated Laboratory Inov4Agro. It aims to showcase the ongoing projects, activities, service provision and lines of research within the most regionally relevant agrarian value chains.
- The “**Today is the Day Celebration**”. This activity is planned to celebrate specific International days (e.g., Water, Climate, Environment, Soil, Sustainability, among others) that are aligned with the CITAB research activities, with the participation of a renowned specialist on each topic as an invited speaker.
- A set of webinars called “**Harvesting Knowledge**”. This set of monthly 10-15 min presentations is dedicated to the dissemination among CITAB’s members of the research developed by its youngest PhD Integrated Members.
- A seminar cycle called “**Sustainable Agrifood Production**”. This is dedicated to the presentation and promotion of the research developed by CITAB scholarships in their final PhD stage. This cycle is a monthly presentation and public discussion of a student’s work with a final prize award for the two best presentations. The prize will be applied to support publication fees or conference participation.

- The “**Scholarship Researchers' Day**”. This is an event organized by CITAB scholarship researchers to disseminate their research activities and foster future collaborations among them.
- Participation/Organization of a Thematic Session in the “**Ciência 2024**”, an event annually organized by FCT.
- Organization of **International Meetings** to strengthen the internationalization of CITAB.
- The programme “**Cientificamente Provável**”. This is a joint initiative of CITAB, the National Secretariat of Education and the National Secretariat for Science and Technology, aiming at the promotion of scientific knowledge and the enrichment of the educational path of young students. This program is designed to stimulate young students’ scientific literacy and skills, motivating them to deepen their knowledge and pursue higher education in their areas of interest (<http://www.rbe.min-edu.pt/np4/2164.html>).
- Engagement in “**Ciência Viva**” activities throughout the year.
- Participation in the **European Researcher Night** and other similar events.
- Implementation of **outreach activities** in primary/secondary schools and student visits to the UTAD Campus, among others.
- **Improving the CITAB website** towards the new Strategic Programme.
- Production of an **animation for the dissemination of the CITAB research**.
- **Strengthening the CITAB's visibility in social media** (Facebook and LinkedIn).
- **Interventions in the media** (TV, Radio and newspapers).