

CENTRE FOR THE RESEARCH AND TECHNOLOGY OF AGRO-ENVIRONMENTAL AND BIOLOGICAL SCIENCES (CITAB)

REPORT OF EXTERNAL ADVISORY COMMITTEE (EAC)

Report on 2018-2023 Activities

INTRODUCTION

CITAB research programme is currently organized into 2 main themes, each of which consists of 2 sub-tasks. They are: -

1. Sustainability of Agri-Food and Forestry Ecosystems in a Changing Environment.
 - 1.1 Integrated monitoring of climate and environmental impacts
 - 1.2 Sustainability in agri-food and forestry ecosystems
2. Technology and Innovation in Agri-food and Forestry Chains for a More Competitive Bioeconomy.
 - 2.1 Innovative technologies and processes
 - 2.2 Valorisation of bio-based products and co-products

These themes are focused on areas of strategic value to the future social-economic development of Northern Portugal.

Since the last Report CITAB has formed a strategic alliance with GreenUPorto. Co-operation with other centres is likely to increase in the year ahead, especially with funds from the Portuguese Rural Development Programme or similar programmes.

Progress since the last reports on CITAB's activities

As recommended in a previous report by the External Advisory Committee (EAC), the consolidation of the research and technology transfer activities of CITAB into the two main thematic areas of: -

- Sustainability of Agri-food and Forestry Ecosystems in a Changing Environment (TS1) and
- Technology & Innovation in Agri-food and Forestry chains for a more Competitive Bioeconomy (TS2),

has ensured that the Centre has focused its effort on a more coherent strategy that integrates, in a logical way, the various skills and research projects that previously existed at the Centre. This integration has had a positive effect on the Centre, not only in terms of its greater focus on themes of economic and social importance to Northern Portugal but also on

its overall impact and success.

In particular, there have been outstanding achievements by the Centre in: -

- The formation and expansion of a Centre of Excellence in forest and fire management with integrated links to the main Portuguese institutions concerned with the sustainability of forest resources and their susceptibility, as a result of climate change. The Group is collaborating internationally through an EU-coordinated project.
- Protecting the economic importance of the Viticulture sector, ensuring its sustainability as well as the contribution it is making to a national cluster of Portuguese laboratories with similar programmes.
- Contributing to a National Programme for Rural Development and Sustainability and successfully achieving important cooperative research grants through the Portuguese Recovery and Resilience Plan.
- Extending cooperation with the University of Porto's GreenUPorto laboratory, focused on sustainable development and innovation in Northern Portugal, to extend the critical mass of research groups working on the topic.

Funding

As mentioned in our previous reports, CITAB core funding from the FCT is very low for a strategic R&D Centre. This impedes the development of basic research which is essential for the development of new skills and future competitiveness at the European level. The Centre relies to a great extent on applied R&D or technology transfer and expertise to maintain its strategic objectives.

CITAB has responded to the challenge of reduced income from the FCT and has made very notable progress in securing funding from more diverse sources since our previous quinquennial review. In 2018, CITAB's income from direct public funding was predominant, whereas in 2022 it amounted to a little over half of the Centre's total income. Particularly notable during this period has been the success of CITAB in participating in international R&D and technology transfer initiatives which increased substantially over this quinquennial period.

In 2023, some 15% of the budget was derived from European funds. This is a notable achievement. CITAB should make every effort to increase funding from this source, given the importance of European collaboration in achieving sustainable agri-food chains across Europe. The PRIMA Programme managed by the PRIMA Foundation (<https://prima-med.org>) and supported by the EU, is an ideal source of funding for collaborative research amongst Mediterranean countries in the area of sustainability, biodiversity and food security. This additional source of funding should be pursued.

Although the Centre has been able to secure more competitive grants from the FCT, there has been an important increase in funding from a wide range of stakeholders and industry. By 2023 this amounted to around 50% of the total income of the Centre. Consulting services were offered to private companies as well as cooperative R&D and Rural Development projects. This was achieved in spite of the disruption to normal working patterns due to the Covid pandemic.

The funding derived from Stakeholders reflects a good balance between local governmental and business interests. As a Group, they are closely involved in advising the Centre on its work and are brought together at regular intervals to review progress and advise on new initiatives.

Information on the number of patents that have been granted on work undertaken by CITAB should be included in the Annual Reports.

Individual Programme Assessments

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

This task acknowledges that environments are changing as a result of climate change and other external factors, and this has a substantial impact on the ecological integrity of soils, freshwaters, and the value they provide to human populations. Integrated frameworks are needed to anticipate, detect, and tackle ecological changes in agricultural, forestry and natural ecosystems and landscapes.

- CITAB is addressing, in an innovative manner, the monitoring and modelling of different crops under variable and more extreme climates, and the effect of herbicides and exogenous compounds. At the same time, it is assessing if biocides and other contaminants influence aquatic communities. These are important challenges to mitigate environmental impairment in soils and freshwater ecosystems. The Centre is addressing these issues appropriately.

The specific mitigation strategies being developed are important. A monitoring system is required to demonstrate how effective they are in their application, such as in the recovery of soil functionality and whether or not there has been an improved ecological status of freshwater as the ultimate sink of pollutants in the basins. It will be very important for CITAB to continue to demonstrate the impact of their research on fields under intensive agricultural production to show that they are compatible with achieving ecologically healthy, adjacent freshwater. The impact of the research should be given more emphasis in the Activities Reports.

CITAB has integrated their research results into demonstration or pilot projects in the North of Portugal in conjunction with the EPA – the Portuguese Environment Agency - in order to consolidate and disseminate the results.

Task 1.2 - Sustainability in agri-food and forestry ecosystems

This task complements Task 1.1. in the sense that the application of spatio-temporal and dynamic predictive analytical tools, that are directed towards understanding how natural (e.g. seasonality, precipitation, energy flow) and anthropogenic (e.g. fertilizer application in agricultural systems, discharge of effluents, variations in crop type) changes influence ecosystem integrity. This should allow any impairment of this integrity, under different land use productive activities, to be detected.

- The CITAB research encompasses multivariate analysis and modelling of habitat, and land use change, impacts on terrestrial and aquatic environments, and ecosystems as well as the characterization of agri-food and forestry systems. CITAB addresses the very important topics of predictive research between relevant landscape characteristics and

management strategies, as well as the evaluation of various ecosystem services to be considered in the cost-effectiveness of the different decisions to be taken by managers and stakeholders. The project ALICE “Improving the management of Atlantic Landscapes: accounting for biodiversity and ecosystem services” is a relevant project. It is focused on promoting sustainable investments in Blue-Green Infrastructure Networks through the identification of the benefits of ecosystem services delivered at the terrestrial-aquatic and land-sea interface in the Atlantic Region.

- It is also important for CITAB to continue their research on good practices in agriculture and forestry activities since this is an essential first step to reinforcing sustainability and mitigating the stronger impacts on the environment.
- The Advisory Committee recommends that CITAB consider following up on the effectiveness of their mitigation measurements, such as the ones addressing river damming for fish populations, as this is an actual EU strategy to increase river vitality.

However, there are other relevant aspects of task 1.2 that need to be reinforced or addressed in a different manner. For instance, the need to study natural systems, their biodiversity and their functioning. Their study is needed to determine realistic restoration objectives – such as defining the ecosystem conditions that restoration efforts should be targeted at when aiming to mitigate the impacts of agriculture and forestry environments on soils and river catchments.

Natura 2000 areas are impacted less and reflect higher biodiversity than in crop production areas. However, today they are threatened by invasive species, an issue of high importance for conservation. CITAB is performing an important function in monitoring natural areas and generating management plans to examine biodiversity and invasive species impacts. Biodiversity conservation is also being addressed from a genetic perspective for freshwater bivalves in CONBIOMICS and EDGEOMICS. This is important work relevant to understanding and characterising the massive worldwide decline in populations of mussels.

The Advisory Committee believes that future work on biodiversity conservation should reflect a more integrated vision at the landscape level.

The prediction of impairment in catchments attributable to climate change and other diffuse pressures (i.e., forestry and agriculture), should be addressed with specific measures of ecosystem restoration to complement good practices.

The innovative methodologies developed by CITAB in agri-food systems should be shared with other countries with similar crops (e.g., Spain) and developed into a European-wide research programme in order that there is effective coordination and implementation of European legislation.

Most importantly, CITAB’s research results need to be applied in demonstration or pilot projects (e.g. Leaving Labs) to consolidate and disseminate their results to user communities.

Task 2.1 Innovative technologies and processes

The stated objectives of this Group are critical to the economic success of the sector but could be more clearly defined and prioritized by indicating the most important challenges that are faced at a local level. Clearly, automation of agricultural production is a major trend in which

CITAB should further develop its expertise.

This Group have provided an important technical service for the other Groups in the Centre as well as developing methodologies for improving knowledge about the factors affecting oenological quality and the effects of increasing solar and drought stress on grapevines. In addition, they are looking at the function of the root systems of Cowpeas under conditions of stress, as well as apples, olives, almonds and chestnuts.

All of these crops are of vital importance to the economy. It would be helpful to have more information about the involvement of the relevant production sectors in the development of their work priorities in the future as well as the specific contribution being made to the adoption of technological change.

The output of the Group forms an impression that the group is not resourced to undertake a core programme of research that will ensure the introduction of new technologies for future applications, especially those that will lead to the adoption of improved technological applications in advanced automation and data processing. It would seem that they are contributing to the technological requirements of other research teams through the application of existing technologies.

The challenge for this Group in the years ahead will be to apply technologies that can clearly demonstrate their ability to contribute to improved productivity through automation and cost reduction.

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

This Task is of growing importance as a focus on producing healthy, sustainable and locally-based foods forms an essential part of the European Green Deal. Adding value to natural products, that are an essential part of the local ecosystem of high botanical diversity, is also an important aspect of this policy.

The effective exploitation of this research is a critical issue that will require input from other research groups and local entrepreneurs at an early stage to determine priorities. Otherwise, there is the possibility of pursuing too many objectives.

The sustainable production of food will seek to provide suppliers with new and innovative solutions by offering natural-origin products that will provide crop protection as well as biostimulants, biocontrol and pheromone products that have a proven, predictable performance. This will utilize the skill base of this research group and should be an important aspect of its future efforts.

The identification and characterization of bioactive molecules in the food chain, to lead to the development of new, high-value, functional foods or bioactive molecules to improve human health, requires a skill base that can determine, and quantify, the effects on human metabolism and the intestinal microflora and demonstrate that these effects are beneficial.

The identification of such molecules by in vitro and rodent in vivo methods, whilst part of the preliminary characterization of benefit, cannot lead to positive claims by industry unless it has been demonstrated that rodent and human metabolism are identical, or that there is evidence from human in-vivo studies that there are similar effects. Factors such as age, gender,

genotype, BMI and diet affect how individuals respond to specific dietary components.

Human gut metabolic studies require special expertise that CITAB presently lacks. This skill base needs to be developed. Alternatively, collaboration with a Centre that has such facilities will be essential so that the group can achieve a greater impact.

This Group should also consider the potential for closer integration with the other thematic programmes of the Centre e.g., by investigating the symbiosis between plant constituents and the microorganisms that can enhance productivity and maximise the yield of valuable constituents under stressful environmental conditions.

Publications

CITAB have improved their Activities Reports considerably over this quinquennium. They are now more visually attractive and informative to a wide spectrum of stakeholders. There has been a significant increase in publication productivity on the part of the Integrated Members of the Centre over the past five years, achieving an average of approximately 3,0 SCOPUS-indexed articles per member in 2023, which is the highest ratio ever. Almost three-quarters of the papers appeared in journals with a high impact factor. From 2018 to 2023, Scopus-indexed articles increased by 72% to a total of 293 in 2023.

Nonetheless, it will be important in the future to publish articles in carefully chosen journals since future evaluations of research impact will consider, besides the number of publications, citations and a good h-index score.

Training & Outreach

CITAB are interacting closely with their principal Stakeholders in the local region which consists of both industrial and local government specialists who offer advice and work proactively with the scientists at the Centre. This helps to ensure that there is good knowledge exploitation.

Some 15 students from international doctoral programmes completed their PhDs in the Centre in 2023. Some 9 conferences were organized most of which had an international input and covered topics related to the main agricultural value chains in Northern Portugal with a focus on organic production and sustainability.

As in previous reports, the Centre's work was the subject of an expanded media interest bringing the work it is undertaking to a wider public audience. The Centre also organized visits from local students to engage them in the S&T work being undertaken and interest them in future career opportunities within the Centre.

Future Activities and Impact

The overarching need to decarbonize agricultural practices and to ensure critical crops are grown to meet this challenge; to grow food sustainably, and to maintain or increase

productivity in a rapidly changing environment, will challenge research centres, like CITAB, to respond with creative ideas.

The UN's Sustainable Development Goals (SDGs) provide a yardstick against which all research institutes' outputs should be assessed. The Centre should ensure that it is evaluated with respect to the UI GreenMetric World University Rankings (<https://greenmetric.ui.ac.id/about/welcome>) in both its Reports and annual programmes.

The importance of this goal, and its urgency, will require extra resources and more integration of the existing resources, to achieve these aims. CITAB has developed a 10-year plan for future activities, together with GreenUPorto, through the "Inov4Agro" mission. This will need to identify where the existing skill base needs to be strengthened in order to obtain additional funding. At present this plan is very general. The highest priority areas need to be identified to ensure that the available resources are focused on issues that will have the greatest impact on the Northern Portuguese economy and environment.

CITAB's effort is dedicated to the assessment of climate change impacts and related adaptation strategies. The study of emissions reduction and mitigation strategies needs to be developed into a coherent strategy, together with the assessment of climate change, avoiding trade-offs between them. This is especially the case for the economic future of farmers given future legislative moves towards new CAPs, carbon credit farm certification, Farm to Fork strategies, etc.

Another example of how the skills of CITAB could be utilized and integrated both internally and externally is in the area of biofortification. Increasingly environmental concerns will focus on locally produced food. Plant-based foods could replace animal-derived foods to a greater extent. These challenges will need a holistic approach with multi-skilled teams working on specific topics.

As has been mentioned in previous EAC reports more emphasis could be placed at the outset of the programmes and projects on the outputs to be expected and the progress that has been made in achieving them, especially in defining what impact it is hoped to make on societal or economic issues, both in relation to the local environment and more widely.

More detail on the extent to which there has been scientific interchange; the percentage of papers co-authored with international partners and the number of researchers from other countries that are undertaking research at CITAB and visa-versa, are also important criteria to assess impact.

Recommendations

The Advisory Group recommends that: -

- A. The scope and organisation of CITAB is focused around **three** main themes consisting of: -
 - a. Natural resources, biodiversity and climate challenges;
 - b. Resilience and competitiveness of the agri-food value chain, and
 - c. Innovative, healthy and safe foods
- B. UTAD/FCT should consider how more blue-skies research could be funded to bring newly emerging skills into the Centre.
- C. Funding should be sought from the PRIMA Foundation.
- D. More focus should be given to public involvement in the Centre's research activities.
- E. Information on patents should be included in the Annual Reports.
- F. More information be provided on how the work undertaken by CITAB has been successfully applied.
- G. Demonstration and pilot projects should be undertaken with appropriate Stakeholders.
- H. Realistic restoration approaches are pre-determined through evaluation exercises.
- I. In Task 1.1 more attention should be given to mitigation strategies since there needs to be work that highlights synergies or trade-offs between adaptation and mitigation strategies.
- J. A more integrated vision of landscape biodiversity and conservation could be beneficial.
- K. The impairment in catchment areas that are attributable to climate change should be addressed through modelling activities.
- L. CITAB undertake more collaborative research with centres that have similar ecosystems with a view to securing European funding.
- M. CITAB/UTAD should consider setting up a permanent administration team with relevant expertise, to help scientists complete complex, multi-partner, EU grant applications.
- N. The work on the valorisation of bio-based products should be more focused on projects that enhance specific bioactive compounds in plant systems that are the most important to the local economy.

- O. The development of microbiological and mycological research skills is required either through recruitment or collaboration.

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