PhD in AGRIFOOD AND ENVIRONMENTAL SCIENCES

CALL 2025 – CYCLE 41

Reserved scholarship
A1 - Development of a Sterile Insect Technique (SIT) Strategy for the Control of *Drosophila suzukii* in Trentino-Alto Adige Fruit Orchards (DroSIT)

Funding body/s: **UniTrento - Centro di Sperimentazione Laimburg**

Supervisor 1: **Prof. Gianfranco Anfora**
Supervisor 2: **Dott.ssa Silvia Schmidt**

Context / Synthetic description of the project

This PhD project aims to develop and implement a sustainable control strategy for *Drosophila suzukii* using the Sterile Insect Technique (SIT) in fruit-growing systems of the Trentino-Alto Adige region. *D. suzukii*, a highly invasive pest, poses a significant threat to soft fruit and cherry production, necessitating innovative and environmentally friendly management solutions. The project will focus on both laboratory and field trials to assess the efficacy of sterile male releases in reducing pest populations and minimizing crop damage. Sterile males for experimentation will be sourced from European companies specializing in SIT technology. This research will contribute to the integration of a classical SIT approach into existing pest management programs, promoting sustainable agriculture and reducing reliance on chemical control methods in the region.
In addition to the classic SIT through irradiation, the student will have the opportunity to contribute to some laboratory activities as part of an ongoing project within the host research unit. These activities are related to the development of an innovative SIT technique based on the release of sterile insect males obtained through genetic engineering (gene driving).

PhD in AGRIFOOD AND ENVIRONMENTAL SCIENCES

CALL 2025 – CYCLE 41

Reserved scholarship:

A2 - Effects of ozone-enriched storage atmosphere on fruit postharvest quality

Funding Body: **University of Trento - Laimburg (Centro di Sperimentazione)**

Supervisor 1: **Annachiara Berardinelli (Unitn)**

Supervisor 2: **Fabrizio Costa (Unitn)**

Context / Synthetic description of the project

Ozone, a highly unstable triatomic oxygen molecule, is one of the most powerful oxidants with several advantages, such as the absence of detectable residues on treated products. The application of ozone in the food industry has significantly increased both at experimental and commercial levels, as a sanitizer in the food industry aiming at inactivation of microorganisms, or as a removal agent of toxic substances such as mycotoxins and pesticide residues. In recent years, ozone has been also applied in the postharvest of fruit for the improvement of potential storability through the ozone-mediated oxidation of ethylene.

The use of ozone in management of post-harvest quality of horticultural products has been recently extensively studied. However, currently available data on fruit changes are limited and fragmented in addition to a scarce knowledge about optimal concentrations of the gas and times of treatments according to the fruit characteristics. It is known that, when applied incorrectly, ozone can also have a negative impact on fruit qualitative attributes.

For a reliable optimization of fruit post-harvest ozonation management and a prolongation of shelf life, the PhD project aims at:

- Optimising the production and the distribution of the gas in a pilot lab setup.
- Studying the effect of the gas on the metabolic processes of a selection of both climacteric (apples and pears) and non-climacteric fruits (strawberries, cherries, and raspberries).
- Studying the influence of ozone on mechanical and chemical attributes and on micro-structural properties.
- Studying the effective role of the ozone in activating the antioxidant defence mechanism in plant cells and metabolising reactive oxygen species (ROS).
- Scaling the technology in a semi-industrial plant.
- Transctiptome analysis to dissect the physiological impact of ozone treated fruit.

PhD in AGRIFOOD AND ENVIRONMENTAL SCIENCES

CALL 2025 – CYCLE 41

Reserved scholarship:
B - Farmers' adaptation to climate change using risk transfer and risk mitigation strategies

Funding Body: **University of Trento – Agriduemila Hub Innovation**

Supervisor 1: Simone Cerroni
Supervisor 2: tbd

Context / Synthetic description of the project

In recent years, extreme weather events related to climate change are increasingly exacerbating production risks (Finger et al., 2022). Risk transfer via agricultural insurances is one of the strategy available to farmers to cope with such risk. However, farmers' adoption of agricultural insurance is very heterogenous worldwide and determinants of production insurances are not clearly understood (Arata et al., 2023). Farmers can also adapt to climate change risk by actively implementing a wide range of risk mitigating strategies, spanning from hail nets to smart irrigation systems, on farm. This project explores farmers' adoption and intention to adopt classic and more innovative production insurances, for example index-based and green insurances, as well as farmers' attitudes and perspectives on the potential synergy between risk transfer and farm management strategies that can facilitate adaptation to climate change risks using stated-preference methods, lab-in-the-field experiments and randomized control trials. These methods are increasingly used to evaluate the adoption of risk management strategies by farmers and related behavioural determinates (Colen et al., 2016). Findings from this projetc contribute to the development of a deeper knowledge and understanding of the behavioural mechanisms behind farmers' decisions to adopt risk management strategies. This can facilitate policy makers in the development of risk management tools that are more acceptable by farmers making food systems more resilient and resistant to the climate crisis the world is experiencing.

Reference

Arata, L., Cerroni, S., Santeramo, F. G., Trestini, S., & Severini, S. (2023). Towards a holistic approach to sustainable risk management in agriculture in the EU: a literature review. Bio-Based and Applied Economics, 12(3), 165–182. https://doi.org/10.36253/bae-14492

Colen, L., Gomez y Paloma, S., Latacz-Lohmann, U., Lefebvre, M., Préget, R., & Thoyer, S. (2016). Economic experiments as a tool for agricultural policy evaluation: insights from the European CAP. Canadian Journal of Agricultural Economics/Revue canadienne d'agroeconomie, 64(4), 667-694.

Finger, R., W. Vroege, A. Spiegel, Y. de Mey, T. Slijper, et al. "The Importance of Improving and Enlarging the Scope of Risk Management to Enhance Resilience in European Agriculture." (2022) 1st ed. M. M. P. Meuwissen, P. H. Feindt, A. Garrido, E. Mathijs, B. Soriano, J. et al, eds. Cambridge University Press: United Kingdom

PhD in AGRIFOOD AND ENVIRONMENTAL SCIENCES

CALL 2025 – CYCLE 41

Reserved scholarship:
C - A framework for climate-resilient forestry, urban planning, and sustainable building practices

Funding Body: **University of Trento – Carbon Planet**

Supervisor 1: **Marco Ciolli - DICAM-C3A**
Supervisor 2: **Sara Favargiotti - DICAM**
Supervisor 3: **Paolo Zatelli - DICAM**

Context / Synthetic description of the project

Forests play a pivotal role in mitigating climate change by sequestering carbon dioxide (CO_2) from the atmosphere. Accurately assessing this carbon sequestration is essential for sustainable forest management and global climate strategies. This study explores the integration of remote sensing technologies and field observations to evaluate carbon storage in forest ecosystems. Remote sensing offers large-scale, high-resolution data on forest biomass, canopy cover, and land-use changes, while field observations provide ground-truth data for calibration and validation, enhancing the reliability of carbon stock estimates. This approach could lead to the integration of heterogeneous data from different sources, allowing a more accurate detection of the environment sequestration at different scales. Additionally, the research examines the potential for creating a sustainable cycle between forest-derived wood products and buildings, enabling long-term carbon storage in the built environment. By promoting the use of timber in construction, forests can contribute to a circular carbon economy where harvested wood acts as a durable carbon sink, and managed forests are regenerating and continue to capture additional CO_2. This dual approach fosters a synergistic relationship between forest conservation and sustainable urban development, presenting an innovative model for climate resilience and resource efficiency.
Expected results will be the development of new algorithms to calculate CO_2 sequestration in a free and open source environment, as well as the advancement of carbon sequestration parameters with a focus on built environment. The main scientific outcomes of the project will be three scientific papers on peer reviewed (ISI) journals and the potential application of the developed approaches to international projects and industrial contest.

PhD in AGRIFOOD AND ENVIRONMENTAL SCIENCES

CALL 2025 – CYCLE 41

Reserved scholarship:

D - Optimisation of Black Soldier Fly Rearing: Innovations for Sustainable Protein Production

Funding Body: **University of Trento - Kinsect s.r.l.**

Supervisor 1: **Ph.D Sihem Dabbou**

Supervisor 2: **Ph.D Giacomo Benassi**

Context / Synthetic description of the project

The insect protein market for animal feed is growing rapidly, driven by rising demand and increasing limitations on traditional sources like soybean and fishmeal, facing environmental challenges linked to marine and forest preservation. Insect farming emerged as a sustainable, locally produced alternative to strengthen and green EU supply chains. Today, the black soldier fly (*Hermetia illucens* L.; BSF) dominates the market, making up over 80% of insect-based feed. Its use in animal feed has been authorized in Europe since 2018.

To make BSF meal competitive with soybean and fishmeal in both quantity and cost, innovative technologies are essential to improve process efficiency—particularly in production stages that remain under-optimized.

The Reproduction and Nursery, where eggs and larvae are produced, remain key bottlenecks limiting the scalability and competitiveness of BSF protein.

The project will adopt a circular economy approach to maximize the value of BSF production, focusing on sustainability, efficiency, and the integration of BSF by-products into animal feed or fertilizers. In particular, the PhD activity will focus on the study and optimisation of artificial rearing of BSF.

The main goals of the project are:

- To optimize BSF adult breeding and nursery production stages, efforts will focus on key performance indicators such as fly density, egg production, egg hatching, and environmental rearing parameters.
- To identify and apply optimal feeding diets for BSF larvae within Trentino Alto-Adige region, thus contributing to the development and sustainability of the territory and, evaluation of volatile organic compounds (VOCs) produced during the rearing process as welfare indicator.
- To explore the use of BSF by-products—particularly exuviae and adults—as animal feed additives.
- To refine the rearing parameters for BSF adults through experimental trials, supported by statistical analysis of each batch’s results.

The project includes planned international mobility.

PhD in AGRIFOOD AND ENVIRONMENTAL SCIENCES

CALL 2025 – CYCLE 41

Reserved scholarship:

E - Advanced Soil Biota-Hydraulics Interface for the WHETGEO-GEOSPACE system

Funding Body: **University of Trento – ICOSHELL project**

Supervisor 1: **Riccardo Rigon**
Supervisor 2: **Concetta D'Amato**
Supervisor 3: **Sara Bonetti**

Context / Synthetic description of the project

Project Overview
This subproject, funded under the ICOSHELL project, aims to develop an integrated modeling system that explicitly accounts for the dynamic interactions between soil biota activity and soil hydraulic properties. Building upon the WHETGEO-1D and 2D frameworks, we will implement a novel coupling between soil fauna population dynamics and plants root growth, evolving soil hydraulic characteristics. The modelling system implemented will be eventually used for studying the feedback between soil-vegetation hydrology.

Key Objectives
1. Extend the WHETGEO model architecture to incorporate time-varying soil hydraulic properties influenced by soil biota
2. Implement the Kosugi soil water retention curve model with parameters that dynamically evolve based on biological activity
3. Develop and integrate a population dynamics module for key soil engineers (earthworms, ants, termites)
4. Create a comprehensive validation framework using laboratory and field experimental data

Methodological Approach
The core innovation of this subproject is the implementation of a feedback loop between biological activity and soil physics. Following Meurer et al. (2020), we will start to model how earthworm populations modify soil structure, but significantly expand this approach by:

1. Replacing the van Genuchten model with the Kosugi water retention curve formulation, which provides a more direct physical interpretation of pore size distribution
2. Developing a differential equation system where the Kosugi parameters (median pore size and standard deviation) are directly modified by biological activity
3. Implementing these dynamics within the robust NCZ algorithm of WHETGEO, ensuring numerical stability across diverse conditions

The population dynamics will be modeled as a set of ordinary differential equations representing different functional groups of soil engineers, their reproduction, mortality, and activity rates as functions of environmental conditions (temperature, moisture, organic matter).

Expected Outcomes
This integration will allow to better capture:

- The temporal evolution of soil infiltration capacity following land-use changes

- The self-reinforcing positive feedback loops of ecosystem restoration, where initial vegetation changes trigger soil biological activity that further enhances water retention
- The resilience of soil hydrological function under climate change scenarios

Implementation Timeline
Months 1-6: Preliminary studies, doctoral school activities

Months: 6-18 Implement Kosugi model in WHETGEO framework, develop and integrate population dynamics module Months 18-24: Validate against experimental data Months 32-36: Upscale to field applications and integration to estimate catchment scale effects. Study effects of soil management

Possible colalnborations
Possible collaboration: EPFL Lausannne, Prof. Sara Bonetti and Dr. Concetta D'Amato

PhD in AGRIFOOD AND ENVIRONMENTAL SCIENCES

CALL 2025 – CYCLE 41

Reserved scholarship:

F - River – floodplain mutual interactions

Funding Body: **University of Trento**

Supervisor 1: **Guido Zolezzi**

Supervisor 2: **Walter Bertoldi**

Context / Synthetic description of the project

Most research on the physical dynamics of river systems has focused on processes occurring within the main active channel(s), while the physical interaction and exchange processes occurring between the permanently wet channel and the nearby floodplain has received attention only recently.

Floodplains are among the most sensitive ecosystems on Earth, they have been co-evolving with rivers, and are increasingly being exploited for human activities, from agriculture to urbanization, at different paces in different regions of the world. Because of this, near-natural floodplains are becoming rare, but investigating their dynamics is pivotal to establish sustainable management strategies also for heavily anthropized systems, in which the natural dynamics might be retrieved during extreme meteorological events.

The proposed research theme addresses the mutual interactions and exchange processes between rivers and floodplains, and can focus on one of the three specific topics described below, depending on the candidate's interests and background.

1) Modelling and understanding the eco-morphodynamics associated with intense bank erosion processes that temporarily shift the river evolutionary trajectories, especially causing rapid and pronounced chennel widening at the spatial scale of the entire reach. A key focus will be the process of rapid, non-selective bank erosion that can be inferred from geomoprhological appraisals but cannot be observed in real-time.
2) Modelling and understanding the physical conditions and processes that favour the establishment of riparian vegetation on river bars, pregressively causing the shift of relevant portions of the active channel to floodplain areas. Relevant processes are related to the interplay between vegetation dynamics, resistance and flow disturbances, with associated sediment transport processes.
3) Modelling and understanding the suitability, persistence, and turnover of physical habitats for different animal species / life stages (including fish, amphibians, birds) in rivers with complex, multi-thread morphologies that are subject to artificial flow oscillations ("hydropeaking") caused by hydropower regulation. Recent projects developed on the lower Noce river (NE Italy) will provide key case studies for this topic.

Also depending on the candidates' background, the research activity can be developed using one or more of the following approaches, ideally in an integrated way: remote sensing, field measurements, mathematical modelling.

Reserved scholarship:

G - Characterization of heat stress response in grapevine - HSR Grape

Funding Body:

MUR – PRIN 2022 Research project title: Dissecting the genetic and physiological mechanisms of grapevine resilience to heat stress - University of Trento

Supervisor 1: **Maria Stella Grando**

Supervisor 2: **Michele Faralli**

Context / Synthetic description of the project

Overview:

Plant growth and many developmental processes are strongly influenced by ambient temperature fluctuations. During heat stress, the temperature rises above the threshold level of plant tolerance and may cause irreversible damage.

Grapevines increasingly encounter heat stress during the growing season that may affect proper development and fruit metabolism, and consequently exert constraints on grape yield and quality. Although the grapevine has a good ability to adapt to various environmental pressures, long-lasting extremely high temperatures or heatwaves may permanently affect yield attributes and plant physiology.

Due to the climate changes, understanding grapevine responses to heat stress is of particular importance for the sustainability of viticulture and one of the most important topics in grapevine biology.

This research aims to investigate the genetic and physiological mechanisms involved in grapevine responses to heat stress. We propose to exploit a strategy that couples genetic and physiological approaches and take advantage of the availability of genetically characterised populations - obtained by crossing important grapevine varieties - that have shown segregation for thermal stress tolerance in preliminary evaluations.

Project goals:

- ✔ To apply innovative phenotyping strategies (e.g., remote sensing coupled with more traditional proximal sensing to monitor dynamic responses to thermal stress);
- ✔ To genetically map the grapevine traits involved in heat stress resilience and thermotolerance within a multi-parental approach;
- ✔ To perform in-depth physiological and molecular characterisation of the heat stress response in segregating individuals with extreme behaviour.

PhD in AGRIFOOD AND ENVIRONMENTAL SCIENCES

CALL 2024 – CYCLE 41

Reserved scholarship:
H - Numerical modelling of atmospheric transport processes of particulate matter along mountain slopes

Funding Body: **University of Trento and Environmental Agency of the Autonomous Province of Trento**

Supervisor 1**: Dino Zardi**
Supervisor 2: **Gabriele Tonidandel**

Context / Synthetic description of the project and research outcome

Particulate matter, composed either of biogenic or abiogenic substances, play a crucial role in the environment, affecting air quality, atmospheric radiation budgets propagation of species, ecosystems' dynamics, human health, and nucleation processes in clouds, and hence precipitation.
Transport of such substances over mountainous terrain is made more complicated than over flat areas by the complexity and variety of the wind structures found over mountain slopes. In particular, thermally driven slope winds, often occurring after daytime heating and nighttime cooling of slopes, offer preferred flow patterns, which may variously combine with convection in the upper atmosphere. Also, turbulence associated with these flows plays a crucial role in the uptake, diffusion and deposition of these substances.
The candidate will develop and apply new concepts, derived from recent advances in our understanding of the above winds, to existing mathematical and numerical models, in order to improve their capability of reproducing the above transport processes in a variety of situations. Both Eulerian and Lagrangian approaches will be tested. The latter will include both forward- and back-trajectories.
Comparison with data from field measurements will allow suitable validation of the models. Cooperation will be pursued with the Environmental Agency of the Autonomous Province of Trento, with the Botany Unit of the Civic Museum in Rovereto, and with the Environmental Botany Unit of the Edmund Mach Foundation.

PhD in AGRIFOOD AND ENVIRONMENTAL SCIENCES

CALL 2024 – CYCLE 41

Reserved scholarship:
I - Development and evaluation of methodologies and tools for seasonal meteorological forecasts to support water resource management and optimize hydroelectric energy production

Funding Body: **University of Trento and Hydro Dolomiti Energia (HDE)**

Supervisor 1**: Dino Zardi**
Supervisor 2: **Lorenzo Giovannini**
Supervisor 3: **Bruno Majone**
Supervisor 4: **Mattia Carlin (HDE)**

Context / Synthetic description of the project

Seasonal meteorological forecasting has gained increasing attention in recent years, due to its numerous potential applications to support decision-making in various sectors. These forecasts, typically extending for several months, bridge the gap between long-term climate projections and traditional short-term weather forecasts.

The present project aims to develop and evaluate advanced methodologies and tools to improve the possibility of applying seasonal meteorological forecasts to support water resource management and optimize hydroelectric energy production in complex terrain regions.

The project will first focus on the evaluation of the performance of different seasonal weather forecast products distributed by various operational centers (e.g., ECMWF, GFS, DWD,…) at different lead times (1 to 7 months), with a particular focus on the Alpine region. Then, different downscaling techniques will be tested to improve the quality of the predictions, focusing in particular on the variables mainly affecting the availability of the water resource (e.g., precipitation, temperature). It is in fact well known that seasonal forecasts can display large errors, especially over complex terrain, hindering the possibility of using these products for practical applications.

Finally, the relations between large-scale teleconnection indices (e.g., North Atlantic Oscillation - NAO, Scandinavian pattern – SCAND, East Atlantic/West Russia - EAWR), typically displaying higher predictability, and local meteorological conditions will be evaluated, to explore the possibility of exploiting these relations to improve seasonal forecasts of local variables.

The research project is developed in collaboration with Hydro Dolomiti Energia Srl, the main hydropower production company in Trentino region.

PhD in AGRIFOOD AND ENVIRONMENTAL SCIENCES

CALL 2024 – CYCLE 41

Reserved scholarship:
J - Transforming biotechnology advances into sustainable solutions for controlling Botrytis cinerea and Plasmopara viticola (Acronym: BioTech4PestControl)

Funding Body: **University of Trento and Numinous srl**

Supervisor 1**: Gerardo Puopolo**
Supervisor 2: **Giovanni Amenta (Numinous srl)**

Context / Synthetic description of the project

Overview:
Plasmopara viticola and Botrytis cinerea pose a significant threat to the wine industry worldwide. The occurrence of populations of both plant pathogenic organisms resistant to monocyte fungicides makes their management one of the most significant challenges in integrated viticulture. However, the potential development of new bioproducts could revolutionize the industry, making wine production more sustainable.
The progress in basic and applied sciences has opened up exciting possibilities for the development of new bioproducts. These products have the potential to effectively manage B. cinerea and P. viticola, thereby enhancing the sustainability of wine production.
UNITN and Numinous, an Italian scientific enterprise investing in the application of new biotechnology to make industrial processes more sustainable, have designed BioTech4PestControl, an innovative research project aimed at translating advances in biotechnology studies into new bioproducts for the management of B. cinerea and P. viticola.

Project goals:
- ✓ To develop and evaluate bioproducts based on microbial Volatile Organic Compounds (VOCs) and small RNA molecules (RNAi) for controlling B. cinerea and P. viticola.
- ✓ To determine how mVOCs and RNAi affect the pathogenicity of B. cinerea and P. viticola using omics technologies.
- ✓ To evaluate the ability of mVOCs and RNAi to trigger resistance mechanisms in grapevine plants using transcriptomics.
- ✓ To determine the optimal dose and time of application.
- ✓ To evaluate the sensitivity of mVOCs and RNAi to rain wash-off and UV light

PhD in AGRIFOOD AND ENVIRONMENTAL SCIENCES

CALL 2025 – CYCLE 41

Reserved scholarship:

K - Temperature extremes in a warmer climate

Funding Body: **University of Trento - PNRR Innovation Fund RETE**

Supervisor 1: **Riccardo Rigon**

Supervisor 2: **Simona Bordoni**

Context / Synthetic description of the project

Arctic amplification is a robust response to global warming, predicted across a range of climate simulations of different complexity and confirmed by observations of the past decades. The resulting weakening of the pole-to-equator temperature contrast in the Northern Hemisphere has been argued to be responsible for an increased probability of blocking episodes and extreme weather in midlatitudes, through a weakened and wavier jet stream. Recent theories cast doubt on this hypothesis and argue that the reduction of meridional temperature gradients that accompanies polar amplification leads to a *reduction*, rather than to an increase, of the synoptic temperature variance near the surface (e.g., Schneider et al. 2015). These arguments are primarily based on a dry framework, focusing on how advection by synoptic scale eddies act on the mean temperature gradient. Building on these ideas, a "moist perspective" is currently emerging, which also accounts for moist processes that might impact temperature variations, such as heat release during condensation and surface cooling due to evaporation. The advantage of this emerging theory is that it provides a scaling for temperature extremes based on the relation between the generation of temperature variance through moist energy transport and its dissipation by the net energy forcing of the atmosphere (e.g., Ge et al. 2025). While promising, these ideas have so far only been tested in idealized aquaplanet simulations that neglect land-sea contrast and realistic topography. In the proposed work, we will build on these promising results and we will provide an unprecedented examination of temperature extremes (including heat waves and cold air outbreaks) in both observations and climate model simulations, spanning from idealized to next-generation Earth System model (ESM) global simulations at storm-resolving resolution. More specifically we will:

1. Extend existing theories for the response of temperature extremes to warming to include local thermodynamic effects, which for instance account for changes in relative humidity over land (e.g., Zeppetello and Battisti 2020);
2. Explore the emerging scaling relations in observations, such as reanalyses and satellite products;
3. Perform idealized simulations to test the relative contribution to temperature variance by different processes (e.g., latent heat release, evaporation contrast between land and ocean);
4. Test emerging hypotheses across the model hierarchy, ranging from the idealized simulations mentioned above to the CMIP6 archive of full ESM simulations supplemented by large-ensemble experiments and km-scale simulations with NextGEMS models.

Expected outcomes include publications in peer-reviewed journals, and theories, simulations and datasets that will be made available to the scientific community.

PhD in AGRIFOOD AND ENVIRONMENTAL SCIENCES

CALL 2025 – CYCLE 41

Reserved scholarship:

L - Advancing Physics-Informed Machine Learning for Environmental Modeling and Smart Irrigation Systems

Funding body: **FBK - Fondazione Bruno Kessler**

Supervisor 1: **Fabio Antonelli**

Supervisor 2: **Riccardo Rigon**

Context / Synthetic description of the project

Physics-Informed Machine Learning is emerging as a powerful tool for bridging data-driven and physics-based modeling, offering robust, efficient, and generalizable solutions across various scientific and engineering domains. This PhD scholarship will focus on developing PIML frameworks for modeling complex hydrodynamic and environmental systems, with a particular emphasis on optimizing next-generation irrigation strategies. By integrating physical laws with machine learning architectures, the research aims to improve predictive accuracy, enhance data efficiency, and enable real-time decision-making. The study will incorporate sensor-driven data assimilation, validate models using experimental and field datasets, and compare the performance of PIML models against conventional numerical and purely data-driven approaches. The successful candidate will contribute to cutting-edge advancements at the intersection of artificial intelligence, computational physics, and environmental modeling, leveraging high-performance computing and state-of-the-art neural architectures to address critical sustainability challenges.

Keywords: precision agriculture; decision support systems; integrative artificial intelligence.

Intellectual Property Notice for PhD candidates under the UniTrento-FBK Agreement.

Please read the following information carefully before submitting your application.

Intellectual Property of Research Results: the intellectual property rights of research results generated by PhD students under scholarships within the UniTrento-FBK Agreement shall belong to FBK.

Transfer of Intellectual Property Rights: FBK will establish agreements with PhD students regarding the transfer of intellectual property rights related to their research results.

Collaboration with UniTrento UniTrento academic staff contribute to research results obtained through PhD scholarships funded by FBK, the determination of IP shares will be defined through separate written agreements based on each party's contribution. PhD students are required to collaborate with UniTrento in all necessary activities related to the joint management of IP.

PhD in AGRIFOOD AND ENVIRONMENTAL SCIENCES

CALL 2025 – CYCLE 41

Reserved scholarship:

M1 - Increasing the resilience of *Vitis vinifera* to a range of abiotic stresses by exploiting genetically improved rootstocks and the potential rootstock-to-scion effect - Acronym: ADAPTROOT

Funding body: **Fondazione Edmund Mach**

Supervisor 1: Lorenza Dalla Costa

Supervisor 2: Michele Faralli

Context / Synthetic description of the project

Our previous work indicates that in grapevine, the gene *VviEPFL9*-2, known to be involved in stomagenesis, may also play a role in root development, potentially via the ABA signaling pathway. Improved water use efficiency as a result of the reduction in stomatal conductance, may also be associated with a limitation of CO_2 diffusion through the sub-stomatal cavity, which reduces photosynthesis and may have a negative impact on plant growth, fruit quality and yield. On the other hand, the observed effect of *VviEPFL9*-2 gene knock-out on root architecture and vascular system is of particular interest and deserves further investigation. Our previous results indicated a beneficial interaction between the KO rootstock and the WT grafted scion in terms of intrinsic water-use efficiency, suggesting the possibility to exploit a new strategy to mitigate the impact of reduced water availability on grapevine, based on the use of genetically improved rootstocks.

The purpose of this PhD project is to explore the physiological fitness of modified 'Kober 5BB' rootstocks, in which the gene *VviEPFL9*-2 has been knocked-out (KO) or overexpressed (OE). Different oenologically important varieties will be then grafted onto the modified rootstocks and subjected to several abiotic stress conditions, in particular water and heat stress. The Kober lines were produced within a previous PhD project (STOMALTER), therefore the plant material will be immediately available for testing. An additional goal of the proposed project will be to elucidate the molecular pathways regulated by *VviEPFL9*-2 in grapevine roots, thus shedding light on unknown molecular mechanisms that may be activated in response to water stress in woody plants. A further objective is the generation of NGT1 'Kober 5BB', modified in *VviEPFL9*-2 gene though a DNA-free editing technology, by transfecting the sgRNA/Cas9 complex in form of ribonucleoprotein in grapevine protoplasts. The NGT1 regenerated plants will open the perspective of conducting field trials to assess the effect of the rootstock modification under uncontrolled environmental conditions.

The availability of novel edited rootstocks with an enhanced adaptation to water stress may hold considerable strategic potential for viticulture, both on an international scale, for the wine-growing regions most vulnerable to drought, and on a local scale, to ensure the long-term cultivation of varieties traditionally associated with a specific geographical area.

PhD in AGRIFOOD AND ENVIRONMENTAL SCIENCES

CALL 2025 – CYCLE 41

Reserved scholarship:
M2 - Advancing HazelNUT Characterization Through Integrated Spectroscopic and CHromatographic techniques – NUTTISCH

Funding body: **Fondazione Edmund Mach**

Supervisor 1: **Bontempo Luana**
Supervisor 2: **Biasioli Franco**

Context / Synthetic description of the project

The characterization of food products using advanced analytical techniques is a rapidly evolving field, particularly for ensuring quality, authenticity, and safety. Hazelnuts (Corylus avellana L.) and their derivatives, such as pastes, oils, and confectionery items, are high-value commodities widely used in the food industry. Due to their economic significance, a key aspect is its quality and deterioration during storage or processing conditions.
To address these challenges, NUTTISCH proposes an integrated analytical approach utilizing Nuclear Magnetic Resonance (NMR), Gas Chromatography-Mass Spectrometry (GC-MS), and Proton Transfer Reaction-Mass Spectrometry (PTR-MS). Despite the individual advancements of these technologies, an integrated framework combining their capabilities has not yet been fully explored in hazelnut characterization. NUTTISCH aims to bridge this gap by creating a holistic analytical methodology that enhances quality control, traceability, and authenticity verification.
Objectives of the project are to develop a combined NMR, GC-MS, and PTR-MS analytical framework for hazelnut characterization. The combination of these techniques will be used to establish biomarkers for quality assessment and freshness evaluation, as well as to investigate the impact of processing techniques (e.g., roasting, grinding, oil extraction) on hazelnut composition.
The project will follow a structured methodology comprising:

Sample Collection and Preparation considering samples from different cultivars and/or geographical origins and/or processing conditions that will be gathered and analyzed.

NMR Spectroscopy, GC-MS Analysis and PTR-MS Monitoring: will be applied on the samples focusing in particular on 1) detection of freshness indicators, 2) determination of primary metabolites that can be precursors of volatile compounds of interest for the hazelnuts quality relatable to specific genetic traits of the hazelnuts variety.

Data Integration and Chemometric Analysis: Advanced statistical and machine-learning techniques will be used to correlate spectral and chromatographic data, enabling robust classification models.

Validation and Industrial Testing: The developed methodology will be tested in collaboration with industry partners to assess its applicability and reliability in real-world scenarios.

Among the expected results there will be a comprehensive metabolic and volatilomic fingerprint of hazelnuts and their derivatives with the identification of critical biomarkers for quality assurance. The integration of NMR, GC-MS, and PTR-MS for hazelnut characterization holds significant promise across multiple domains including deepen the understanding of hazelnut metabolic and volatile profiles, contributing to innovative quality control workflows, enabling industries to implement more efficient and reliable methods.

PhD in AGRIFOOD AND ENVIRONMENTAL SCIENCES

CALL 2025 – CYCLE 41

Reserved scholarship:

M3 - Characterization of the Sensory Evolution of Wines through Advanced Analytical Methodologies (GC-MS/MS and LC-HRMS)

FUNDING BODY: Fondazione Edmund Mach

Supervisor 1: **Roberto Larcher**

Supervisor 2: **Tomas Roman**

Supervisor 3: **Tiziana Nardin**

Supervisor 4: **Mauro Paolini**

https://ctt.fmach.it/Classificazioni/Aree-tematiche/Enologia-alimenti-e-bevande

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Context / Synthetic description of the project

Aging plays a crucial role in the sensory evolution of wine. In sparkling wines, the evolution of aroma is strongly influenced by the second fermentation and the contact with yeast during "*sur lies*" aging. During this period, yeast cells release tertiary compounds like fatty acids, amino acids or peptides, which contribute to the formation of complex aromas, including toasted bread, bread crust, yeast. The balance between freshness and complexity is essential in the sensory perception of sparkling wines: moderate aging allows the wine to preserve a richer array of greener, floral and fruity scents, while excessive aging may result in the loss of freshness and primary fragrances. The aromatic evolution of wines is, therefore, the result of a delicate interplay between the release of aromatic precursors and the chemical modification of free forms. This experimental study aims to highlight the compositional factors that most accurately characterize the aging *sur lies* process, as well as the potential correlation between measurable compositional aspects and the sensory perception of the wine's evolution.

PhD in AGRIFOOD AND ENVIRONMENTAL SCIENCES

CALL 2025 – CYCLE 41

Reserved scholarship:

M4 - Enological valorization of PIWI varieties

FUNDING BODY: Fondazione Edmund Mach

Supervisor 1: **Tomas Roman**

Supervisor 2: **Roberto Larcher**

Supervisor 3: **Maurizio Bottura**

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Context / Synthetic description of the project

PilzWiderstandsfahige or PIWI are mould-resistant grape varieties obtained as a result of interspecific crosses of different *Vitis* species and further re-crossing with *Vitis vinifera.* Previously, breeders selected varieties based on the quality perception of wines within those that showed the best resistance performance to moulds. Recently, and thanks to marked-assisted selection, breeders have speed-up the iter and new perspectives have been developed, where selection is guided to fulfill enological expectations. The rapid increase in the number of genotypes already available and those to come for wine production raises, however, issues for both breeders and winemakers. The ambiguous consumer acceptability of varietal PIWI wines might not provide sufficient added value to generate the expected income for producers. This might be overcome by consumers' acknowledgement of the style in Denomination of Origin wines, for which product specifications are well established and defined. The project aims to characterise the grapes and wines of PIWI varieties, defining markers and features potentially used in the identification of the genotypes that best suit the wine style and/or product specifications. Based on this, best practices will be evaluated in compliance with the defined features, with particular emphasis on the technological variability that might be achieved with the use of winemaking biotechnologies.

PhD in AGRIFOOD AND ENVIRONMENTAL SCIENCES

CALL 2025 – CYCLE 41

Reserved scholarship:

M5 - Use and management of *Kluyveromyces marxianus* strains in the production of fermented beverages

FUNDING BODY: Fondazione Edmund Mach

Supervisor 1: Tomas Roman
Supervisor 2: Raffaele Guzzon
Supervisor 3: Mauro Paolini
Supervisor 4: Silvia Schiavon
Supervisor 5: Roberto Larcher

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Context / Synthetic description of the project

Kluyveromyces marxianus is a yeast capable of both respiratory and fermentative metabolism, generating energy through the tricarboxylic acid (TCA) cycle via oxidative phosphorylation or via ethanol fermentation. Under conditions of high sugar concentration, yeasts such as *Saccharomyces cerevisiae* exhibit a strong preference for fermentation, directing pyruvate towards ethanol production, despite the lower net energy yield compared to the TCA cycle. This phenomenon, known as the Crabtree effect, is hypothesized to confer a competitive advantage in certain ecological niches because sugars depletion by fermentation is faster than respiration and the end product (ethanol) is selective against other microorganisms. Although *K. marxianus* is generally classified as Crabtree-negative, it possesses genetic capacity for ethanol production via fermentation and may adopt this metabolic pathway under specific conditions. This discrepancy in the Crabtree status of *K. marxianus* likely reflects strain specificity and variability. Nonetheless, some strains have been reported to yield up to 10% (v/v) ethanol from glucose. However, this fermenting capacity is not its sole interesting feature; *K. marxianus* exhibits one of the fastest growth rates among eukaryotic microbes, being strongly influenced by oxygen levels, which in turn affects the fermentative capacity. Not only, but the enzymatic pool of this yeast (i.e. pectinase, lipases, superoxide dismutases, β-glucanases and β-glucosidases) make it interesting in the production of beverages, as the sensory profile is influenced by their activity but also because *K. marxianus* is capable of metabolizing complex sugars, as lactose. The project aims to isolate *K. marxianus* strains from different food matrices and characterize them for their use in the production of fermented beverages. Depending on the product specifications and characteristics of the raw material, the more suitable fermenting conditions will be investigated, among which the interaction with other yeast concomitantly employed and the technological variability possibly induced on the chemical composition affecting the quality of the beverages, both in terms of chemical markers or active compounds.