Ph.D. Day 2025

CORSO DI DOTTORATO IN SCIENZE AGRARIE E AMBIENTALI

ATTI DELLA GIORNATA

UNIVERSITÀ DEGLI STUDI FIRENZE | Scuola di Agraria

UNIVERSITÀ DEGLI STUDI FIRENZE
DAGRI
DIPARTIMENTO DI SCIENZE E TECNOLOGIE AGRARIE, ALIMENTARI, AMBIENTALI E FORESTALI

ORDINE DEI DOTTORI AGRONOMI E DEI DOTTORI FORESTALI DELLA PROVINCIA DI FIRENZE

Ministero della Giustizia

Contenuti

Programma della giornata

VENERDÌ 19 DICEMBRE

Aula C della Scuola di Agraria

Piazzale delle Cascine, 18 - Firenze

Welcome Meet & Cheers
Ph.D. Edition

L'evento, organizzato dal Corso di Dottorato in Scienze Agrarie e Ambientali (SAA) dell'Università di Firenze, vuole facilitare la conoscenza tra dottorandi e lo scambio di esperienze e idee. A questo si aggiunge l'intersezione con il mondo della libera professione attraverso l'incontro con alcuni/e rappresentanti dell'Ordine dei Dottori Agronomi e Dottori Forestali di Firenze.

Programma

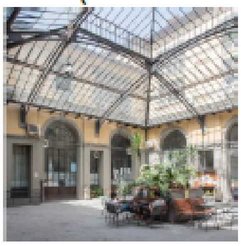
15:00 Benvenuto e saluti del Presidente del corso di Dottorato in Scienze Agrarie e Ambientali, Prof. *Carlo Viti* e del Delegato Al Dottorato Di Ricerca di UNIFI, Prof. *Stefano Cannicci*

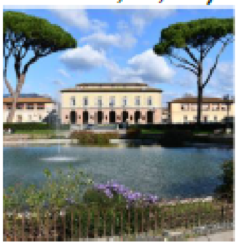
15:15 I dottorandi del XXXVIII presentano le loro attività di ricerca

16:45 Storie di Ph.D. con la Dott.ssa *Carolina Fabbri* (PhD, attualmente presso Yanmar R&D Europe, Firenze)

17:15 Tavola rotonda: Il fabbisogno di ricerca dei liberi professionisti e come i programmi di ricerca si relazionano con il mondo professionale. Con *Fabio Burroni* (Dottore Agronomo ODAF Firenze), *Andrea Triossi* (Dottore Agronomo, Agri4), *Anna Dalla Marta* (Prof. Associato, DAGRI-UNIFI), *Gaio Cesare Pacini* (Prof. Associato, DAGRI-UNIFI), *Riccardo Bozzi* (Prof. Ordinario, Presidente della Scuola di Agraria di UNIFI). Modera: *Elisa Corneli* (Presidente di Chiantiform)

17:45 Poster session (dottorandi dei cicli XXXIX, XL, XLI) e brindisi finale





L'evento è aperto a studenti di corsi di laurea triennale e magistrale che vogliono conoscere il percorso di studio di terzo livello (dottorato), docenti e ricercatori che desiderano conoscere le tematiche di ricerca degli attuali cicli di dottorato o cercare un momento di confronto e scambio.

Ai Dottori Agronomi e Forestali che parteciperanno saranno riconosciuti i crediti formativi come da normativa nazionale

Registrati entro mercoledì 17 dicembre: https://forms.gle/pqxLWwRGehuKb9Zo8

UNIVERSITÀ DEGLI STUDI FIRENZE | Scuola di Agraria

UNIVERSITÀ DEGLI STUDI FIRENZE DAGRI DIPARTIMENTO DI SCIENZE E TECNOLOGIE AGRARIE, ALIMENTARI, AMBIENTALI E FORESTALI

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Presentazioni Dottorand3 del 38° ciclo

Cosimo Beltrami:*Marginal area valorisation: chestnut-derived products for plant biostimulation and protection*

Luca Bernabò:*Purple non-sulfur bacteria: ideal microbial cell factories for biotransformation of agro-industrial wastes into high-added value molecules*

Sara Campigli: *Role of the exopolysaccharide levan in the life cycle of Pseudomonas syringae pv. actinidiae biovar 3, a phytopathogenic member of the bacterial community of Pseudomonas sp. associated with kiwifruit*

Roberta Ferrante:*Development and implementation of genetic indicators of biodiversity*

Michele Moretta:*Crop productivity and sustainability of Agro-Voltaic systems in response to climate change*

Ilaria Santi:*Effetti interattivi del riscaldamento globale e della gestione sulla diversità vegetale delle comunità del sottobosco e il microclima delle foreste mediterranee*

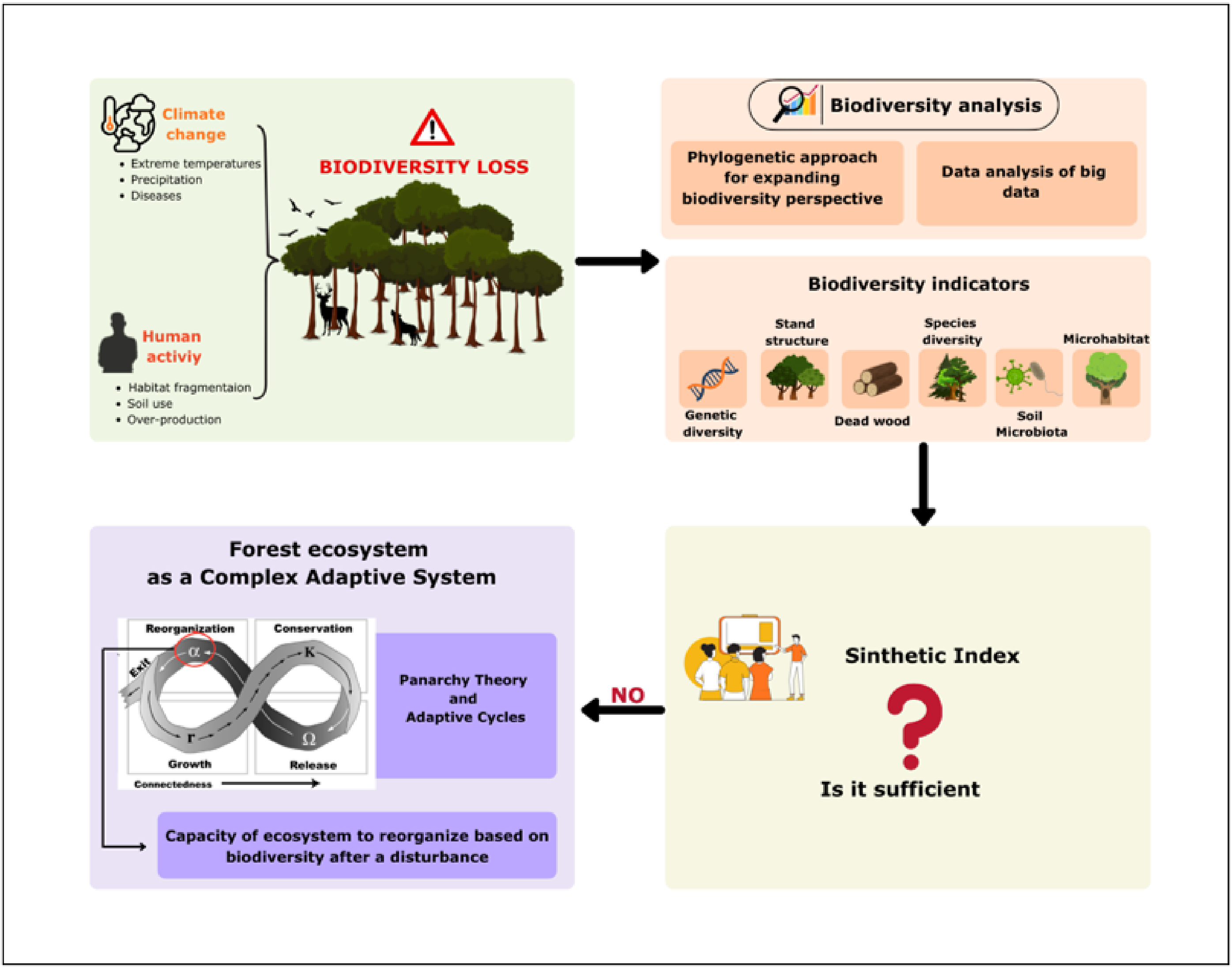
Francesco Serafini:*Circular agroecology in practice: research pathways from long-term experiments to soil biodiversity*

Andrea Viviano:*Plants, carbon dynamics, and ozone pollution*

Moderatori: Lorenzo Ferretti e Luca De Guttry

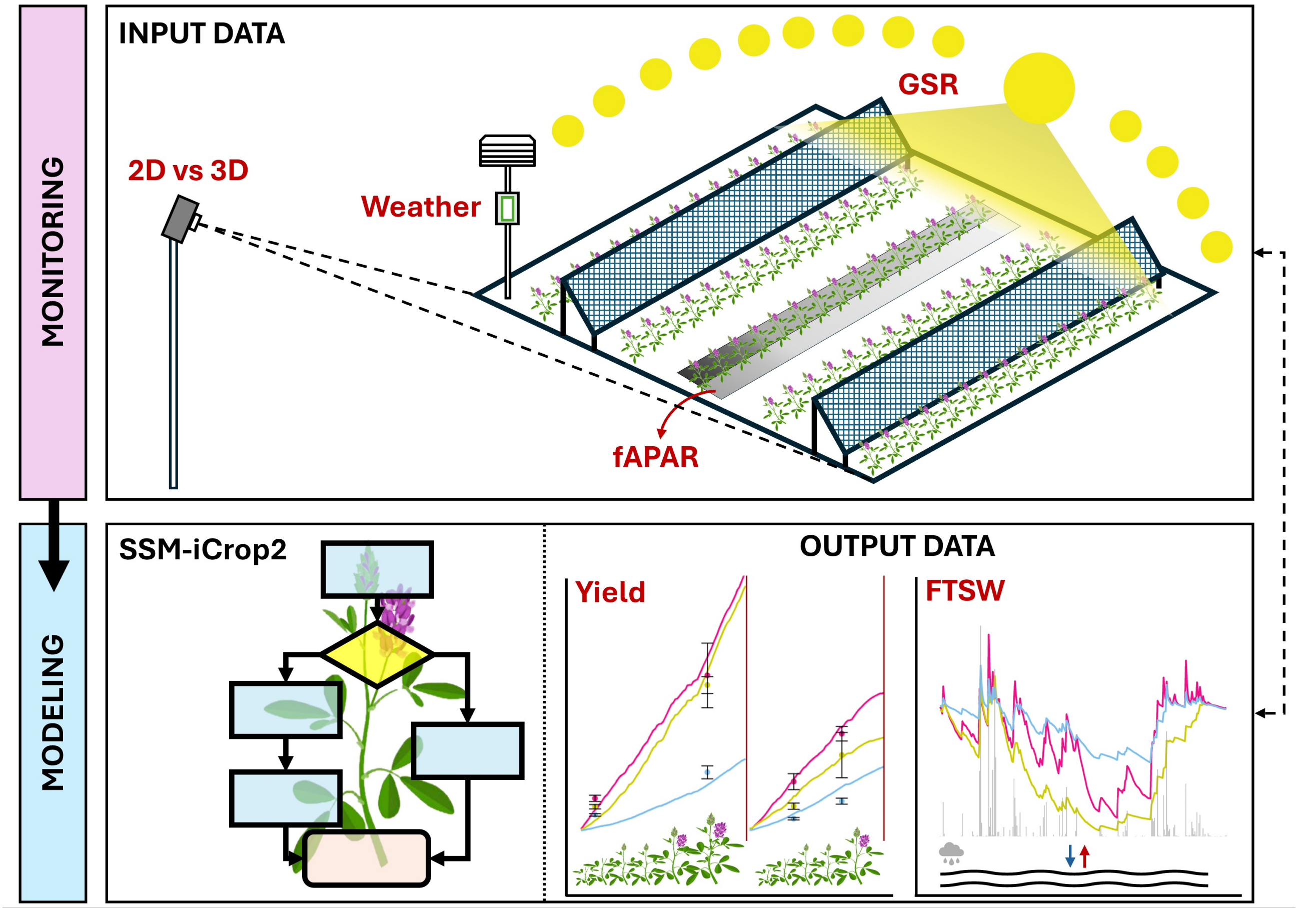
Roberta Ferrante: *Development and implementation of genetic indicators of biodiversity*

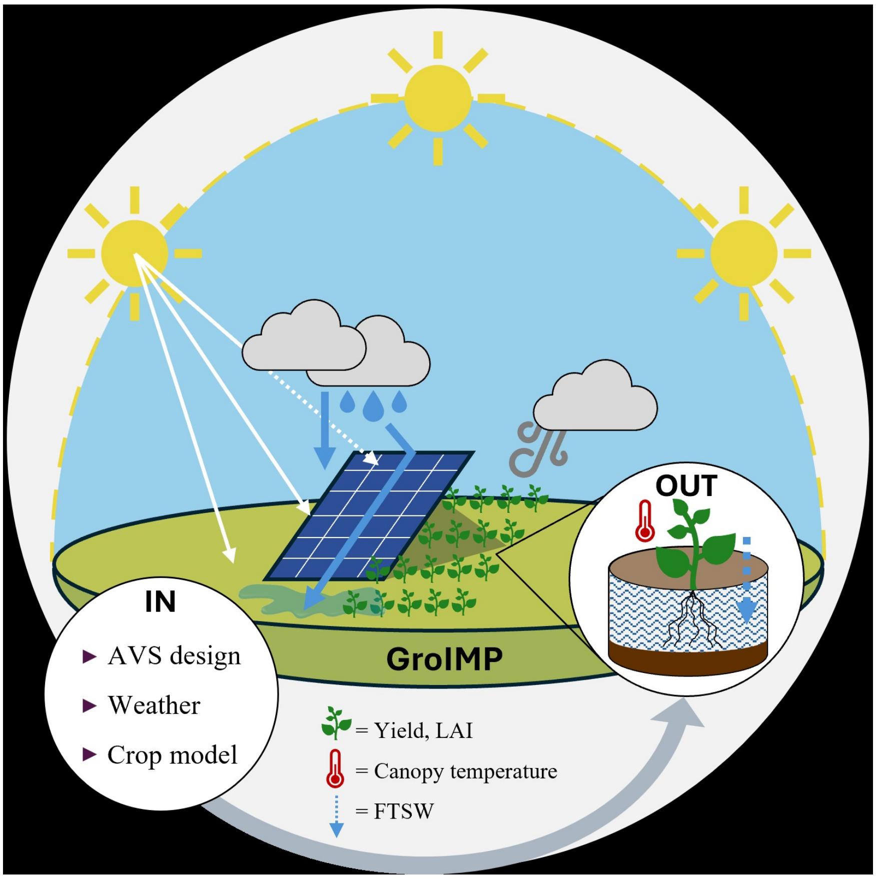
Graphical abstract



Michele Moretta: *Crop productivity and sustainability of Agro-Voltaic systems in response to climate change*

Graphical abstract





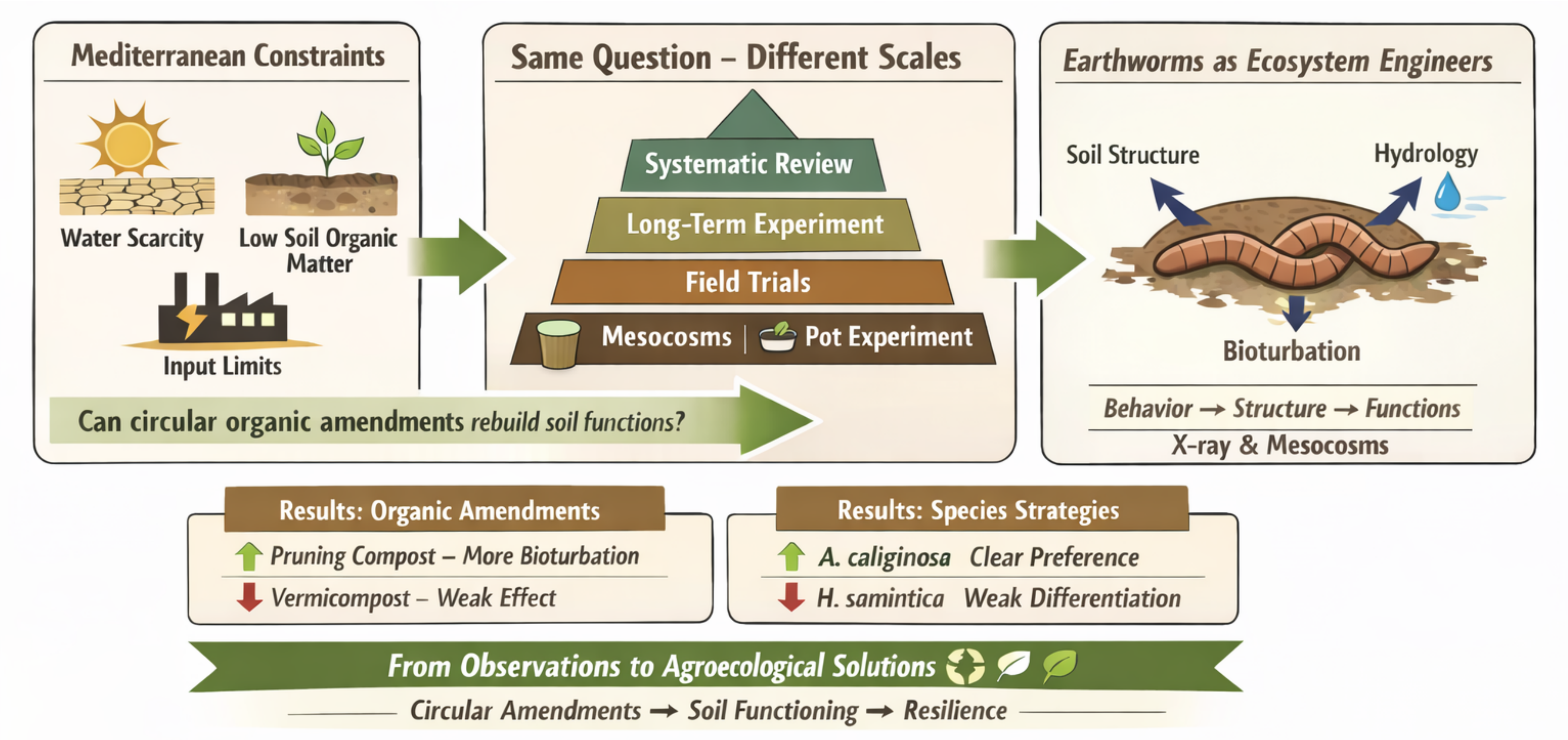
Ilaria Santi: *Effetti interattivi del riscaldamento globale e della gestione sulla diversità vegetale delle comunità del sottobosco e il microclima delle foreste mediterranee*

Abstract

Forests play a fundamental role in sustaining biodiversity and regulating the terrestrial climate, yet the understorey – the forest layer composed of woody and non-woody vascular plants below a threshold height of ca. 1 m – is increasingly affected by the combined impacts of forest management and climate variability. The buffering capacity of forest canopies mitigates exposure to macroclimatic extremes, but this function is highly dependent on canopy structure, management intensity, and edge proximity. Understanding how these local drivers interact with climatic stressors is therefore crucial for predicting ecological responses and guiding adaptive management strategies. This thesis investigates how forest management, canopy structure, and climate jointly influence microclimatic conditions and, in turn, shape the taxonomic, functional, and phylogenetic diversity of understorey plant communities across temperate European forests, with particular emphasis on Mediterranean forests due to their high ecological significance. In Chapter 2, the effects of forest management on microclimate and diversity in a mediterranean oak forest were analysed. Open-canopy stands significantly reduced air-temperature buffering, particularly in spring, due to limited canopy closure and lower stand density. Dense canopies, in contrast, stabilized near-ground thermal conditions and maintained higher humidity. Coppiced forests were therefore more tightly coupled to macroclimatic fluctuations, while high forests buffered understorey biodiversity against warming and drought stress. Forest management practices, such as coppicing and thinning, induced pronounced changes in the taxonomic, functional, and phylogenetic structure of understorey communities. Canopy opening promoted generalist, thermophilous, and light-demanding species, leading to increased species richness in Mediterranean-type temperate forests. However, functional diversity declined under disturbance: coppiced stands were dominated by species with higher leaf dry matter content (LDMC) and reduced interspecific trait variability. This pattern indicates strong environmental filtering toward conservative strategies, ultimately resulting in lower ecosystem resilience. Consistently, phylogenetic diversity was reduced in coppiced forests across southern Europe. In Chapter 3 the effects of forest management on intraspecific trait variation were examined in two mediterranean oak forests. Coppicing influenced intraspecific trait variation, generally enhancing phenotypic variability and plasticity across species. Morphological and physiological adjustments reflected adaptive strategies to altered environmental conditions, with consistent shifts toward smaller leaves, lower specific leaf area, and greater stress tolerance. Although generalist and specialist species often exhibited similar directions of trait change (e.g., both reduced their leaf area in coppiced stands), 1 species-specific responses were also apparent, underscoring the complex interplay between functional strategies and environmental heterogeneity. Overall, these findings indicate that forest management can either enhance or constrain intraspecific variability depending on environmental heterogeneity and resource distribution, ultimately shaping species' adaptive potential. Finally, in Chapter 4 the effects of forest management and stand structure, climate-change drivers— specifically warming and drought—and their interactions were assessed in Central European temperate forests. Plots subjected to higher drought intensity showed stronger declines in species evenness and specialist richness. Open stands amplified the negative effects of warming on community evenness, driven by the increased dominance of thermophilous species under more open canopies. In contrast, phylogenetic diversity increased more markedly in plots experiencing greater canopy cover loss, while phylogenetic dispersion declined more strongly in plots exposed to higher temperature increases. Overall, these results highlight the pivotal role of canopy structure and local microclimate in mediating the combined effects of forest management and climate change on understorey communities. Maintaining structurally complex forests may therefore be an effective strategy to preserve biodiversity and sustain ecosystem functioning under increasingly severe climatic stress. This thesis provides a valuable framework for nature-oriented forest management and offers a foundation for future research addressing the interactive effects of management and climate drivers, particularly in Mediterranean regions, where empirical evidence remains comparatively scarce.

Francesco Serafini: *Circular agroecology in practice: research pathways from long-term experiments to soil biodiversity*

Graphical abstract



Andrea Viviano: *Plants, carbon dynamics, and ozone pollution*

Abstract

Tropospheric ozone (O_3) is a widespread phytotoxic pollutant that constrains plant physiological performance, alters carbon allocation patterns, and threatens forest functioning under current and future atmospheric scenarios. This dissertation develops an integrated, multi-scale framework to quantify O_3 effects on woody species by combining controlled fumigation experiments, trait-based modeling, long term field observations, and high-resolution growth analyses. Free-Air Controlled Exposure (FACE) experiments on ornamental and forest species show that flux-based metrics outperform concentration-based indices in predicting ecophysiological responses. In particular, the Leaf Index Flux (LIF), which integrates stomatal O_3 uptake (POD_1) with leaf structural investment (leaf mass per area), consistently shows higher explanatory power for photosynthesis, respiration, chlorophyll status, and photochemical efficiency, highlighting the importance of coupling physiological fluxes with morphological traits in O_3 risk metrics. Experiments on Robinia pseudoacacia further demonstrate that rhizobial symbiosis mitigates O_3 injury by reducing stomatal O_3 uptake and buffering biomass losses, resulting in higher critical levels compared to O_3-sensitive species. Across a broader range of woody taxa, O_3 induced biomass reductions are species and functional type-dependent, with belowground compartments showing the highest sensitivity, suggesting that O_3 affects not only total carbon accumulation, but also its distribution among plant organs. Field-based assessments integrating sap flow measurements refine stomatal flux estimates and improve the prediction of O_3-visible foliar injury, supporting the revision of critical levels using in situ physiological data. Finally, high-frequency dendrometric analyses coupled with rolling partial-correlation approaches indicate that dendrometric time series can be effectively used to explore short, sub-monthly periods during which ozone exposure may be associated with variations in irreversible radial growth. These associations emerge primarily at fine temporal scales and tend to be progressively attenuated when growth and ozone signals are aggregated over longer windows. Overall, this study highlights the potential of integrating site-specific ozone flux estimates with high-resolution dendrometric data to improve the interpretation of ozone–growth relationships in mature Mediterranean beech forests. This work supports the adoption of physiologically-based, flux-based, and temporally-explicit frameworks as a robust basis for improving ozone risk assessment in forest ecosystems.

Poster Dottorand3 del 39° ciclo

Hydrogen production in bio-electrochemical systems with purple non-sulfur bacteria

Chiara Capelli, XXXIX cycle

Introduction

Bio-electrochemical systems (BESs) are promising tools that exploit **microbial electron transfer** to drive **energy-producing** reactions and could support the **valorization of organic waste** streams such as brewer's waste (BW)[1]. Purple non-sulfur bacteria (PNSB), especially *Rhodopseudomonas palustris*, have versatile metabolisms, but their electroactivity is still not fully understood[2].

Aim

- Determine whether *R. palustris* 42OL can efficiently uptake electrons from a biocathode.
- Assess its potential in enhancing **electron-driven H_2 production**.
- Evaluate if redox mediators can strengthen **microbial-electrode interactions** by facilitating electron transfer.

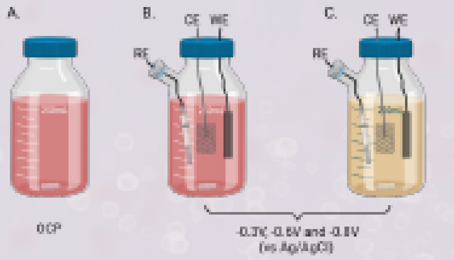
Methodology

Phase I: Effect of cathodic polarization

- -0.3V, -0.6V, -0.8V (vs Ag/AgCl)
- controls: non-polarized + abiotic control

Reactor setup

- Strain: *R. palustris* 42OL
- Configuration: 250mL single-chamber, sterile BW, anaerobic, continuous illumination



Phase II: Use of redox mediators

- -0.6V (vs Ag/AgCl)
- controls: non-polarized
- AQDS as redox mediator

Reactor setup

- Strain: *R. palustris* 42OL
- Configuration: 250mL double-chamber, anaerobic, continuous illumination, acetic acid as carbon source

RESULTS

Phase I: effect of cathodic polarization

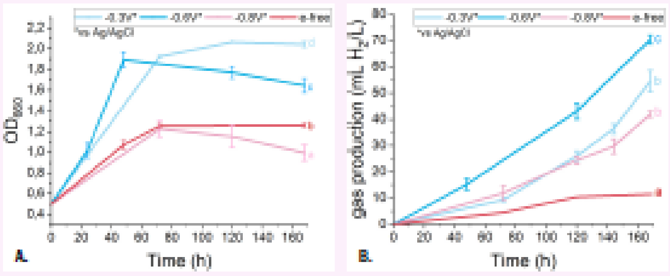


Figure 1. Biomass growth (A) and H_2 production (B) of *R. palustris* 42OL. Moderate cathodic potentials (–0.3 and –0.6 V) increased biomass (0.91 ± 0.01 g L⁻¹ and 0.73 ± 0.03 g L⁻¹) and yielded the highest H_2 production (54–70 mL L⁻¹), while –0.8 V inhibited growth and reduced H_2 output.

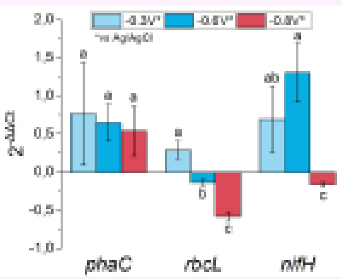


Figure 2. RT-qPCR analysis of metabolic gene expression in *R. palustris* 42OL under cathodic polarization. NifH was maximally induced at –0.6 V, while rbcL was increasingly downregulated at more negative potentials. phaC expression remained stable across all voltages. Values are normalized to recA and to the photoheterotrophic control.

Phase II: use of redox mediators

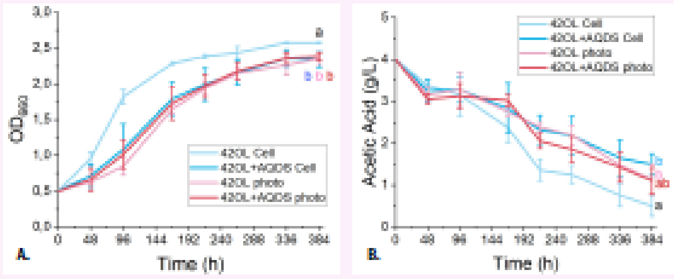


Figure 3. Biomass production (A) and acetic acid consumption (B). The 42OL Cell exhibited the highest biomass accumulation, and acetic acid consumption followed the same trend: the 42OL Cell degraded acetic acid rapidly, while the 42OL + AQDS Cell condition exhibited the slowest degradation (with a better ratio between biomass production and substrate consumption)

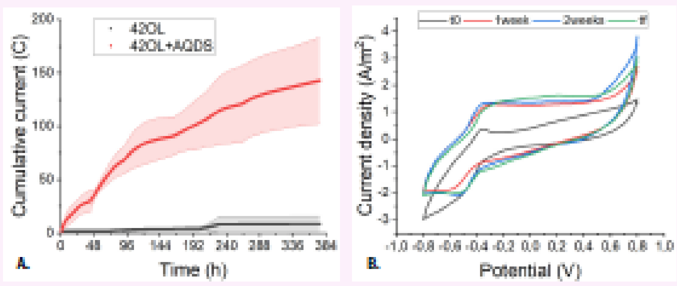


Figure 4. (A) Cumulative Charge: The addition of AQDS (red line) leads to a significant enhancement in extracellular electron transfer, resulting in much higher total charge accumulation compared to the control (black line). (B) Cyclic Voltammetry (CV): CVs show a progressive increase in current density and distinct redox peaks, confirming the development of stable cell-electrode interactions and electroactivity over time.

DISCUSSION

- First demonstration of *R. palustris* 42OL growing photoheterotrophically in a BES using BW
- **Electroactivity confirmed** via CV and CA; the addition of AQDS further strengthened cell-electrode interactions.
- Optimal Potential at –0.6 V: highest H_2 production, biomass, and PHB accumulation, consistent with transcriptional data.
- **Metabolic Flexibility:** electrode-derived electrons can simultaneously drive multiple metabolic pathways.

REFERENCES

1. Daghio, M., Aulenta, F., Vaiopoulou, E., Franzetti, A., Arends, J. B., Sherry, A., ... & Rabaey, K. (2017). Electrobioremediation of oil spills. Water research, 114, 351-370.
2. Vasiliadou, I. A., Berná, A., Manchon, C., Melero, J. A., Martinez, F., Esteve-Núñez, A., & Puyol, D. (2018). Biological and bioelectrochemical systems for hydrogen production and carbon fixation using purple phototrophic bacteria. Frontiers in Energy Research, 6, 107

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Università degli Studi Firenze

UNIVERSITÀ DEGLI STUDI FIRENZE

DAGRI DIPARTIMENTO DI SCIENZE E TECNOLOGIE AGRARIE, ALIMENTARI, AMBIENTALI E FORESTALI

PhD in Agricultural and Environmental Sciences XXXIX cycle

Effects of water stress on agronomic, morphological and physiological parameters of maize hybrids with different drought tolerance

Andrea Carli*, Leonardo Verdi, Graziano Ghinassi, Giulia Pastacaldi, Roberto Vivoli, Anna Dalla Marta

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Context

Maize (*Zea mays* L.) is a crop of primary global importance, widely used for human and animal consumption as well as for industrial and energy purposes. Due to its high water requirements, maize production is increasingly challenged by climate change, particularly as a result of reduced rainfall during growth stages most sensitive to water stress. In this context, the adoption of drought-tolerant (DT) hybrids combined with deficit irrigation strategies, aimed at optimising irrigation volumes without excess, represents a key approach to improving water use efficiency and preserving water resources.

Aims

- Estimate demand and calculate water productivity.
- Assess the degree of water stress resistance of drought-tolerant hybrids.
- Understand the agronomic, morphological and physiological responses of hybrids to different levels of water availability.

Methodology

Experimental field and treatments

- CREA "Fagna" experimental farm (Scarperia, FI); sandy-loam soil.
- 3 years of field trials: 2024 – 2025 – 2026.
- 4 maize hybrids (FAO 300–400; DT vs conventional)

P0217 (400_DT) – P0729 (400) – P9889 (300_DT) – P9363 (300).

- Treatments: full irrigation (I_{100}), deficit irrigation (I_{50}), rainfed (I_0).
- Irrigation management: drip irrigation; ET_0 (Penman–Monteith) x K_c

I_{100} = ET_c – rainfall; I_{50} = 50% I_{100}.

- 3 replicates; 36 plots (22 m² / plot).

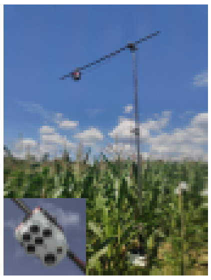
Yield parameters

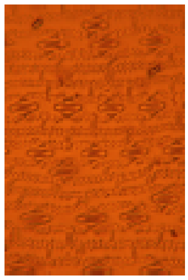
- Grain yield (GY) and biomass.
- Harvest index (HI).
- Water productivity (WP).
- 1000 KW and ear size.
- Grain quality: starch, lipids, proteins.

Agronomic and physiological surveys

- Phenology; height; canopy cover (CC); leaf area and morphology.
- Vegetative vigour: chlorophyll; NDVI.

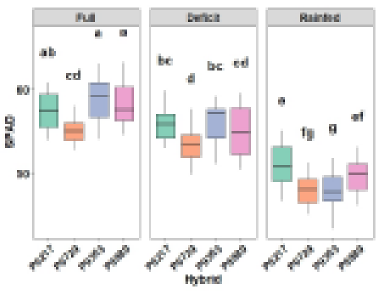
- Leaf physiology: RWC; stomatal conductance (G_s) and transpiration; ΦPSII.
- Multispectral and thermal images.
- Stomatal micromorphology: density and stomatal index, stomatal size.



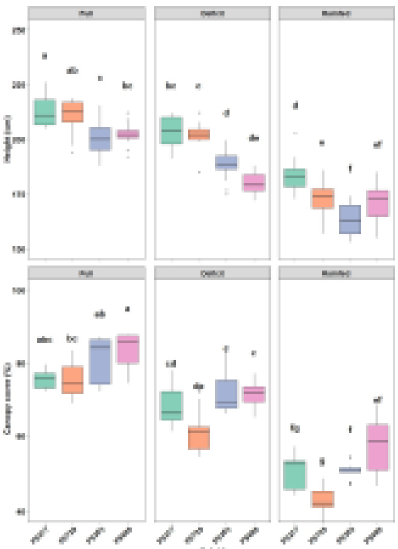


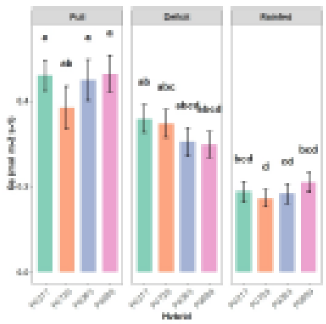
Results

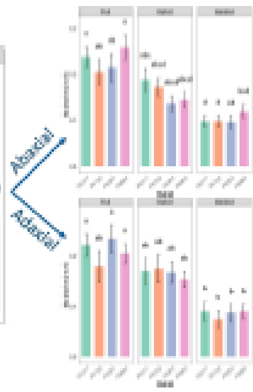
- Plant height and canopy cover decrease with water stress.
- DT hybrids maintain greater height and canopy cover under RF.
- One fewer leaf is formed under water deficit.
- P0217 shows the best stay-green under Deficit and Rainfed.
- NDVI trends mirror chlorophyll index patterns.



- G_s is mainly driven by the abaxial surface, except in P9363.
- Leaf water content remains unchanged under deficit conditions.







- In 2025, GY did not decrease under I_{50}.
- Water productivity was lower under full irrigation.

Irrigation	Hybrid	GY (t ha⁻¹)	AGB (t ha⁻¹)	Harvest index	WP (Kg m⁻³)	Hybrid	GY (t ha⁻¹)	AGB (t ha⁻¹)	Harvest index	WP (Kg m⁻³)
	400					300				
I_{100}	P0217	13,77	23,20	0,60	3,44	P9889	10,54	18,83	0,55	2,64
I_{50}		13,14	21,73	0,61	4,25		10,22	16,79	0,61	3,30
I_0		9,81	17,38	0,56	4,42		9,26	15,29	0,61	4,16
I_{100}	P0729	13,93	23,88	0,58	3,48	P9363	11,43	19,77	0,58	2,86
I_{50}		13,80	22,71	0,61	4,49		10,03	16,27	0,62	3,24
I_0		8,79	15,73	0,56	3,96		9,33	15,17	0,62	4,20

- Rainfall during the flowering and early ear formation stages enabled high yields even with a 50% reduction in irrigation
- Combining deficit irrigation with DT hybrids can enhance both economic and environmental sustainability

UNIVERSITÀ DEGLI STUDI FIRENZE

Doctorate in Agricultural and Environmental Sciences
cycle XXXIX

UNIVERSITÀ DEGLI STUDI FIRENZE

Assessment of soybean water productivity and grain yield under optimal and regulated deficit irrigation

Pastacaldi G., Ghinassi G., Verdi L., Dalla Marta A.

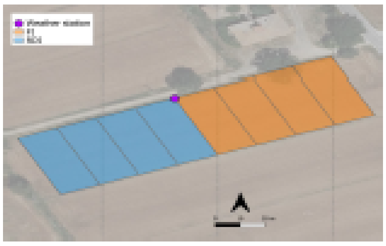
Introduction

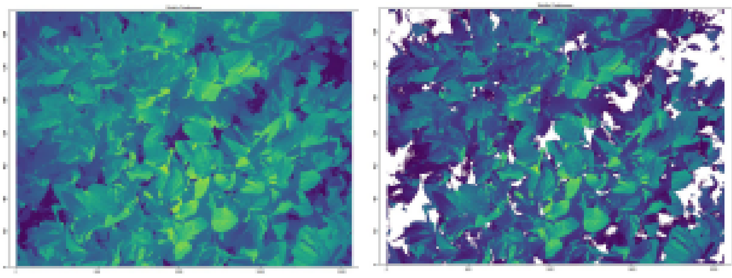
Soybean (Glycine max (L.) Merr.) is the **fourth largest cultivated crop** (FAOSTAT, 2023), source of protein and fat for both livestock and humans, but it is also **high-water requiring crop**. To prevent water loss and environmental damage caused by over-irrigation, it's important to:

- **Reduce the volumes** of irrigation water applied;
- **Develop reliable tools** for estimating crop and net irrigation water requirements.
- Combine agronomic knowledge with **proximal and remote sensors as non-destructive methods** of evaluating water stress and optimising irrigation scheduling.

Objectives

The aims are to: (a) examine the effects of varying water regimes, **full irrigation (FI)** and **regulated deficit irrigation (RDI)**, on **soybean productivity and seeds quality**; (b) assess how changes in plant water status affect **canopy spectral reflectance and vegetation indices (VIs)**; (c) assess of soybean health and water status via **remote sensing and proximal technologies, validated with in situ measurements.**





Materials and methods

A **two-year experimental** field (2024 and 2025) was set in Chianacce (Arezzo).

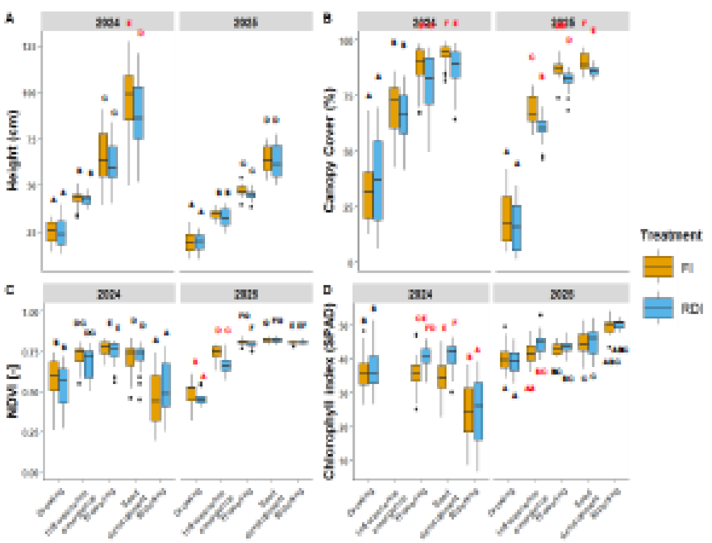
Two irrigation treatments were applied:

T1. **FI, 100%** cumulative evapotraspirative balance;

T2. **RDI, 70-100-70% FI** during growing, flowering, and maturation respectively.

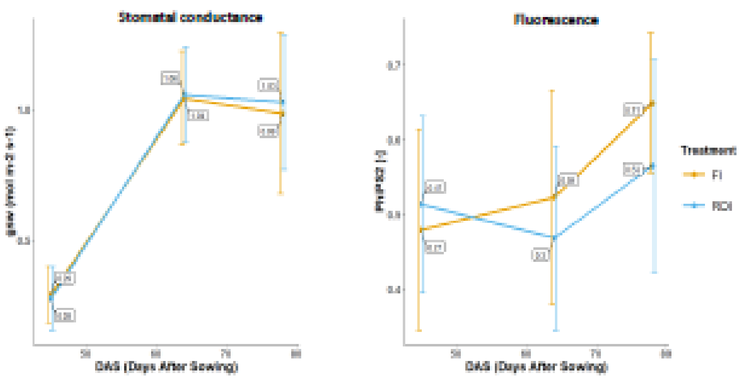
Crop health and water status parameters were monitored during the whole growing cycle:

- Chlorophyll index
- Normalized Difference Vegetation Index (NDVI)
- Canopy Cover
- Crop height
- Stomatal conductance, fluorescence, leaf temperature
- VIs and leaf temperature from multispectral and thermal camera



Preliminary results

- **Crop height and NDVI show no significant differences between FI and RDI** in 2024 and 2025, but **canopy cover and chlorophyll index do, starting from inflorescence stage** in 2024, a trend confirmed in 2025. FI assumes higher values than RDI, except for chlorophyll index.
- **There are no differences in stomatal conductance, but fluorescence values** are significantly **higher for FI** than for RDI.
- In 2024, **RDI productivity and quality achieved higher values than FI, but not significantly**. In 2025, RDI was more productive than FI, significantly so for biomass and water productivity (WP), but not for yield and harvest index (HI).
- The analysis of multispectral and thermal images from camera and satellite is currently underway.



		Yield (kg ha⁻¹)	Abov. biomass (kg ha⁻¹)	HI [-]	WP (kg ha⁻¹ mm⁻¹)	Protein (%)	Fat (%)
2024	FI	2744 ± 105b	7745 ± 282b	0.36 ± 0.01a	5.1 ± 0.2a	30.9 ± 0.2a	25.6 ± 0.3a
	RDI	3119 ± 237b	7915 ± 614b	0.40 ± 0.01a	6.7 ± 0.5a	31.1 ± 0.1a	25.4 ± 0.1a
2025	FI	3881 ± 189a	7047 ± 408a	0.56 ± 0.03a	13.1 ±0.6a	-	-
	RDI	4273 ± 130a	7988 ± 283b	0.54 ± 0.02a	16.4 ± 0.5b	-	-

The data are provided as mean ± standard error

Acknowledgments

PRIN 2020 project "Looking back to go forward: reassessing crop water requirements in the face of global warming" (REWATERING) funded by the Italian Ministry of University and Research (CUP: B53C22000110006; code: 2020FFWTJR_003)

The optimization of the contemporary plant-soil feedback under legume–cereal intercropping systems

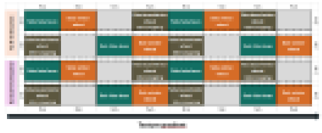
PhD candidate: Riccardo Picone[1,2]
Supervisors: Shamina Imran Pathan[1], Giacomo Pietramellara[1], Georg Guggenberger[2], Norman Gentsch[2]
[1]University of Florence, [2]University of Hannover

INTRODUCTION

- Increasing **crop yields** with lower **inputs of fertilizers** is necessary to enhance **agroecosystem multifunctionality** under a **global change** scenario
- **Legume-cereal intercropping** is a valid solution to achieve this objective, with **yield increases** up to ~50% compared to sole cropping
- The effects of intercropping legumes and cereals on the **soil-plant nutrient** and **carbon (C) cycling** are not fully elucidated
- We hypothesized that the **diversification** of **rhizodeposits** through the intercropping of **fava bean** and **wheat** could cause an increase in soil and root **bacterial** and **fungal diversity** and **functionality** with respect to processes favoring **nutrient** and **C** retention in soil, resulting in the enhancement of **plant performance**

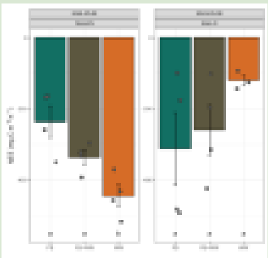
METHODS

- **Greenhouse gas** emissions
- **Soil C** and **nutrient** pools
- Soil and plant biomass organic C $\delta^{13}C$ and total N $\delta^{15}N$
- Soil **enzyme** activities, microbial **C use efficiency**
- **Soil** and **root** bacterial and fungal communities **metabarcoding** and **functional potential**
- Root **metabolomics**
- Soil **multifucntionality**

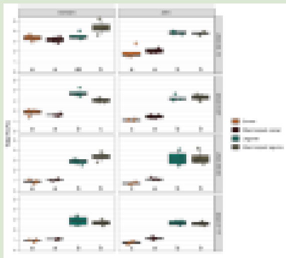


RESULTS

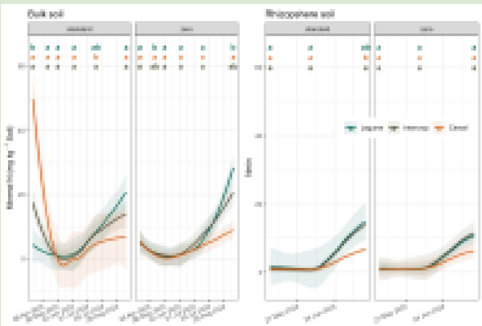
- No significant effects on **soil organic C concentration**
- Faba bean enhanced soil **potassium** (K) availability
- Wheat enhanced soil **magnesium** (Mg) availability
- Increased organic **N** and **P mineralization** potential
- No relevant changes in **microbial biomass C** and **C/N ratio**



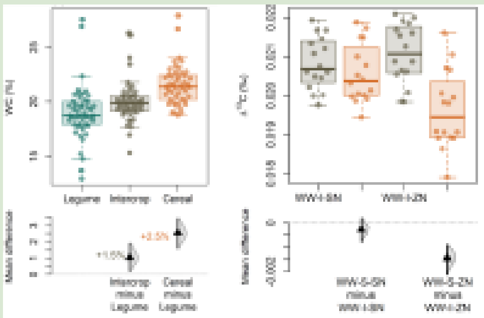
Net Ecosystem Exchanges
FB = faba bean, WW = Winter wheat



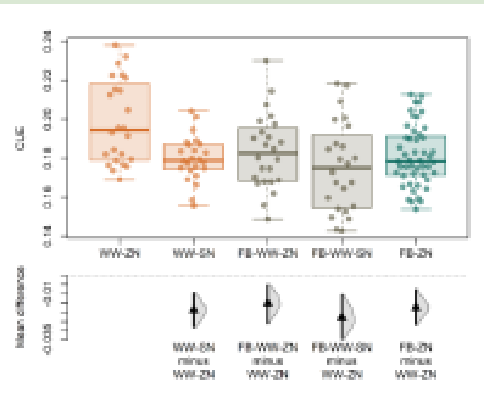
Plant biomass total N content



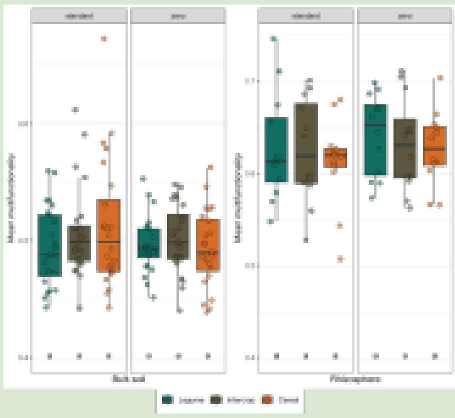
Mineral N availability



Water availability in soil and wheat biomass $\Delta^{13}C$



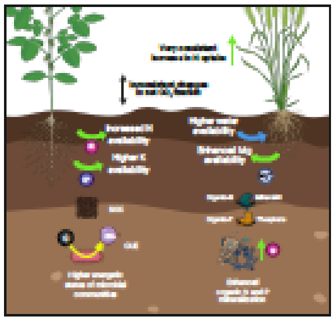
Microbial C use efficiency



Soil multifunctionality

CONCLUSIONS

- **Positive** effect on **N cycling**
- **Increased N uptake** by the **cereal** without fertilizer application
- Improved **C availability** for soil microbes
- The **availability** of some **macronutrients** (K, Mg) is increased
- **P** is possibly **used** more **efficiently** by plants
- The effects on soil **multifunctionality** are **inconsistent**



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EXPECTED RESULTS

- More **diverse**, **interconnected**, and **functionally redundant** microbial communities
- A higher **functional potential** for more efficient **nutrient** and **C cycling**
- Different **metabolomic patterns** between sole- and intercropped **plant roots**
- **Higher** soil **multifunctionality**

LEGUMINOSE
the way to a green transition

UNIVERSITÀ DEGLI STUDI FIRENZE
DAGRI

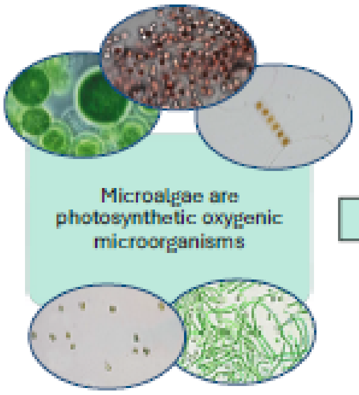
Scienze Agrarie e Ambientali PhD Day
Firenze, 19.12.2025

MICROALGAL CULTURES FOR OBTAINING RAW MATERIALS FOR BIOSUSTAINABLE INDUSTRIAL AND FOOD APPLICATIONS

PhD Student: Lorenzo Reali

Supervisor: Prof. Liliana Rodolfi
Co-Supervisor: Prof. Natascia Biondi

Research project introduction



Microalgae are photosynthetic oxygenic microorganisms

→ Production of polysaccharides:
- Starch
- β-glucans
- Exopolysaccharides

→ Application in industrial fields:
- Nutraceutical
- Cosmetics
- Biomaterials

→ Increase environmental sustainability by increasing CO_2 fixation and reducing energy consumption

First Year PhD Activity Summary:

Screening

- Investigation of different strains for **starch**, **β-glucan** and **exopolysaccharide** production
- 500 mL tubes bubbled with an air:CO_2 mixture
- Continuous light of 160 µmol photon m^{-2} s^{-1}, 27 °C temperature
- Cultivation in replete (all) and nitrogen and phosphorous-depleted media (starch and beta-glucan trials)

Optimizing

- **Starch accumulation** dynamic investigation in two selected strains
- Cultivation outdoors during July
- 7 L bubble tubes with controlled temperature (27°C) and pH (7,8)

Testing

- **Biomaterial** from marble waste, Ca-/bicarbonate-enriched microalgae biomass, and pectin
- **Exopolysaccharide** role in maintaining microalgae viability in the material

Second Year PhD Activity

Analysis of samples from the screening

Culture medium → **Exopolysaccharides** → Precipitation with alcohol → Quantification with phenol-sulfuric acid method

Biomass → Extraction with hot water → **Exopolysaccharides**

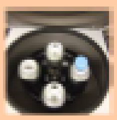
Biomass → Extraction with enzymes → **β-glucan** → Quantification with analytical KIT

EPS production and recovery for analysis

Cultivation conditions

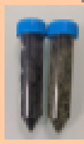
- 0.5 L tubes bubbled with air:CO_2 mixture
- continuous light

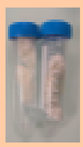
Centrifugation of the culture → **biomass** / **medium**



medium → Polysaccharide extraction → Freeze-drying for transportation

biomass → Freeze-drying for transportation





EPS production in 6-L annular columns

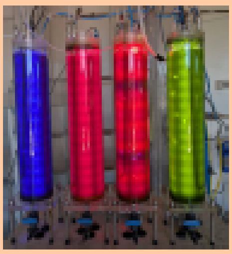
Trials to increase EPS from selected strain

Medium → Released EPS

Biomass → Cell-Bound EPS

- Two different batches
- Fluorescent tubes light (250 µmol photon m^{-2} s^{-1})
- Increasing nutrient limitation
- 33°C temperature

Activity at F&M S.r.l.



- Batch regime
- Led light: blue, red, violet, and white (300 µmol photon m^{-2} s^{-1})
- Severe N and P limitation
- 30°C temperature

EPS purification and characterization

Activity at University Clermont Auvergne

Ultrafiltration of EPS to remove salts and impurities on:
- **Cell-bound polysaccharide** extracted from biomass
- Freeze-dried **polysaccharide collected from culture media** in Florence

→

❑ Characterization:
- Total sugars
- Uronic acids
- Neutral sugar
- Proteins
- Sulphate groups

❑ Monomeric composition

Supervision Prof. Céline Laroche

Ultrafiltration

Freeze-dryer

Freeze-dried EPS

Acknowledgments: Part of the research was carried out at Centro di Competenza Valore, Florence, Italy (Regione Toscana, Par-FAS 2007-2013 Projects).

PhD DAY
DECEMBER 19th, 2025

LONG –TERM EFFECTS OF BIOCHAR ON VINEYARD SOIL: A MESOCOSM EXPERIMENT

Elisabetta Toni[a], Matteo Daghio[a], Alessandra Lagomarsino[b], Roberta Pastorelli[b], Francesco Primo Vaccari[c], Marco Fusi[d], Carlo Viti[a]

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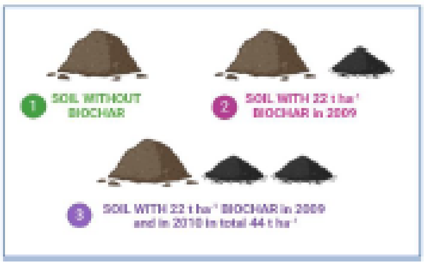
INTRODUCTION

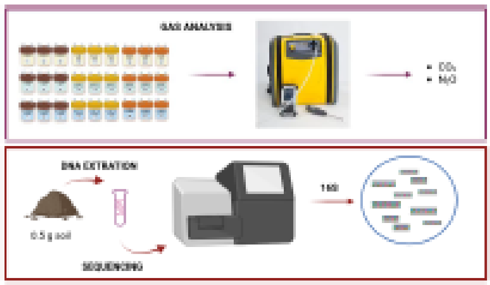
Biochar application plays an important role in mitigating greenhouse gas emissions. Adding biochar to soil can reduce levels emission of methane (CH_4), nitrous oxide (N_2O) and carbon dioxide (CO_2). In addition, biochar application to soils stimulates soil microbial activity. Previous studies have also shown that biochar can alter microbial communities' structure, with positive effects on carbon and nitrogen cycles. However, there is little published data on the long-term behaviour of biochar in soil (Idbella *et al.*, 2024).

AIM

The present study aims to assess the effect of long-term application of biochar on GHGs emissions and bacterial community.

MATERIALS AND METHODS





RESULTS

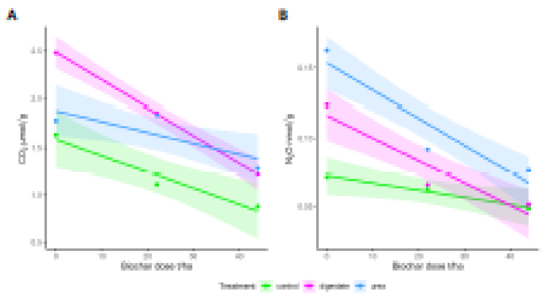


Figure 1 - Cumulative CO_2 (plot A) and N_2O (plot B) emissions. The data are represented as linear models fitted with 95% confidence bands (ANCOVA CO_2: $F_{4,27}$= 28.15; *p*-value < 0.0001; ANCOVA N_2O: $F_{5,27}$=32,23; *p*-value < 0.0001). Shading indicates the standard error of the model predictions. The dots indicate the average values recorded at the end of the experiment for each condition.

The findings demonstrated that biochar **effectively mitigated greenhouse gas emissions**, particularly in the digestate treatment. The magnitude of mitigation was found to be **greater at higher doses of biochar** applied to the soil.

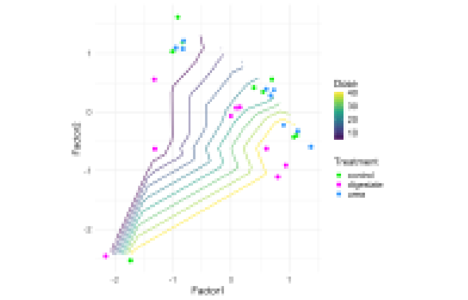


Figure 2 - Model-based ordination plot. Each point represents a soil sample, positioned according to the first two latent variables (Factor1 and Factor2), derived from community composition data. Permanova analysis: R^2 = 0.79; *p*-value = 0.001.

The spatial distribution indicated a **significant influence of both type of nitrogen source** (mineral vs organic) **and dose of biochar** on microbial community structure.

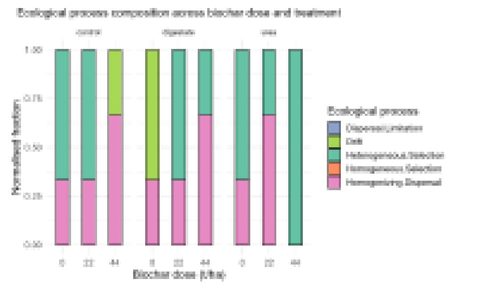
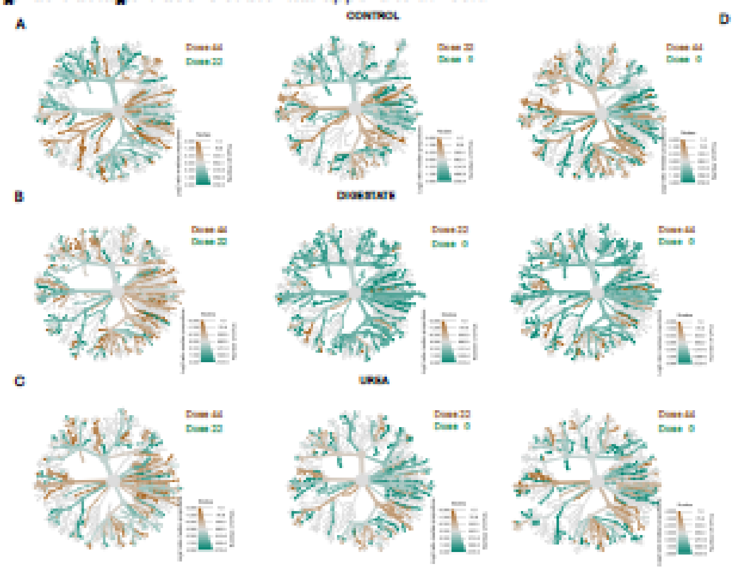


Figure 3 - Bacterial community composition in soils amended with increasing rates of biochar (0, 22, and 44 t/ha) under fertilization. Data indicate distinct patterns of microbial assemblage associated with the interaction between biochar application and nutrient source.

The presence of biochar and the input of nitrogen, whether organic or mineral, **modulates community assembly, shifting the balance towards deterministic dynamics.**



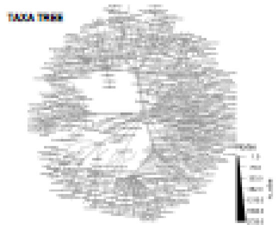


Figure 4 - Phylogenetic trees showing the composition and relative abundance of bacterial taxa in soil. Each panel represents one fertilization regime, the single showing variation in microbial community composition along pairwise comparison of biochar dose. Key taxa identified in the taxonomic reference map panel D.

These patterns highlight **biochar's role as a modulator of soil microbial ecology**, interacting strongly with fertilization regimes.

CONCLUSIONS

- BIOCHAR, EVEN SEVERAL YEARS AFTER ITS INITIAL INCORPORATION INTO SOIL, RETAINS A REMARKABLE CAPACITY TO MITIGATE GREENHOUSE GAS EMISSIONS.
- BIOCHAR SIGNIFICANTLY MODULATES THE COMPOSITION AND STRUCTURE OF THE SOIL BACTERIAL COMMUNITY, ACTING AS A POWERFUL ECOLOGICAL DRIVER OF CHANGES IN MICROBIAL ASSEMBLY.
- BIOCHAR RESHAPE TAXONOMIC DIVERSITY, BUT ALSO INFLUENCE KEY FUNCTIONAL PROCESSES, INCLUDING NUTRIENT CYCLING, ORGANIC MATTER DECOMPOSITION, AND MICROBE-MEDIATED GREENHOUSE GAS FLUXES.
- THESE RESULTS HIGHLIGHT THE DUAL ROLE OF BIOCHAR AS A MODULATOR OF THE MICROBIOME AND, CONSEQUENTLY, OF BIOGEOCHEMICAL PHENOMENA, WITH IMPLICATIONS FOR SUSTAINABLE SOIL MANAGEMENT AND CLIMATE CHANGE MITIGATION.

Finanziato dall'Unione europea NextGenerationEU
Italiadomani

Integrating phenotypic, genotypic, and environmental data for predictive modeling in durum wheat (*Triticum durum* Desf.) cultivation using Artificial Intelligence

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2- Department of Agriculture, Food, Environment and Forestry (DAGRI), University of Florence. Via Maragliano, 77 - 50144 Florence, Italy
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UNIVERSITÀ DEGLI STUDI FIRENZE

NIAB

BACKGROUND

The **Mediterranean area** is experiencing **rising temperatures** and reduced water availability, posing **risks** to durum **wheat cultivation**. Understanding how **yield** and **protein quality** respond to different environments is now essential to **optimize agronomic practices** and **limit potential losses**.
With the growing availability of agronomic, climatic, and genomic **data, machine-learning** approaches have become increasingly valuable. These **algorithms learn patterns** from complex datasets, enabling the **extraction of hidden relationships** and **supporting** more accurate, environment-specific **agronomic decisions** in durum wheat production (Fig. 1).

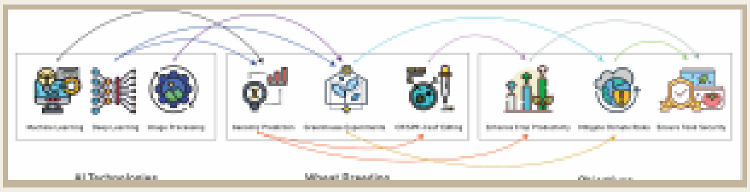


Figure 1. Pipeline for big-data-driven machine learning in durum wheat.

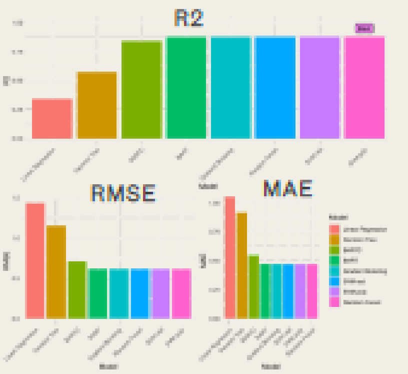
GOALS

- Develop a **machine-learning predictive** model for durum wheat yield and protein content based on phenotypic, genetic, and climatic data.
- **Identify key genetic polymorphism** to create genotypes suited to specific climates and agronomic needs like yield or protein content.

MATERIALS & METHODS

- **Phenotypic data:** 200 durum wheat varieties, 14 traits, collected over **24 years** (1998–2022) in 119 Italian field trials (CREA).
- **Climate data:** Historical ERA5 series including radiation, GDD, precipitation, moisture, soil water, wind, and temperature, provided as **weekly means.**
- Genomic data: **157 varieties genotyped** for 25,636 SNPs (T3/Wheat database).
- **We evaluated multiple machine learning models:** Random Forest, Linear Regression, and Gradient Boosting.

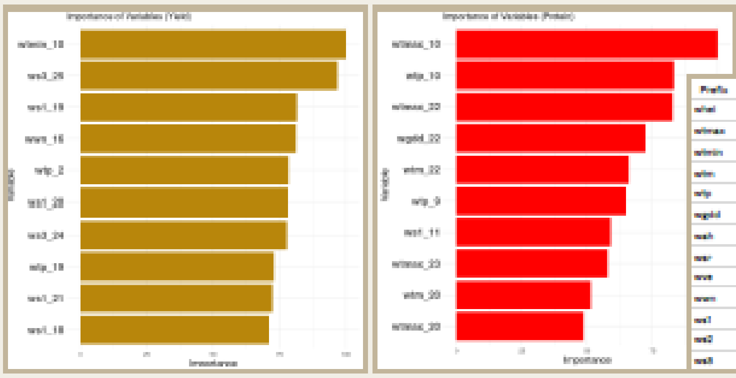
MACHINE LEARNING MODELS EVALUATION



Although SVM achieved slightly higher R^2 (Fig. 2), **Random Forest** was chosen for interpretability, **robustness, speed,** easier integration with mixed data, and comparable **performance.**

Figure 2. Predictive performance of the tested ML models for Yield, evaluated through R^2, RMSE, and MAE.

CLIMATE-BASED MACHINE LEARING RESULTS



Prefix	Meaning
[illegible]	heat waves
[illegible]	maximum
[illegible]	minimum
[illegible]	Mean temperature
[illegible]	Total precipitation
[illegible]	Growing degree days
[illegible]	Air humidity
[illegible]	Solar radiation
[illegible]	Eastward wind (U10)
[illegible]	Northward wind (V10)
[illegible]	Soil moisture (layer 1)
[illegible]	Soil moisture (layer 2)
[illegible]	Soil moisture (layer 3)

Figure 3. Top 10 weekly predictors driving Random Forest predictions for yield and protein content, ranked by importance. The final number in each variable name indicates the corresponding week of the year.

YIELD

The most important predictors for yield were **minimum temperature** in early March , **precipitation** in early January, and a series of **soil-moisture** and **wind** signals from mid-April to late June, highlighting the key role of **early-season temperature** and **late-season water availability** (Fig. 3).

PROTEIN

Protein content was primarily driven by **maximum temperature** and **precipitation** in **early March** together with **temperature-and GDD-related** variables in **late May to early June** and **soil moisture** in mid March, indicating a **strong sensitivity** of grain protein formation to **early-season heat** and **water dynamics.**

GWAS ON CLIMATE RESIDUALS

Twelve **SNPs** (Fig. 4) with LOD > 3 were located within **regions of known QTLs**[1] . Overall, our SNPs fall within 73 QTLs, **44** of which are previously **associated** with **yield**, highlighting the relevance of these loci for trait variation. For **protein** content, twelve SNPs (Fig. 4) mapped to 58 known **QTL regions, including 4 directly** linked to grain protein content. The remaining QTLs may influence protein levels indirectly through traits such as grain weight, which affects the relative protein percentage.

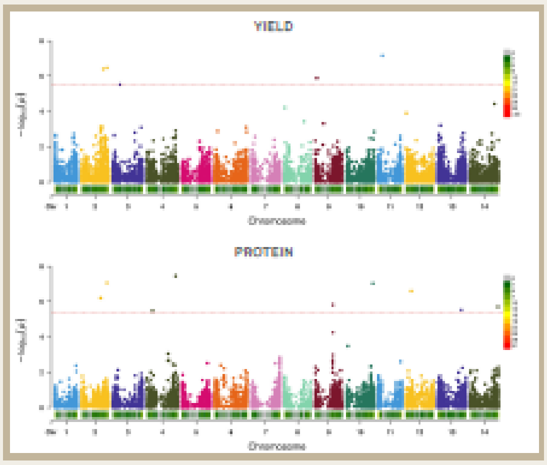


Figure 4. Manhattan plot of GWAS results obtained using the FARMCPU model, showing SNP associations with yield and protein content across the genome.

SUMMARY AND PROSPECTS

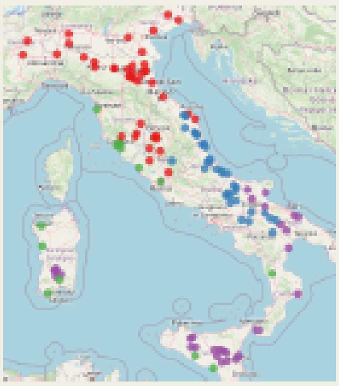


Figure 5. Climatic zones identified via consensus clustering of annual averages of weekly variables. Four stable clusters were obtained; points are colored by assigned cluster.

This approach proved reliable, as **significant SNPs** co-localized with known QTLs. The **pipeline** will **next** be applied to additional traits in the phenotypic database, including **thousand-kernel weight** and **heading date,** and extended across **homogeneous climatic zones** to evaluate differences in **genetic signals** under contrasting environments. Climatic zones were identified through **consensus clustering:** annual averages of weekly environmental variables were clustered using k-means across years, and the results were combined into a co-occurrence matrix. The most stable partition consisted of **four clusters,** which were then **geographically mapped** (Fig. 5).

Bibliography:
1 - Maccaferri, M., Harris, N.S., Twardziok, S.O., et al. (2019). Durum wheat genome highlights past domestication signatures and future improvement targets. Nature Genetics.
2 - Molnar, C., et al. (2023). Study becomes insight: Ecological learning from machine learning. Frontiers in Ecology and the Environment.

Poster Dottorand3 del 40° ciclo

Effects of Light Spectrum on Growth, Biochemical Composition and Hydrogen Production in *Synechocystis sp.* PCC 6803

Francesco Balestra. PhD Student DAGRI Unifi and Istitute of BioEconomy – CNR; Tutor: Dr. Cecilia Faraloni. Istitute of BioEconomy – CNR;
Co-Tutor: Prof. Alessandra Adessi, Microbiologia agraria, alimentare e ambientale, (DAGRI), UNIFI

Introduction

Light spectrum regulates photosynthesis, metabolism, and hydrogen (H_2) production in cyanobacteria. Among these, Synechocystis sp. PCC 6803 is a model organism to study and optimize photobiological processes for bioenergy applications.

Objectives

- Test the effect of light spectrum (white, orange, blue) on growth and metabolism
- Evaluate pigment composition and photosynthetic performance
- Assess hydrogen production under controlled conditions

Light Treatments

ORANGE BLUE WHITE

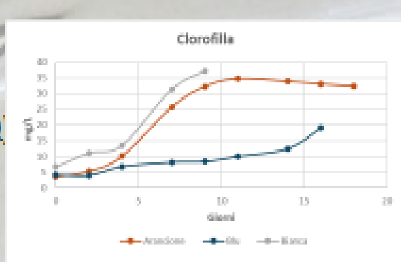
Experimental Procedure

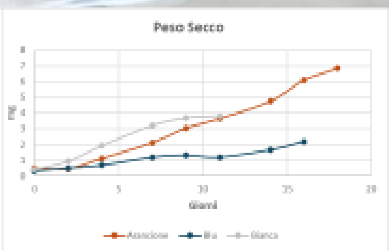
Growth: Synechocystis sp. PCC 6803 was cultivated in glass tube photobioreactor, in BG11 medium supplemented with marine salts (35 g L^{-1}) under controlled temperature, pH, and light intenisty (200 µmoles photons m^{-2} s^{-1})

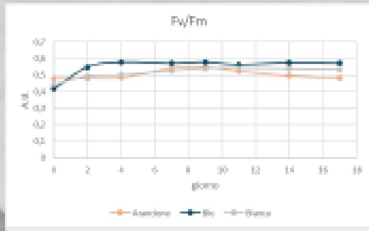
H_2 production: Cultures were placed in Roux bottles under continuous LED illumination (200 µmoles photons m^{-2} s^{-1}), with O_2 absorbers, monitoring redox potential, O_2, pH, H_2 production

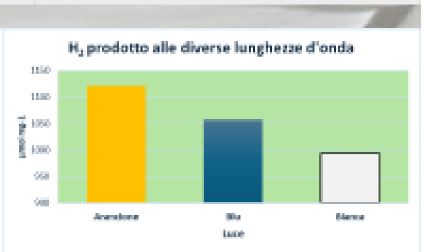
Measurements

- Growth (dry weight)
- Pigments (chlorophyll a, carotenoids)
- Photosynthetic activity (fluorescence, ETR, NPQ)
- Biochemical composition
- Hydrogen production (GC analysis)









Results and Discussion

- Orange light enhanced chlorophyll content and photosynthetic capacity
- Blue light promoted carotenoid accumulation
- Orange light promoted the highest Hydrogen production
- Hydrogen accumulation occurred only under orbital agitation, highlighting the importance of effective mixing and oxygen depletion

Conclusions

Light spectrum drives distinct physiological strategies in Synechocystis sp. PCC 6803. Optimized light quality combined with proper mixing is essential for efficient photobiological hydrogen production.

Key Messages

- Light quality controls metabolic allocation
- Orange/red favors photosynthesis, blue favors photoprotection
- Hydrogen production requires optimized light and mixing

Development of a combination of innovative digital technologies aimed at early detection of *Ceratocystis platani*, a regulated forest pathogen.

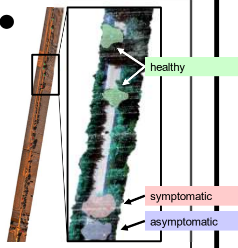
Hari Berto[a,b], Giovanni Marino[b], Francesco Pecori[b], Alessia Lucia Pepori[b], Nicola Luchi[b], Dániel G. Knapp[c], Francesco Ferrini[a,b], Johanna Witzell[c] and Alberto Santini[b]

[a] University of Florence, Department of Agriculture, Food, Environment and Forestry (DAGRI), Firenze, Italy
[b] National Research Council, Institute for Sustainable Plant Protection (CNR-IPSP), Sesto Fiorentino, Firenze, Italy
[c] Department of Forestry and Wood Technology, Linnaeus University, Växjö, Sweden

This PhD project is founded by the Horizon project FORSAID[1], which aims to harness innovative technologies to ensure plant health in Europe's forests.

Aim_1 (planned for next spring)
Proximal remote sensing of *Platanus* damage in controlled environments and nurseries.
Will be monitored the development of symptoms of *Ceratocystis platani* infection on *Platanus orientalis* saplings, in a High-Throughput Plant Phenotyping (HTPP) facility placed at "Metapontum Agrobios" Research Centre of ALSIA. With the analysis of the multispectral images, it will be possible to assess the plants' state of health and find the indices which can supply an early detection of the infection.

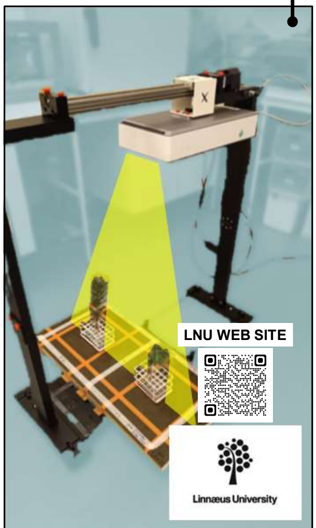
Aim_2 (preliminary surveys and results)
Aerial remote sensing of tree damage at regional scale.
The indices found with the previous study, will be employed for early detection of *Ceratocystis platani* infection in urban and forest areas, using the remotely piloted aerial systems (RPAS) and, if possible, airborne platform. One of the strengths of this project is the potential reduction in the number of plane trees to be inspected



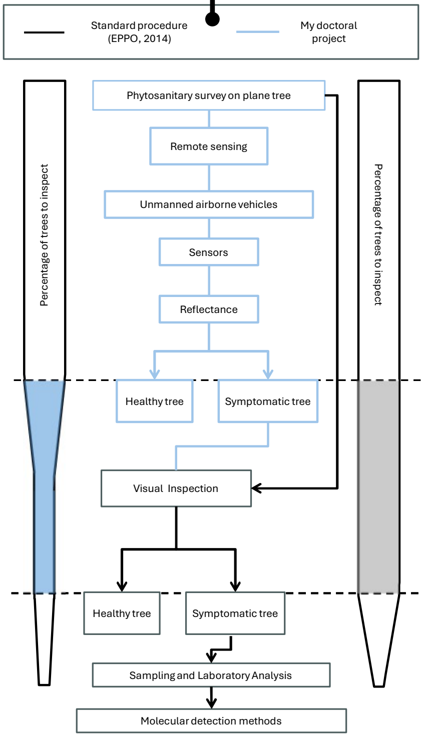
Categorisation of plane tree infection stage by field survey

Improving phytosanitary inspections through remote sensing
Appling remote sensing in phytosanitary survey can help to reduce the percentage of trees to inspect. If on the basis there is a well tested protocol that can help to discriminate between healthy trees and possibly infected trees. In this research project we want to explore if is possible identify the early infection of canker stain disease. Is important to highlights that remotes sensing results must be confirmed by a traditional survey in the field.

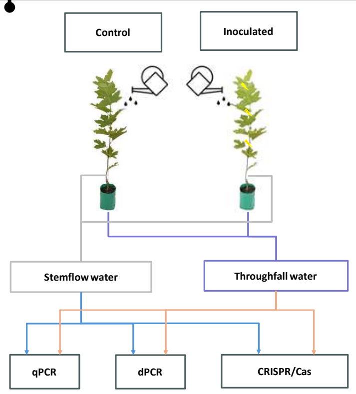
Aim_1.1 (ongoing)
Proximal sensing of *Pinus sylvestris* damage caused by *Diplodia sapinea* in controlled environments.
In collaboration with the Linnaeus University in Sweden, I am conducting research to evaluate the effects of *D. sapinea* infection on *Pinus sylvestris*. The experiment takes into account the reflectance of needles using PlantEye instrument. This instrument provides a detailed point cloud of a single plant. The methodology developed in this experiment could also be applied to plane tree to study the effects of *C. platani* infection.



PlantEye at the Linneus University



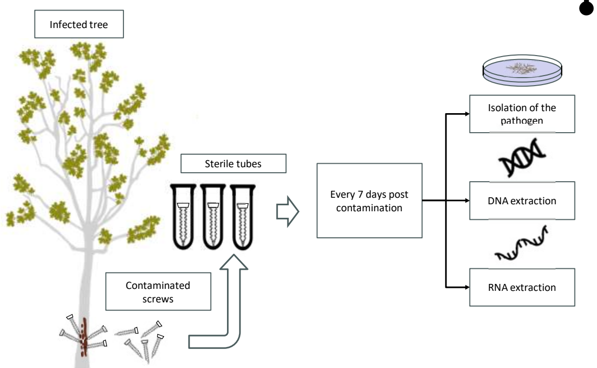
Aim_3 (planned for next spring)
Detection of *C. platani* in environmental DNA
The purpose is to develop a procedure for processing eDNA (environmental DNA) collected from different matrices (stemflow and throughfall). From these samples the presence of *Ceratocystis platani* DNA will be tested. Using different molecular techniques (real-time PCR, digital PCR (dPCR) and metabarcoding), which will be combined and compared with each other. This experiment will be conducted in collaboration with WSL, Birmensdorf (CH).



Hierarchy graph for the experiment in the aim number three


30 four years old plane trees ready for the experiment

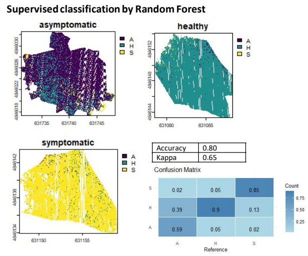
Aim_4 (preliminary experiment were done, the proper experiment is scheduled for the next year)
Pathogen survival on pruning tools
This objective relatively falls outside to the main aim, but since the pathogen is mainly transmitted by infected pruning tools, it is important for a better understanding of the spreading pathway and the pathogen's behaviour. The main goal is to determine how long the *C. platani* spores can survive on surface of pruning or cutting tools. Some pruning tools will get in contact with the infected tree tissue. In addition, a protocol for identifying live pathogen based on RNA will be implemented.



Process graph for the experiment in the aim number four

Aim_2
Remote sensing preliminary test of detection by drone sensors
During the spring was done a preliminary drone survey in a highly infected area by *C. platani*. The plane trees were categorised based on their symptoms in healthy, asymptomatic and symptomatic. Then the data were processed in order to find difference between different rate of infection. Some simple vegetation index seems to be higher in the asymptomatic trees. Different methodology were tested to identify the early infection stage, starting with simple vegetation indices comparison until machine learning and deep learning methods. The latter have shown the most promising results. Further surveys are needed to confirm this preliminary results.

Supervised classification by Random Forest



This figure presents the results of a supervised classification of plane tree canopies using a Random Forest model. Model performance was evaluated using overall accuracy (0.80) and Cohen's Kappa (0.65), indicating substantial agreement between predicted and reference labels. The confusion matrix (bottom right panel) summarizes prediction reliability across categories, with values normalized between 0 and 1. It reveals that symptomatic trees were most accurately identified, while asymptomatic and healthy classifications showed more overlap.

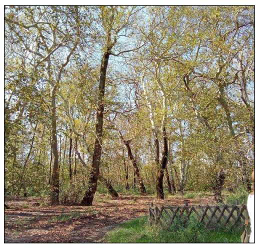
Expected results

Aim_1
Specific markers of pathogen infection (*C. platani*) based on multispectral/hyperspectral measurements allowing to identify the early stage of infection. Additionally, the study will be able to supply information on the relation between pathogens and host saplings.

Aim_2
Infestation severity is based on machine learning algorithms at tree level and to map of urban and forest pathogen damage. Early detection will be possible in areas where symptoms are not yet present, and to assess the spread of diseases can be assessed without the need for on-site monitoring. Additionally, provide the essential information needed to adopt phytosanitary measures that limit its spread and impact, especially in remote areas.

Aim_3
Protocols for identifying *C. platani* in water flow from tree stems will be based on digital PCR, real time PCR and metabarcoding. The advantages and disadvantages of the methods (dPCR, qPCR and metabarcoding) will be listed and compared. Biosurveillance through eDNA is essential to reduce the threat arising from the spread of this regulated pathogen.

Aim_4
The quantification of disease spreading by pruning and cutting tools is based on experimental evidence. The persistence of the pathogen on the pruning tools will be assessed. This has important implications to improve phytosanitary measures. Aimed to control the pathogen spread. In addition, development of specific detection molecular protocols based on RNA is considered.



[1]**FORSAID**
Forest surveillance with artificial intelligence and digital technologies
FORSID receives founding from the European Union's Horizon Research and Innovation Programme under grant agreement 101134200.

Corso di Dottorato in Scienze Agrarie e Ambientali (SAA) ciclo XL

FORSAID WEB SITE

IPSP CNR WEB SITE

SAA WEB SITE

Feel free to contact me!
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PhD Day 19/12/2025

CIRCULAR VALORISATION OF AGROFORESTRY RESIDUES: CUSTOMIZED CORROBORANTS FOR ON-SITE USE AGAINST BIOTIC AND ABIOTIC ADVERSITIES OF AGRICULTURAL CROPS

Università degli Studi Firenze — Da un secolo, oltre.

Phd student
Leone Boatto

Phd day
Scienze Agrarie e Ambientali
19 Dicembre 2025

Supervisor
Prof. Stefania Tegli

Laboratorio di Patologia Vegetale Molecolare, Dipartimento di Scienze e Tecnologie Agrarie, Alimentari Ambientali e Forestali (DAGRI), Università degli Studi di Firenze, Florence, Italy.
Email: leone.boatto@unifi.it

INTRODUCTION

Wood vinegar (WV) is a complex organic liquid obtained as a by-product of the pyrolysis of lignocellulosic biomass derived from waste materials such as pruning, wood residues, or other agricultural by-products . WV has attracted growing scientific interest due to its potential as a corroborant, antimicrobial agent and plant growth regulator, within the framework of more sustainable and circular agricultural strategies. WV acts as a biostimulant at low concentrations, enhancing vegetative growth, photosynthesis, productivity, and stress tolerance (drought, salinity) through activation of antioxidant enzymes and reduced lipid peroxidation. In hydroponics, it can help regulate nutrient solution pH and lowers nitrate accumulation in leaves. In soils, WV improves enzymatic activity, fertility, and nutrient bioavailability.

AIM

Chemical characterisation → *GC-MS, profiling, composition*

Chemistry–biology link → Correlation between composition and effects

Dose optimisation → Concentration-dependent effects

On-site customised products → Applied, circular corroborants

OBJECTIVES & METHODOLOGY

Chemical Characterization of Wood Vinegar

Objective: Define chemical signatures of WV from *V. vinifera* and *O. europaea* pruning waste.
Approach: GC–MS–based profiling and multivariate comparison of WV from different biomass sources.
GC–MS • phenolics • organic acids • biomass origin • composition-activity
Expected Impact: Identification of composition–activity links supporting targeted WV applications.

Evaluation of wood vinegar treatments in plants subjected to abiotic stress:

Objective: Evaluate WV efficacy in improving crop tolerance to abiotic stress.
Approach: Controlled trials on model plants such as basil, lettuce, and tomato under salinity, drought, and heat stress.
Salinity • drought • heat • dose-response • crop performance • SOD • POD • CAT
Expected Impact: Identification of effective WV concentration ranges enhancing plant performance.

Turfgrass Management Under Stress Conditions

Objective: Improve turfgrass resilience and disease control using WV treatments.
Approach : Stress assays on *Agrostis* and *Zoysia* combined with tests against *Clarireedia* spp.
Water stress • heat stress • dollar spot • resilience
Expected Impact: Reduced stress damage and dollar spot severity under sustainable management schemes.

Soil Microbiome and Rhizobial Interactions

Objective: Assess WV effects on soil microbiota and legume–rhizobia symbiosis.
Approach: Rhizobox-based monitoring of root growth and nodulation following WV application.
Rhizobox • nodulation • root growth • beneficial microbes • soil health
Expected Impact: Optimized WV use preserving beneficial soil–plant interactions.

Antimicrobial Activity Against Plant Pathogens

Objective: Test WV as a natural antimicrobial tool in plant protection.
Approach: In vitro and in vivo assays against plant pathogens such as *Phytophthora infestans* and *Clavibacter michiganensis*.
in vitro • in vivo • growth inhibition • disease suppression
Expected Impact: Validation of WV as a complementary disease management strategy.

Gene Expression Analysis

Objective: Clarify plant molecular responses to WV treatments.
Approach: qPCR analysis of stress-related genes in treated vs. untreated plants.
qPCR • stress markers • biotic response • abiotic response • mode of action
Expected Impact: Mechanistic support for WV-driven stress mitigation.

Insect Pest Deterrence

Objective: Evaluate WV deterrent effects on key insect pests.
Approach: Behavioral and oviposition assays using *Drosophila suzukii*.
Drosophila suzukii • oviposition • behaviour • deterrence
Expected Impact: Reduced pest pressure supporting integrated pest management.

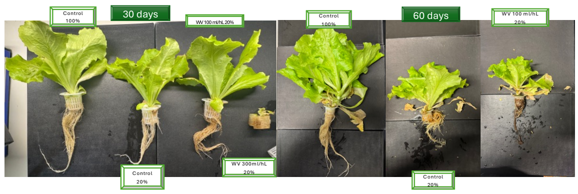


Figure 1: *L. sativa* hydroponic experiment. WV (fir wood) concentration of 300 ml/hL exhhibits phytotoxicity with significantly stunted plant growth. WV concentration of 100 ml/hL led to increased shoot and root biomass after 1 month under nutrient limited conditions, ultimately damaging the root system after long-term exposure

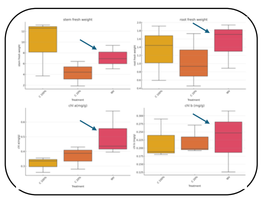


Figure 2: Differences between treatment for stem and root fresh weight and chl a and b for *L. sativa* in hydroponic culture

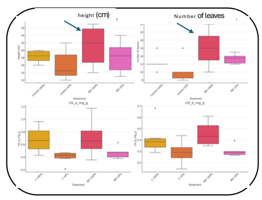


Figure 3: Differences between treatment for plant height, number of leaves, chl a and b for *O. basilicum* in hydroponic culture

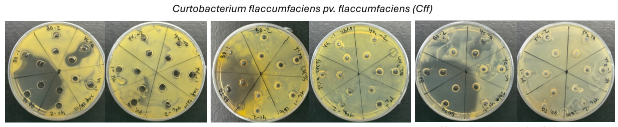


Figure 4: Antimicrobial assay. 4 WV tested at different concentrations (100%, 10%, 1%), results showed no activity at lower concentration for all WV tested, whereas high concentration resulted in strong antimicrobial activity for one product (BD), and mild activity for another one (YC), no activity detected for the two grapevine-derived products (YV1, YV2)

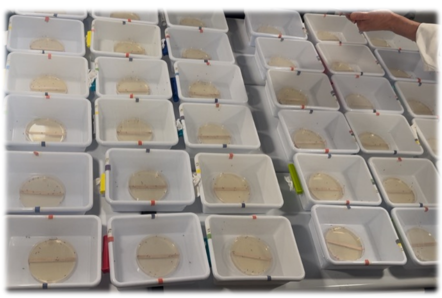


Figure 5: *Drosophila suzukii* bioassay. Evaluation of WV treatments on oviposition deterrence against insect pest *drosophila suzukii*.

UNIVERSITÀ DEGLI STUDI FIRENZE
DAGRI DIPARTIMENTO DI SCIENZE E TECNOLOGIE AGRARIE ALIMENTARI, AMBIENTALI E FORESTALI

PhD STUDENT: EMMA BEATRICE CROCE
SUPERVISOR: Prof. PIERO BRUSCHI
CO-SUPERVISOR: Prof. FABIO VAIANO

PhD Day in Agricultural and Environmental Sciences

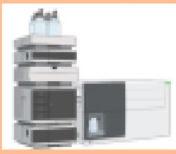
Exploring *Leonotis leonurus* (L.) R. Br. as alternative to cannabis: a study on the impact of botanical traits, cultivation techniques in modulating the production of psychoactive substances and drugs.

ONLINE FORUM

Leonotis leonurus is the plant most frequently represented in these psychonaut forums

AIMS OF THE WORK

Development and optimization of an LC-MS/MS method to detect and quantify leonurine



How different cultivation techniques influence plant growth and quali-quantitative production of leonurine and other bioactive compounds;

Characterization of the plant's terpene profile using GC-MS to evaluate organic-specific volatile compound distribution

WORK IN PROGRESS

RESULTS

All tested samples showed leonurine levels below the limit of detection (not detected)

HYPOTHESIS

- absence of leonurine
- forms not extractable under current conditions
- expressed only under specific physiological stages

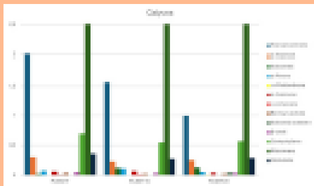
NEXT STEPS

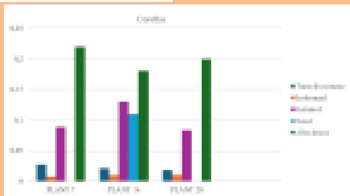
- Refine the extraction method
- Optimization of the analytical method and structural characterization of leonurine
- Analysis of other species that contains leonurine
- Macro and micro mophological study of the plant in order to confirm identification and to investigate the secretory structures of the plant

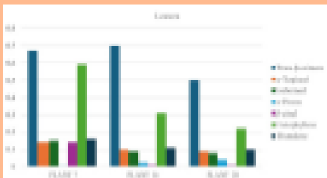
NEXT STEPS

Exposure of plants to water and light stress conditions to evaluate effects on leonurine production

RESULTS







NEXT STEPS

- Continuation of the terpenic profile analysis across different plant organs
- Development of a targeted method for the identification of diterpenes (e.g., leoleorins)

UNIVERSITÀ DEGLI STUDI FIRENZE

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Supervisor: Prof. Gaio Cesare Pacini

PhD in Agricultural and Environmental Sciences XL Cycle – Year 2

Impact of advanced agri-voltaic systems designed according to the principles of agroecology on water, energy and food balance: assessment at farm and landscape level

1. Problem statement

How to redesign agroecosystems to address water, energy and food crisis

2. Project Idea

Global energy demand is expected to increase, but a 1.2% annual decline in primary energy demand could occur starting in 2030 due to electrification and improved process efficiency (IEA, 2023). Renewable energy, especially solar, will play a key role in this shift. However, large-scale solar power generation requires significant land, which competes with agricultural use. Agrivoltaic (AV) systems, which combine farming with electricity generation, can reduce land use conflicts and provide economic, social, and environmental benefits (Campana et al., 2021; Mamun et al., 2022).

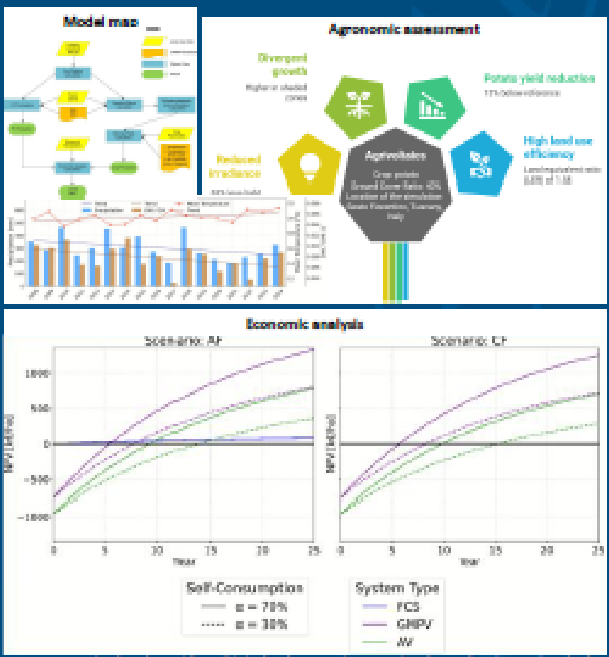
3. Project description

The project focuses on developing an advanced agrivoltaic system in agroforestry context combining agroecology principles (Gliessman, 2015) and renewable energy. The system will be co-designed by the Department of Agricultural, Food, Environmental, and Forestry Sciences and Technologies (DAGRI) in collaboration with the Department of Industrial Engineering (DIEF) of the University of Florence and it will integrate photovoltaic panels, trees, and herbaceous crops into a three-tier agroforestry model. The project aims to assess the agrivoltaic system's impact on crop yields, water balance, soil fertility, microclimate, ecosystem services, and solar energy use efficiency. The evaluation will account on model-based analysis and filed experiment in different pedo-climatic scenarios in Italy.

4. Activities carried out during the 2° year

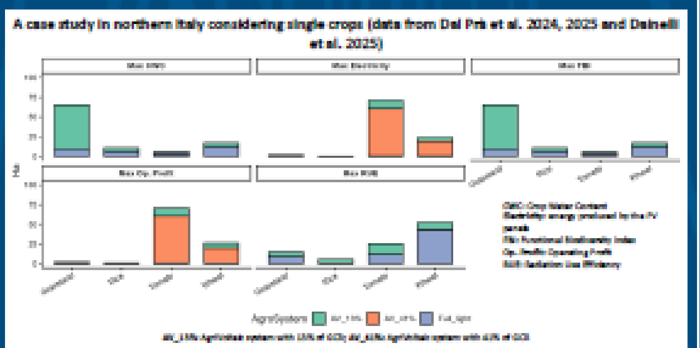
- Model-based simulation of an agrivoltaic system in collaboration with DIEF-UNIFI
- Application of multi-objective optimization (MOO, Groot et al., 2012) methods to agrivoltaic systems at farm and landscape level in collaboration with the University of Wageningen (NL)

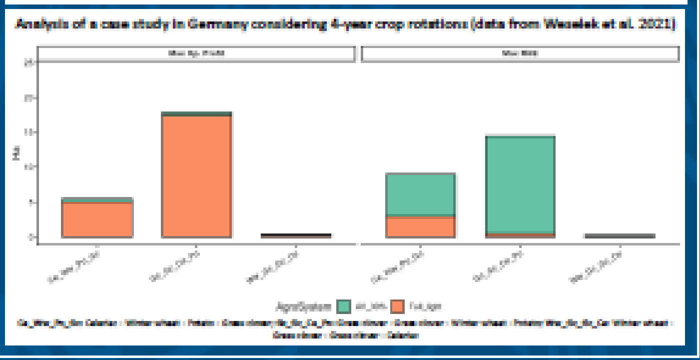
5.1 Result of the simulation



Net Present Value (NPV) trend for Full light (FCS), Ground-mounted PV (GMPV) and Agrivoltaic (AV) systems per hectare, shown for self-consumption rates α = 0.70 and α = 0.30 under both Abandoned Farmland (AF) and Conventional Farming (CF) scenarios

5.2 Result of the MOO





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“Reducing methane emissions through genetic selection in dairy cattle”

Silvia Graziani, Simone Callegaro, Francesco Tiezzi

Department of Agriculture, Food, Environment, and Forestry (DAGRI), University of Florence, Florence, Italy

Methane emissions

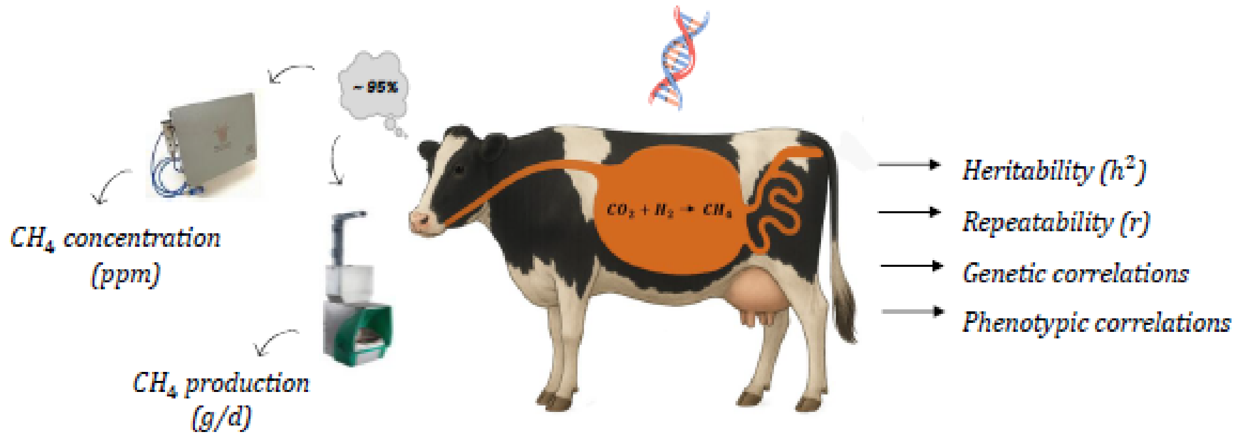
Environmental impact

Energetic loss for the animal

Genetic selection is an effective and permanent strategy to reduce enteric emissions, but it requires **reliable**, **repeatable**, and **large-scale measurable phenotypes**

Enteric methane emissions can be measured using several techniques, including respiration chambers, GreenFeed systems, SF_6 tracer methods, laser-based approaches, and sniffer sensors

GreenFeed and **sniffer** systems allow high-throughput measurements across farming conditions, but measure different methane-related phenotypes



Moderate to high genetic/phenotypic correlations between different traits may indicate that selection for reduced methane concentration could also result in lower methane production

These, combined with moderate heritabilities, can improve the accuracy of genetic evaluations for breeding more sustainable animals

PhD day – Florence, 18th December 2026

Influence of Acoustic Vibrations on the Morphological, Physiological, Molecular, and Anatomical Traits of *Olea europaea*

PhD Student: Hafiza Komal Naem
PhD School: PhD in Agricultural and Environmental Sciences.
Supervisor: Prof. Elisa Masi
Department of Agriculture, Food, Environment and Foresty (DAGRI)
University of Florence, Italy

LINV International Laboratory of Plant Neurobiology

Università degli Studi Firenze | Dipartimento di Scienze e Tecnologie Agrarie, Alimentari, Ambientali e Forestali

INTRODUCTION

Modern agriculture, including olive cultivation, faces major challenges due to climate change and the need for sustainable practices. As an alternative to chemical methods, the use of sound vibrations has emerged as a promising green technology to enhance plant defense mechanisms and stimulate beneficial traits in *Olea europaea*. Research demonstrates that sound stimulation can increase the production of important metabolites such as sugars, hormones, proteins, and secondary compounds (Gosh et al. 2017; Jung et al. 2018; Bhandawat and Jayaswall 2022), boost photosynthetic activity and overall productivity, and activate defense responses against both biotic and abiotic stresses (Appel and Croft, 2014; Body et al. 2019) and abiotic agents (Demey et al. 2023; Ali et al. 2024). Additionally, sound waves may influence the rhizosphere microbiome, further supporting plant health and resilience.

OBJECTIVES

01 Investigate the effects of mono-frequency sounds and ultrasounds on live plants, an area not yet explored.

02 Record and characterize ultrasounds emitted by drought-stressed plants.

03 Optimize acoustic treatment protocols to identify the most effective frequency, timing, and duration.

04 Study plant perception of acoustic stimuli in both controlled and field conditions.

05 Evaluate the morpho-physiological, molecular, and anatomical responses of healthy perennial crops—such as olive trees—to stress-induced ultrasound signals.

MATERIAL AND METHODS

This pot experiment tested whether long-term acoustic vibration (120 Hz) improves drought tolerance in olive plants. Vibro plants (8) received 120 Hz stimulation for six months; Non-vibro plants (8) served as controls. All were grown under controlled light, temperature, humidity, and soil conditions. Drought began on May 13, 2025 at 25% field capacity after full saturation. Plants were rewatered twice (days 36 and 45), and the trial ran for about two months. RWC, photosynthesis, and stomatal conductance were measured, and leaf samples under drought were collected for ROS, POD, and SOD analyses. Stress induction was verified using t-tests, and data were graphed in Origin. In years 2–3, ultrasound signals from stressed and control plants will be recorded and combined with monofrequency tones to create optimized sound treatments (20–60 days), which will then be applied to indoor and outdoor plants for morphophysiological, anatomical, and molecular assessments

PRELIMINARY PHASE EXPERIMENT

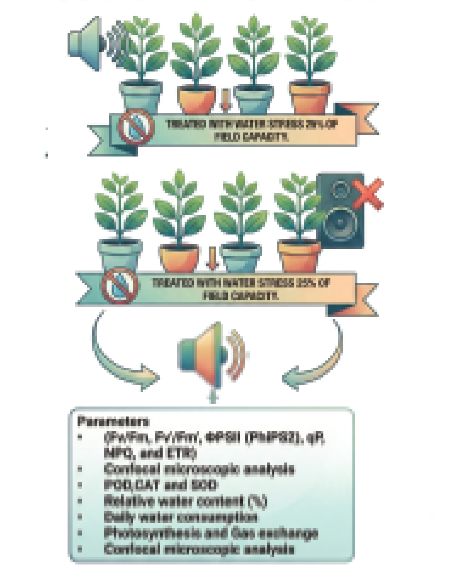
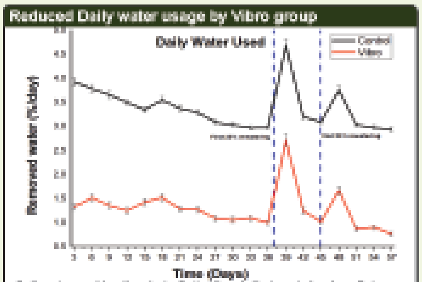


Figure 1. Graphical representation of experimental layout of preliminary phase experiment.

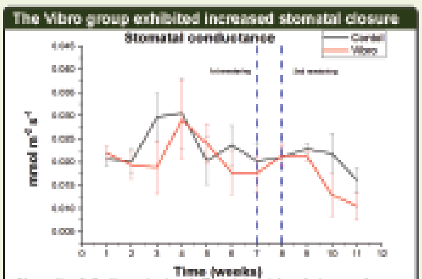
RESULTS

Reduced Daily water usage by Vibro group



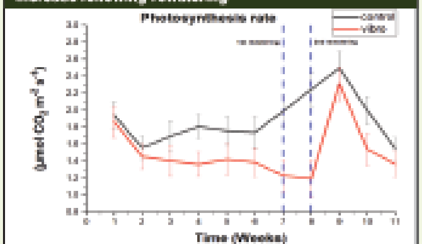
Daily water used by olive plants. Dotted lines indicate watering days. Data show means and SD (N=8).

The Vibro group exhibited increased stomatal closure



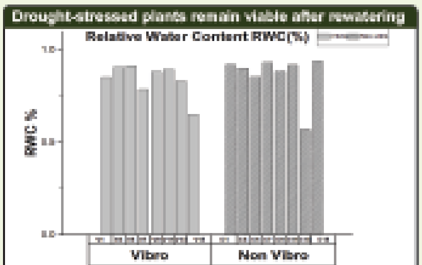
Six months of vibration pretreatment affected stomatal conductance under drought. Vibro plants started higher, dropped in weeks 7–8, aligned with controls after rewatering, and later showed stronger stomatal closure. Data are means ± SE (N = 8).

Stable photosynthesis in vibro plants, with a sharp increase following rewatering



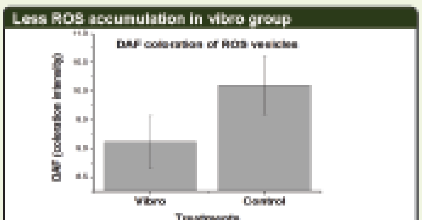
Six months of vibration pretreatment affected photosynthetic rate under drought. Vibro plants declined more than non-vibro plants, responded mildly after rewatering, and both groups later decreased again. Data are means ± SE (N = 8).

Drought-stressed plants remain viable after rewatering



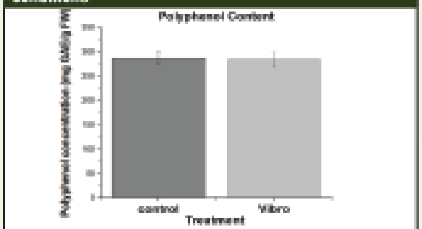
Bar graphs show the RWC of vibro (Vi) and non-vibro (Cti) plants measured before the first rewatering, confirming that all plants were still viable and able to regain water.

Less ROS accumulation in vibro group



Graphical representation of the impact of six months of vibration pretreatment on the coloration intensity of ROS vesicles under drought conditions

Polyphenols remain unaffected by vibro-induced conditions

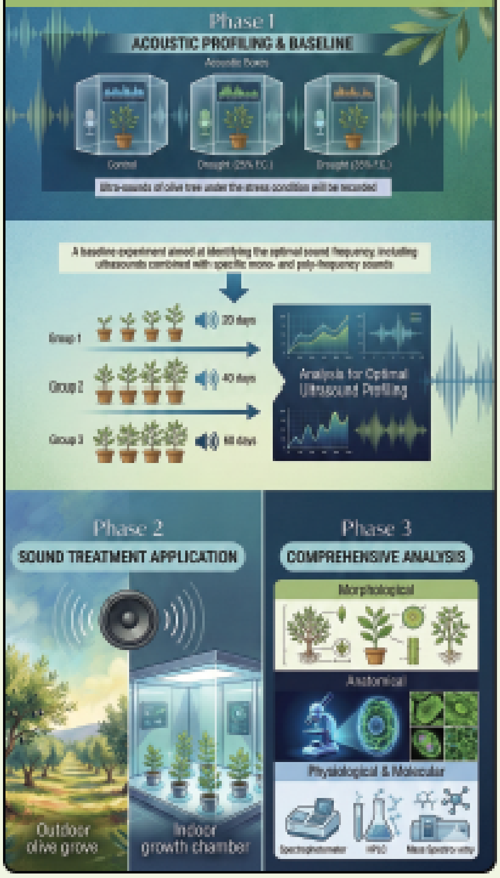


Graphical representation of the impact of six months of vibration pretreatment on the coloration intensity of polyphenol concentration under drought conditions.

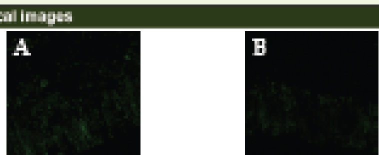
EXPECTED RESULTS

- Evidence that perennial crops like olives perceive sound.
- Identification of ultrasound frequencies emitted by drought-stressed plants.
- Proof that healthy plants detect and respond to stress-related sounds from neighbors.
- Development of effective mono- and poly-frequency sound treatments to boost growth and stress tolerance.
- Optimization of timing, duration, and combinations of sound treatments.
- Framework for applying acoustic methods in sustainable agriculture.
- Initial insights into how acoustic vibrations affect root development and rhizosphere microbes.

NEXT STEP



Confocal images



Confocal microscopy images showing ROS intensity in the control (A) and the vibro group (B).

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Bioactive compounds from pruning waste

Consiglio Nazionale delle Ricerche
Istituto per la Protezione Sostenibile delle Piante

UNIVERSITÀ DEGLI STUDI FIRENZE

LIÈGE université

INTRODUCTION

Nursery companies face challenges in sustainable management, including reducing chemical use and properly disposing of pruning waste. A promising solution is the recovery and valorization of these residues, which are rich in bioactive compounds. The project focuses on optimizing the extraction of tannins from pruning waste, followed by their characterization and quantification to assess their potential as biostimulants, including analyses of water content and nutrient levels. In parallel, the steam distillation process is optimized to produce essential oils, which are subsequently tested for their efficacy as herbicides, insecticides, and fungicides.

MATERIALS AND METHODS

Distillation of ornamental nursery plants: *Laurus nobilis*, *Pistacia lentiscus*, *Cinnamomum camphora*, *Liquidambar styraciflua*, and *Cupressus × leylandii*.

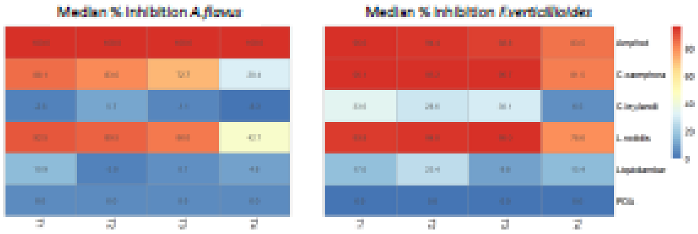
The essential oils obtained were analyzed by GC-MS and subsequently tested for their herbicidal, insecticidal, and fungicidal potential at the University of Liège (Agro-Bio-Tech).

From the residual biomass, tannins were extracted from *L. nobilis* and *P. lentiscus* and evaluated for their effectiveness as natural biostimulants on strawberry plants (cv. Clery) under greenhouse conditions. Chemical analyses of the extracts were performed using HPLC-DAD-MS.

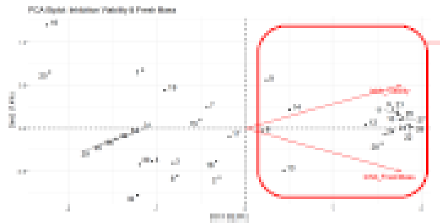
1) First experiment: determine the optimal concentration of the tannin extract by testing three different dilutions.
2) Second experiment: evaluate the same optimal concentration under moderate water stress conditions.

PRELIMINARY RESULTS

- First results of the contact fungicidal test: Applied volume 0.10 mL of essential oil. Tested fungi: *Aspergillus flavus* and *Fusarium verticillioides*.



- First herbicide test on *Trifolium incarnatum* and *Lilium pratensis*. Two growth stages: cotyledon and first leaf

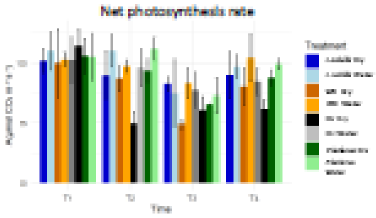


Points on the right: highly phytotoxic treatments.

1° exp.) Optimal dilutions identified under full irrigation:

L.nobilis: Dilution 1 (2 mL/L).
P.lentiscus: Dilution 2 (4 mL/L).
Wood distillate (WD1): Dilution 1 (2 mL/L).

2°exp.) Optimal dilutions tested on strawberry under water stress.



CONCLUSION AND FUTURE PERSPECTIVES

Fungicidal test (contact): *L. nobilis and C. camphora* inhibited *A. flavus* and *F. verticillioides* → strongest effect on *F. verticillioides*.
Herbicidal test: *L. nobilis* → strong herbicidal effect on *Trifolium* and *Lilium* (cotyledon and first leaf stage),
C. camphora → slight effect on *Trifolium*.
Next steps: Test lower effective concentrations and start insecticidal test.

The first experiment allowed us to identify the optimal dilutions for the tannin-rich extracts (Dilution 1 for *L. nobilis*, Dilution 2 for *P. lentiscus*) and for the wood distillate BioDea® (Dilution 1), under full irrigation conditions.
In the second experiment, those dilutions were tested on strawberry plants under water stress, confirming their effectiveness even under more challenging conditions.
Future studies will focus on the extract that showed the strongest biostimulant activity, with an improved experimental design and a higher number of replicates in the upcoming field experiment.

PhD day in Agricultural and Environmental Sciences

19th December 2025

CO_2 biofixation with selected microalgae for biofuel production in a zerowaste approach

PhD student: Daniel Ronca   Supervisor: Prof. Liliana Rodolfi   Co-supervisor: Dr. Giacomo Sampietro

Department of Agriculture, Food, Environment and Forestry (DAGRI), University of Florence, piazzale delle Cascine 18, 50144 Florence, Italy. E-mail:

AIM OF THE WORK

Maximise ISOPRENE production in GM *Synechocystis* KJ08 strain cultivated under different environmental (temperature, pH, light intensity and spectrum) conditions in an optimized photobioreactor, evaluating the potential environmental, economic and technical feasibility of the process with a biorefinery approach.

MATERIALS & METHODS

Synechocystis sp. PCC6803 (WT)

Bioreactor setup: 6-L PMMA Annular Column (F&M-AC15/9) photobioreactors

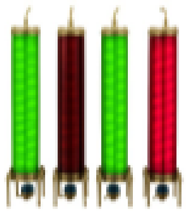
Tested variables:
- **Light spectrum:** White *vs* Purple
- **Light intensity:** 50, **300**, 600 µmol photons m^{-2} s^{-1}
- **pH:** 6.0, **7.8**, 9.0
- **Temperature:** 32, **36**, 40 °C
- **Culture regime:** Fed-batch

Optimized annular column for GM cultivation

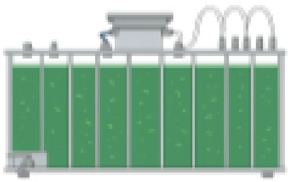
Synechocystis KJ08 (GM)

Bioreactor setup: 2.5-L glass annular column photobioreactors optimized for isoprene production

Tested variables:
- **Light spectrum:** White
- **Light intensity:** 100-300 µmol photons m^{-2} s^{-1}
- **pH:** 7.8
- **Temperature:** 36 °C
- **Culture regime:** Fed-batch



Scaling-up to 100 L PBR



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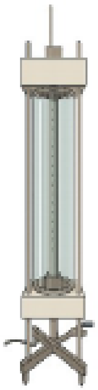
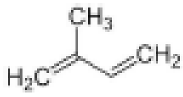
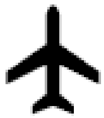


ISOPRENE



JET FUEL



1st year

- Define the optimal parameters for high biomass productivity in *Synechocystis* sp. PCC6803 wild-type
- Evaluate and study light utilization efficiency under different conditions also with different strain and technology

2nd year

- Test the best parameters for isoprene production with the genetically modified (GM) strain in an optimized photobioreactor
- designed for isoprene production

3rd year

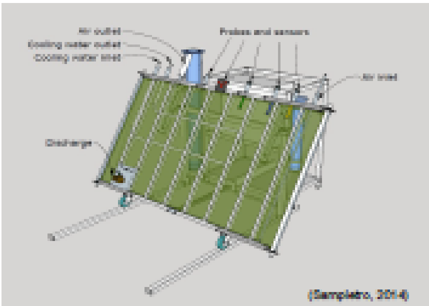
- Scaling-up to large volume flat panel or annular column reactor designed to produce, recover and trap isoprene

Bioreactor setup: 40-L 50° N-S Green Wall Panel (GWP®-III) photobioreactors

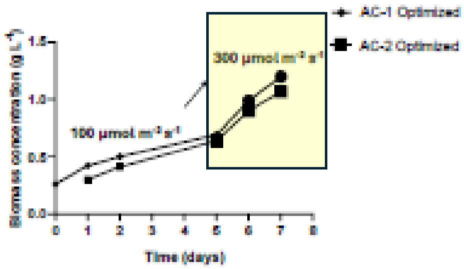
Strain: *Tetraselmis suecica* F&M-M33

Experimental conditions:
- **Sunlight**
- **pH:** 7.8
- **Temperature max:** 28 °C
- **Culture regime:** Fed-batch, semicontinuous (10, 30 and 50% daily dilution rate)
- **Shading devices**

Outdoor trial in summer period



Synechocystis KJ08 (GM)



RESULTS (*Synechocystis* sp. PCC6803 WT)

	Light spectra trial		Light intensity trial				pH trial				Temperature trial			
Difference Biomass Productivity (%)	W300	P300	W50	W600	P50	P600	W Ph 9.0	W Ph 6.0	P pH 9.0	P pH 6.0	W 32°C	W 40° C	P 32° C	P 40°C
CNT W300 pH 7.8 T.36 °C		+ 36.4%	+ 500%	+ 0%			+ 24%	+ 329%			+ 16.8%	+ 0%		
W50	+ 83.3%			+ 83.3%	+ 37.5%									
W600	+ 0%		+ 500%			+ 25%								
W300 pH 9.0	+ 19.4%							+ 242%	+ 100%					
W300 pH 6.0	+ 70.9%						+ 70.8%			+ 133%				
W300 T.32°C	+ 22.9%											+ 22.8%	+ 11.8%	
W300 T.40° C	+ 0%										+ 18.4%			+ 24%
CNT P300 pH 7.8 T.36° C	+ 26.7%				+ 189%	+ 10.4%			+ 78.2%	+ 817%			+ 35.8%	+ 12.2%
P50		+ 82.8%	+ 80%			+ 86.7%								
P600		+ 11.8%		+ 22.6%	+ 200%									
P300 pH 9.0		+ 64.2%					+ 50%			+ 300%				
P300 pH 6.0		+ 86.2%						+ 57.1%	+ 75%					
P300 T. 32°C		+ 56.7%									+ 13.5%			+ 36.8%
P300 T. 40 °C		+ 13.9%										+ 18.4%	+ 26.9%	

Conclusion

- In WT strain, biomass productivity of 0.30 g L^{-1} d^{-1} was obtained with white light at 300 µmol m^{-2} s^{-1} intensity, pH of 7.8 and 36 °C. Increasing light intensity to 600 µmol m-2 s-1 did not induce significant increase in productivity
- The first trials on GM strain shows that increasing white light intensity from 100 to 300 µmol m^{-2} s^{-1} enhances biomass productivity of *Synechocystis* KJ08 from 0.11 to 0.23 g L^{-1} d^{-1}

Next steps

- Upcoming work will aim to verify whether the reduced growth is mainly caused by diverting carbon flux to isoprene synthesis than biomass. Different environmental conditions (light spectrum, light intensity and temperature) that stimulate isoprene production over growth in the GM strain will be tested.

BIOLOGICAL VALORIZATION OF PLANT-BASED WASTE AND BY-PRODUCTS

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Introduction

In Italy, agri-food by-products represent an economic value of €8.5 billion per year, but much of this potential is lost as they are treated as waste, leading to high costs and the loss of bioactive compounds like fibers, polyphenols, and vitamins (Rana et al., 2021; Bianchi et al., 2020).

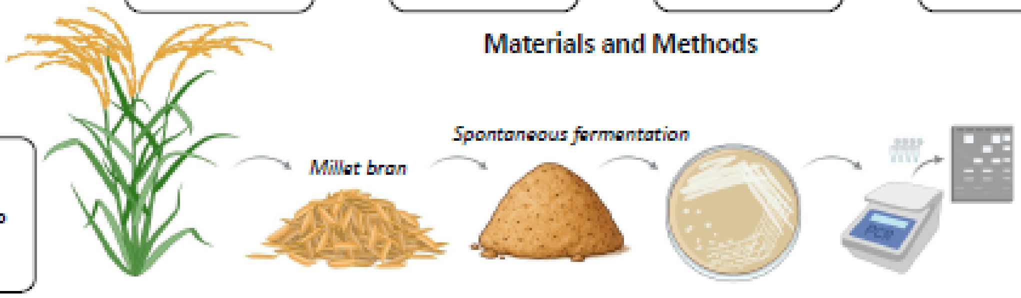
Recent advances suggest that lactic acid bacteria (LAB) fermentation can transform food by-products, improving their nutritional properties and suitability for sustainable applications, while enhancing safety, shelf life, nutrient bioavailability, and phenolic compounds (Silva et al., 2021; Garcia et al., 2020).

Research Aims

Isolation and characterization of lactic acid bacteria from by-products during fermentation → Identification of microbial strains capable of producing bioactive compounds → Development of a microbial biobank for applications in the food industry. → Creation of functional ingredients for enhanced nutrition

Materials and Methods

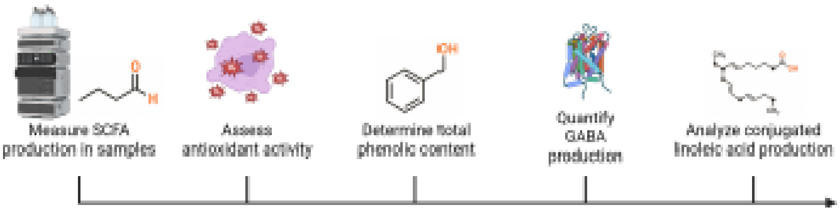
Millet is an ancient grain, gluten-free also suitable for special diets



A total of thirteen strains were detected

STRAIN	SPECIES
MIL 1	*Weissella paramesenteroides*
MIL 3	*Weissella paramesenteroides*
MIL 9	*Lactiplantibacillus plantarum*
MIL 10	*Weissella paramesenteroides*
MIL 16	*Weissella paramesenteroides*
MIL 24	*Weissella paramesenteroides*
MIL 31	*Weissella paramesenteroides*
MIL 38	*Weissella paramesenteroides*
MIL 42	*Lactiplantibacillus plantarum*
MIL 45	*Weissella paramesenteroides*
MIL 46	*Weissella paramesenteroides*
MIL 51	*Weissella cibaria*

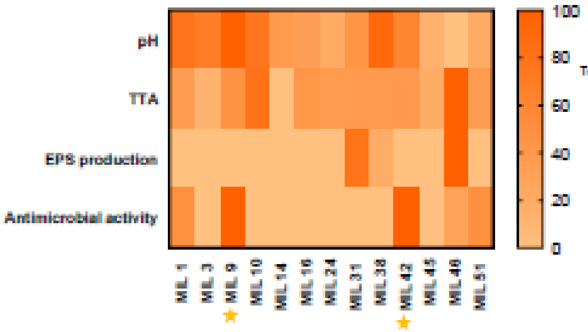
Technological traits

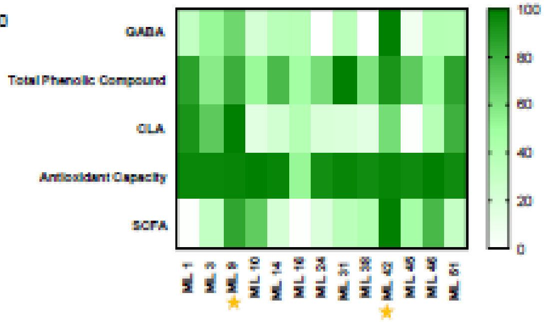


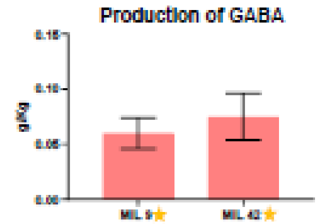
Nutritional traits

Selection of strains to be used for the production of the fermented millet bran ingredient

Results of Fermented Millet Bran





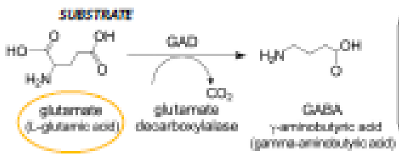


Lactiplantibacillus plantarum MIL 9 and MIL 42 selected for the production of the fermented millet bran ingredient

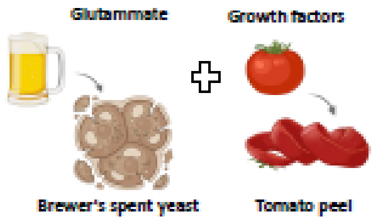
Ongoing Research Activities

1

How can sustainable sources of glutamate and growth factors be effectively utilized to enhance GABA production?



Enhance the concentration of glutamate (substrate) and growth factors with other by-products.



GABA is the main inhibitory neurotransmitter in the central nervous system. It supports blood pressure reduction, better sleep, anxiety relief, and glucose metabolism.

Ongoing

2

Ex vivo tests on cells:

- *In vitro* assays of fermented millet bran:
  - Cytotoxicity and anti-inflammatory activity on RAW 264.7 and Caco-2 cells

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Poster Dottorand3 del 41° ciclo

Multisensor High-Throughput Phenotyping for Discriminating Biotic and/or Abiotic Stress in Herbaceous Crops

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*Anna Rita Balingit (email: annarita.balingit@unifi.it)

Introduction

Climate change and emerging biotic pressures increasingly threaten crop yield, demanding rapid and precise tools for monitoring plant stress. High-throughput phenotyping (HTP) offers a scalable approach to capturing morphological and spectral traits across growth stages. This project aims to advance automated HTP methodologies to improve early stress detection and deepen our understanding of crop physiological responses.

Objectives

- Identify stress-specific spectral signatures through multisensor characterization;
- Develop a predictive model linking morpho-physiological traits to biotic and/or stress conditions for early diagnosis;
- Create a scalable automated HTP system for extracting morphological and spectral herbaceous crops traits.

Materials and methods
PhD project workflow

1

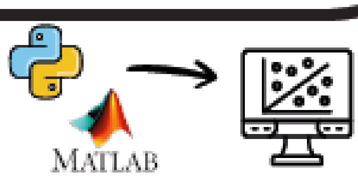
Literature review

Address key research gaps by analyzing predisposing conditions and defining major biotic and abiotic stresses, while identifying the most relevant spectral and morphometric phenotypic traits.

2

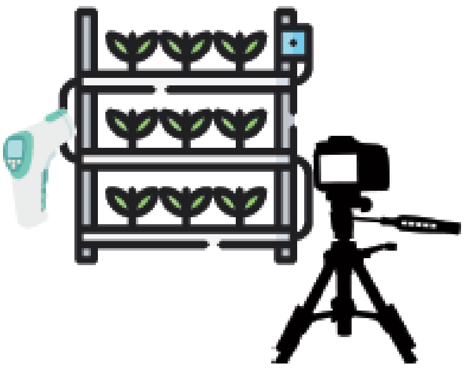
Experimentation in growth chambers

Apply the stress protocols and collect proximal imaging data (RGB, hyperspectral, thermal) capturing both morphometric traits and spectral signatures, across the different phenological stages of stressed crops.



Data analysis

Process imaging data to identify stress-related phenotypic patterns, develop an automated pipeline for extracting key morpho-physiological traits.



3

Experimentation in greenhouse and/or field conditions

4

Acquire whole-plant multisensor HTP imagery in greenhouse conditions and assess scalability to field environments, followed by statistical analysis of the resulting data.

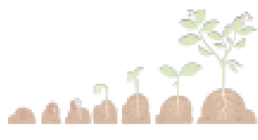
5

Expected results

- Development and validation of an automated high-throughput phenotyping (HTP) system for assessing crop physiological responses under biotic and/or abiotic stress.
- Establishment of a methodology for acquiring and analyzing morphological traits and spectral features across phenological stages in stressed crop species.
- Creation of an integrative interpretative model combining morphological and spectral traits to enable early detection of crop stress and improve understanding of plant physiological responses.

STAY TUNED

SOON



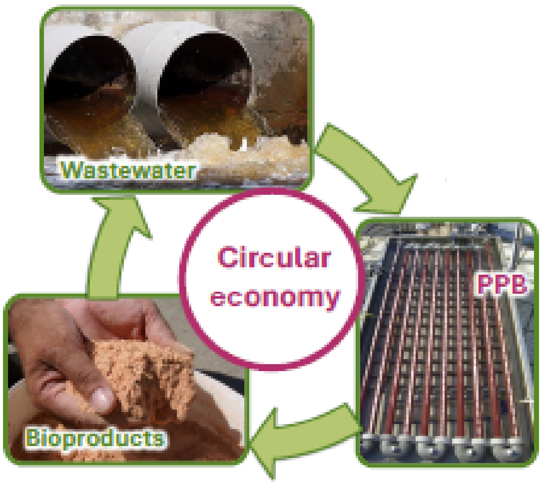
Engeneering purple bacteria co-culture for integrated wastewater treatment and dual bioproduct recovery

Fabio Bracali
Department of Agriculture, Food, Environment and Forestry (DAGRI) University of Florence

UNIVERSITÀ DEGLI STUDI FIRENZE

INTRODUCTION

Municipal and agro-industrial wastewaters (WW) can be viewed not as a treatment burden but as an organic-rich resource for low-cost microbial cultivation. **Purple phototrophic bacteria (PPB)** are particularly suited for this approach due to their metabolic versatility, tolerance to high organic loads, and ability to accumulate valuable bioproducts [1,2].
Among these, **carotenoids**, pigments with antioxidant, nutraceutical, and aquaculture uses, and **coenzyme** Q_{10}, a key molecule for pharmaceutical and cosmetic applications, are especially relevant [3].
Natural WW consortia can also act as metabolic partners, supplying fermentation-derived substrates that stimulate PPB growth and productivity [1].
This project aims to unravel these interactions and design a synthetic community that maximizes dual production of CoQ_{10} and carotenoids within a circular-economy framework.



METHODS

This project integrates **microbial ecology, multi-omics, and bioprocess engineering**.

- WW communities will be profiled through 16S rRNA sequencing, shotgun metagenomics, and network analysis
- Chemiorganotrophic isolates will be screened for PPB-stimulatory metabolites using HPLC, Biolog phenotyping, and whole-genome sequencing
- Synthetic consortia will be tested in controlled photofermentation reactors, measuring CoQ_{10}, carotenoids, organic acids, and population dynamics via flow cytometry

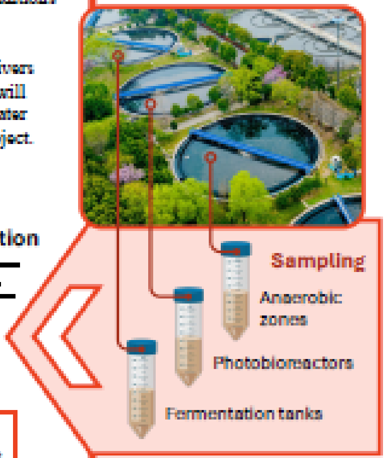
EXPECTED RESULTS

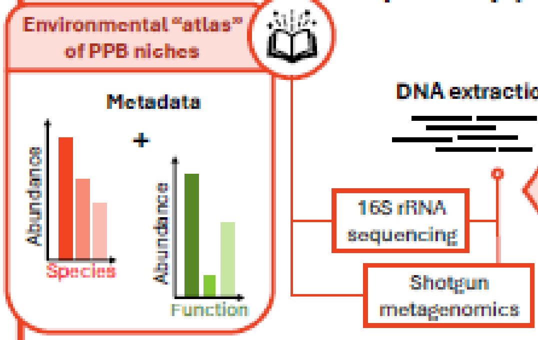
- Identify key chemiorganotrophic partners supporting PPB performance
- Uncover microbial interaction networks that drive PPB dominance and metabolic bottlenecks affecting high-value product formation
- Design and validate synthetic consortia and single-stage photobioreactor strategies that enhance dual CoQ_{10} and carotenoid production from WW

PROJECT DESCRIPTION

Red core - Sampling & Environmental Characterization

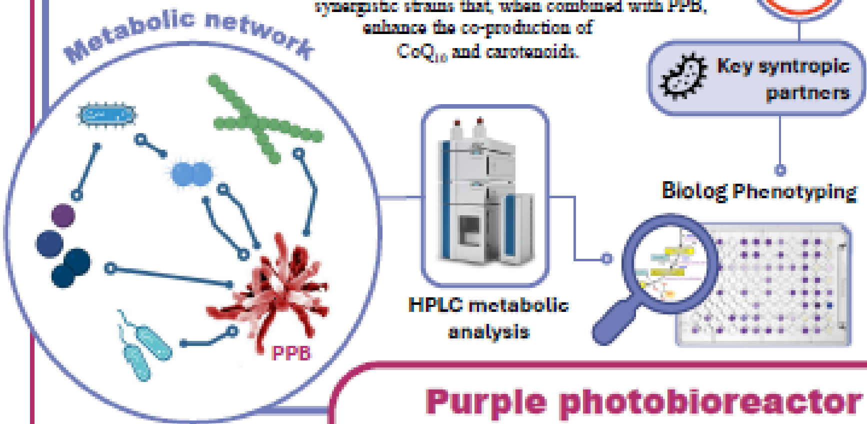
This phase explores where and why PPB thrive within municipal and agro-industrial WW environments, and how natural conditions shape their ability to accumulate CoQ_{10} and carotenoids.
Sampling will be carried out at Aqualia, Spain.
It will identify **PPB hotspots** and the key environmental drivers that regulate isoprenoid-based metabolite production. This will guide PPB strain selection from the DAGRI collection for later phases of the project.



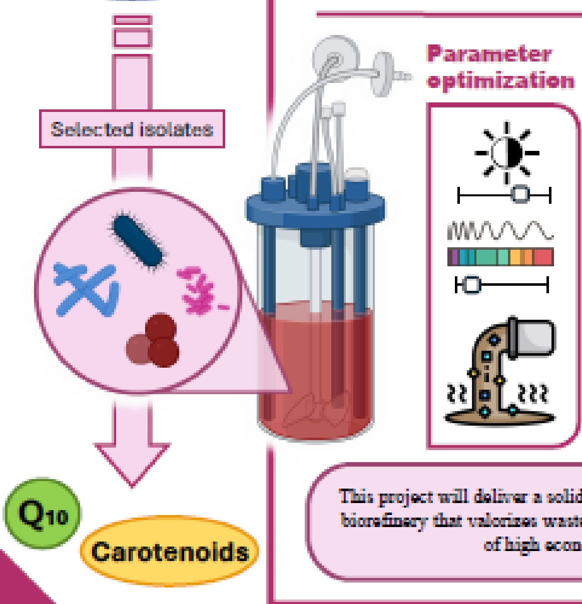


Networking core - Identifying Key Syntrophic Partners & Biostimulants

Phase 2 identifies the **chemiorganotrophic partners** that naturally support PPB by supplying beneficial metabolites, relieving inhibition, or improving redox conditions. These "**biostimulant producers**" will form a toolbox of synergistic strains that, when combined with PPB, enhance the co-production of CoQ_{10} and carotenoids.



Purple photobioreactor



The final phase combines PPB with selected microbial partners into **synthetic consortia** and tests them in **single-stage photobioreactors** (up to tree PPB and five cross-feeding partners), in photofermentative conditions.
These communities are evaluated for substrate use, PPB enrichment, metabolite yields, and overall stability. The objective is to demonstrate their potential to outperform monocultures.

This project will deliver a solid prototype for a single-stage PPB biorefinery that valorizes waste streams into bioactive molecules of high economic relevance.

CITATIONS:
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CREATING "FERTILE AND HEALTHY" TECHNOSOLS FROM A CIRCULAR ECONOMY PERSPECTIVE TO IMPROVE THE SUCCESS OF PLANTING IN URBAN ENVIRONMENTS

Beatrice Fiore, XLI CICLO

State of the Art

Over half of the global population lives in cities, where urbanization consumes soil and disrupts natural soil–atmosphere processes through widespread impermeable surfaces. Even unsealed urban soils are often degraded and provide limited ecosystem services. Yet soil quality—crucial for plant establishment and soil functioning—is frequently overlooked in green infrastructure. Low-quality, organic-poor substrates remain common, despite cities producing compostable biomass that could help restore urban soils and support de-sealing efforts.

Purpose of the research

This project aims to improve soils used in urban green infrastructure by incorporating urban organic and inorganic waste materials. The study takes place in a recently de-sealed area composed of residual highway construction materials, including concrete, asphalt, and other inert debris. Soil and spontaneous vegetation will be analyzed, and the same soil will be used in a controlled pot experiment to obtain preliminary data and maintain experimental continuity even in case of field delays.

Tree growth will be evaluated across four technosol formulations based on the de-sealed soil, amended with different organic inputs: **control soil, compost, manure-based vermicompost, and coffee-ground vermicompost.**

Materials and Methods

Experimental Design

The project combines a pot experiment in a nursery—using lysimeters that simulate urban planting pits under controlled conditions—and a field experiment in Parco delle Carpugnane (Calenzano, Florence), set on recently de-sealed soils composed of inert construction residues.

Site Selection & Preparation

Suitable de-sealed plots are identified through photo-interpretation and GIS analysis, followed by baseline soil sampling to assess physical, chemical, and biological degradation. In parallel, the nursery is prepared with custom lysimeters filled with the same de-sealed soil.

Planting

Two to three common urban deciduous tree species are selected and planted following a randomized complete block design with at least three replicates per treatment in both experiments. Standardized procedures and uniform nursery stock ensure consistency across sites.

Monitoring (2 years)

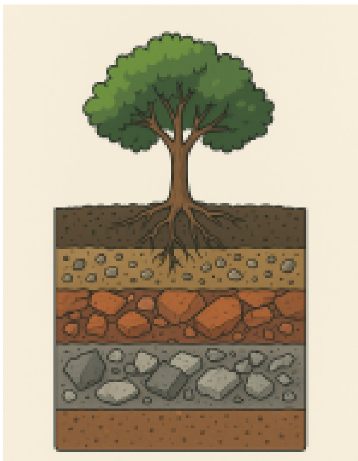
Soil assessments include structure, porosity, infiltration, water retention, organic matter, nutrients, pH, microbial activity, and earthworm presence. Plant monitoring covers height, stem diameter, root biomass (pots), gas exchange, chlorophyll content, water potential, and pest or disease symptoms.

Data Analysis

Data are analyzed using multifactor ANOVA to evaluate treatment and environmental effects, complemented by multivariate analyses to explore soil–plant relationships and performance patterns.

Expected results

- Better vegetative and physiological performance of trees.
- Improved soil physical, chemical, and biological properties.
- More stable, hydraulically efficient compost-based technosols suited for stormwater management.
- Promotion of circular economy practices through organic waste valorization.
- Scientific publications and conference contributions to support the adoption of organic-based technosols in urban greening.



PhD course in Agricultural and Environmental Sciences
Cycle XLI

Cold Forest Microrefugia in the Mediterranean Region: microclimate, plant diversity and conservation

Filippo Fortuna

BACKGROUND

What are cold forest microrefugia?

Small-scale sites hosting relict plant communities outside their current biogeographic range.
Beech (*Fagus sylvatica* L.) low-altitude populations are a particular kind of cold forest mediterranean microrefugia.

Where can we find cold forest microrefugia in the mediterranean region?

Geomorphological complexity is a key feature enabling marked microclimatic decoupling between local and regional climates, thus making the persistence of cold forest microrefugia possible.
In the Mediterranean macro-bioclimatic region of Tuscany, many low-altitude beech cold microrefugia are associated with abyssal sites, located in gorges, at the bottoms of narrow valleys, on N-facing steep slopes.

Why are cold forest microrefugia important?

- Their presence maintains high species turnover, which is crucial in sustaining key ecosystem functions.
- Cold microrefugia plant communities exhibit high taxonomic, phylogenetic and functional α-diversity levels, due to contact with surrounding Mediterranean and sub-Mediterranean vegetation.
- Due to their long-term persistence and isolation form zonal Appennine beech populations, cold forest microrefugia may show distinct phenotypic adjustments and/or genotypic adaptations to local ecological conditions.
- The microclimatic stability of these environments has important conservation implications, as it may support the long-term persistence of populations threatened by climate change.

Why do we need to study cold forest microrefugia in the Mediterranean region and what is currently missing?

Despite their ecological uniqueness, knowledge on distribution and ecological features of these refugia in the Mediterranean region remains limited and poorly addressed by current research.

Typical catenal vegetation sequence in a Mediterranean fluvial valley hosting abyssal beech stands. Upper slope positions (A) are dominated by thermophilus Mediterranean vegetation. Mid-slope positions (B) host transitional sub-Mediterranean communities. Valley bottoms (C) support a distinctive assemblage of hygrophilous phytocenoses with the co-occourence of continental (e.g. Fagus sylvatica L.) and oceanic (e.g. Taxus baccata L.) taxa and associated herbaceous floristic elements.

GENERAL AIMS

- Clarify the effects of **microclimatic decoupling** on the vegetation of selected cold abyssal beech microrefugia.
- Assessing the contribution of cold forest microrefugia to local and regional **biodiversity**.
- Study of **phenotypic adaptations** in characteristic species (woody and herbaceous) comparing relic and zonal populations
- Produce a **comprehensive and updated checklist and features database** of cold mediterranean beech microrefugia sites in Tuscany.
- Develop a **probabilistic model** for beech cold beech microrefugia distribution in the mediterranean region.
- Evaluate measures and sustainable forest management (SFM) practices for cold mediterranean beech microrefugia **conservation**.

(WP1) DISTRIBUTION

AIMS

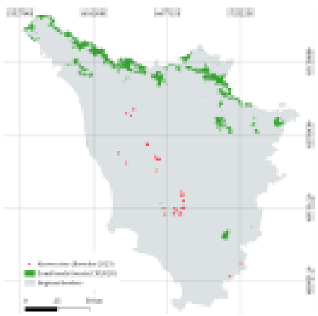
- Quantitatively assess beech cold microrefugia **distribution** and **stational characteristics**
- Collect a set of **geomorphological variables** and derived indices to highlight common features of known beech abyssal microrefugia

MATERIAL & METHODS

- Literature review (WOS, PubMed, Scopus, ...)
- Field investigations
- Geospatial analysis (QGIS, SAGA)
- Statistical analysis (R)

EXPECTED RESULTS

Cold mediterranean abyssal beech microrefugia may share a set of common geomorphological features, testifying their ecological singularity.



Geographic distribution of selected beech cold microrefugia for beech in Tuscany, compared with zonal beech forests. Own elaboration from Bartolini (2023) and CFI (2020) data.

(WP2) VEGETATION & DIVERSITY

Understory vegetation sampling design along a putative altitudinal gradient and corresponding vegetation sequence. Red squares corresponds to 5x5m quadrat (group A = uphill vegetation; B = hillside vegetation; C = abyssal vegetation).

AIMS

Compare plant communities along an altitudinal gradient, from valley bottoms (microrefugia) to upper slope phytocenoses, focusing on:

- Floristic **composition and structure**
- Taxonomic, functional, and phylogenetic **diversity**
- **Dynamism** and **catenal relationships**

MATERIAL & METHODS

- Vegetation surveys (Braun-Blanquet phytosociological method)
- Vegetational and structural characterization of sampled communities
- Statistical analysis (R, SAGA)

EXPECTED RESULTS

Highlight plant diversity and phyto-ecological specificity of low-altitude beech microrefugia, using a community-based comparative approach.

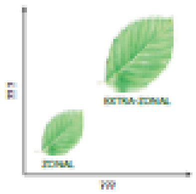
(WP3) PHENOTIPIC PLASTICITY

AIMS

Assess multilevel phenotypic plasticity of abyssal beech relic populations and associated herbaceous species, through leaf and reproductive functional traits analysis.

MATERIAL & METHODS

- Sampling in selected zonal and extra-zonal populations
- Leaf trait measure
- Statistical analysis (R)



EXPECTED RESULTS

Abyssal beech populations and associated herbaceous species, may show adjustments and adaptations induced by the specific environmental conditions of cold microrefugia, highlighting divergence from populations in their geographical and altitudinal optimum.

(WP4) MICROCLIMATE

AIMS

Quantify the **decoupling** from regional climatic conditions through direct measurements of microclimatic gradients in a sample of cold beech microrefugia. Highlight relationships between **microclimatic variability**, **topographic factors**, and **vegetation**, evaluating compositional variation and its effect on biodiversity.

MATERIAL & METHODS

- Microclimate monitoring (T-RH sensors)
- Microclimatic datasets analysis
- Comparison with macroclimatic data
- Correlation with composition and diversity of corresponding phytocenoses, and geomorphological variables

EXPECTED RESULTS

Highlighting the strong relationships between vegetation, local environmental gradients, and topographic variables

Sensor positioning along a hypothetical altitudinal-microclimatic gradient. Point "low" corresponds to a cold beech microrefugia site.

COLD BEECH MEDITERRANEAN MICOREFUGIA DEFINITION & DISTRIBUTION

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- Roma-Marzio et al. (2017) *Heterotopy remastered with a quantitative tool: the case study of European beech (Fagus sylvatica L. subsp. sylvatica) in peninsular Italy and Sicily*. Atti della Società Toscana di Scienze Naturali, Memorie, Serie B, Volume 124, pp. 87-93
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VEGETATION AND DIVERSITY

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- Stojnić et al. (2022) *Spatial patterns of leaf shape variation in European beech (Fagus sylvatica L.) provenances*. Trees 36, 497

MICROCLIMATIC DECOUPLING

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UNIVERSITÀ DEGLI STUDI FIRENZE

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PhD in Agricultural and Environmental Sciences *// XLI Cycle – Year 1*

Research project

Study of *Triticum estivum* Organic Heterogeneous Material in Agroforestry for an Agroecological Transition in the Mediterranean Area

1. Problem statement

In a context of **climate crisis**, **soil degradation**, and **agricultural biodiversity loss**, how can **seed and food systems** be effectively secured and rendered more resilient for **future uncertainties**.

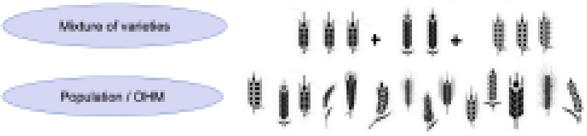
2. Project Idea

The **2030 Agenda** calls for a transformation of food systems through **innovative** agricultural policies and practices. Growing awareness of the negative impacts of conventional agriculture has favored alternative models, notably **agroecology** (Gliessman, 2015).

Market competitiveness has promoted input-intensive agriculture with **high-yield varieties**, but modern soft-wheat cultivars, being genetically **uniform** and **input-dependent**, are unsuitable for agroecological systems.

The introduction of **Organic Heterogeneous Material (OHM)** is the main innovation of **EU Organic Regulation 2018/848**, which **defines it** as a plant entity that:

- ❑ *shares common phenotypic characteristics*
- ❑ *exhibits a high level of genetic and phenotypic diversity*
- ❑ *is neither a specific variety nor a mixture of varieties*
- ❑ *has been produced under organic conditions*



3. Project description

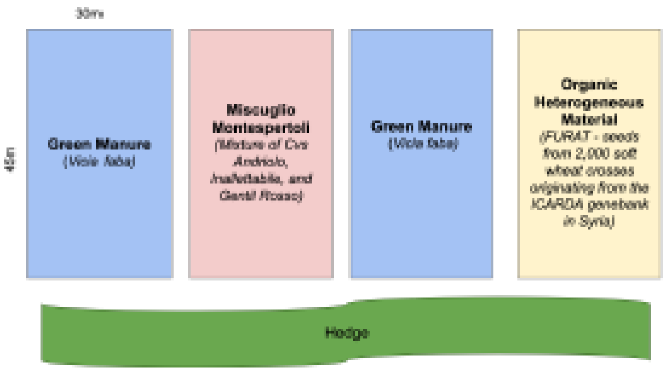
The main objective is to assess the adaptation, agronomic performance, soil microbial activity, and ecosystem benefits of **the FURAT soft wheat population** (OHM) at the **MoLTE site**. This population was originally selected at the ICARDA centre in Syria. The aim is to provide scientific evidence on the effectiveness of OHM as a strategy to enhance **resilience** and **sustainability** in line with **agroecological principles**.

4. Research activities

1- **Comparative Agronomic Evaluation**: evaluate the productivity, stability, and adaptability of the soft wheat **FURAT** compared to the soft wheat **varietal mixture** control (*Miscuglio Montespertoli*) in **2 different sites** adopting the crop **rotation practice.**

2- **Environmental Impact Assessment:** assess the impact on biodiversity and soil quality, with a focus on the evaluation of **soil microbiome** considering **interactions** between the hedges and OHM / varietal mixture.

3- Activities defined within the **RevAgroForMed** PRIMA project



5. Expected results

The use of **OHM** is increasingly important due to its **broad genetic base** and ability **to adapt** to different **soil and climate conditions**. Its benefits include more stable production, restoration of soil fertility, greater resilience of agroecosystems, mitigation of crop damage from climate change, and the spread of agricultural biodiversity in the fields.

6. References

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Rete Semi Rurali
REVAGRO FOR MED

Using -omics approaches for the development of rhizobium-based bioinoculants for chickpea under drought conditions

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Keywords: Chickpea; *Mesorhizobium*; Drought Stress; Bioinoculants; Multi-omics

Background

Chickpea (*Cicer arietinum* L.) is a key legume crop valued for its nutritional profile and moderate drought tolerance. However, increasing water scarcity driven by climate change severely threatens its productivity. Beneficial rhizobia, particularly *Mesorhizobium* spp., form nitrogen-fixing symbioses with chickpea roots [1] and can enhance plant performance under stress by modulating transcriptional, physiological, and metabolic responses [2,3]. Although microbial inoculants show strong potential for improving drought resilience, the application of integrated –omics approaches to identify élite strains and dissect plant–microbe interactions remains limited [4]. Understanding the molecular and metabolic bases of drought-resilient symbiosis is essential for developing next-generation bioinoculants for sustainable chickpea cultivation.

Objectives

The main goal is to develop *Mesorhizobium*-based bioinoculants enhancing chickpea drought resilience. Specific aims are:

- Characterization of plant-rhizobium trascriptional response to drought.
- Detect metabolic signatures of beneficial interactions.
- Uncover gene networks and metabolite markers driving beneficial symbiosis under stress.
- Integration of multi-omics data to select élite strains for bioinoculant formulation.

Project Workflow

The project employs a three-phase approach to rationally develop drought-resistant bioinoculants. Phase 1 begins with strain isolation and **Whole Genome Sequencing (WGS)**, followed by **pan-genome analysis** to select promising candidates (Fig.1). Phase 2 then tests these strains in controlled conditions, comparing water regimes (Well-watered vs. Drought) through phenotyping and **RNA-seq analysis** to evaluate functional performance **(Fig.2)**. Finally, Phase 3 uses NMR (Nuclear Magnetic Resonance) profiling to identify metabolic markers and integrates genomic and transcriptomic data (multi-omics integration), systematically guiding the final selection of élite strains for the bioinoculant (Fig.3).

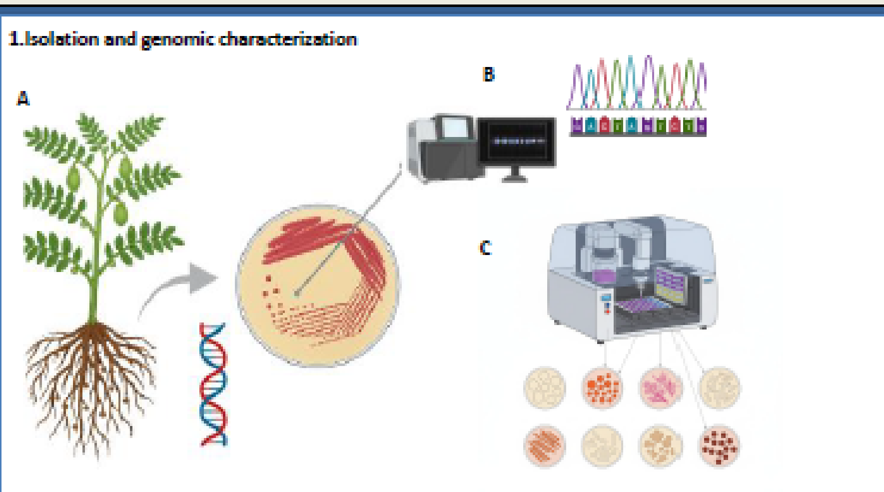

Figure 1. Isolation of *Mesorhizobium* strains (A), Whole Genome Sequencing (B) and Phenotype Microarray for strain characterization (C).

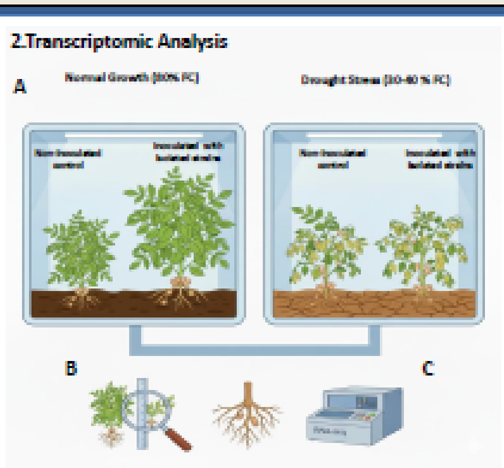

Figure 2. Plants experiment in two water regimes (A); Phenotypic assessment of biomass, height, RDW, nodulation (B); and RNAseq (C) on roots and nodules.

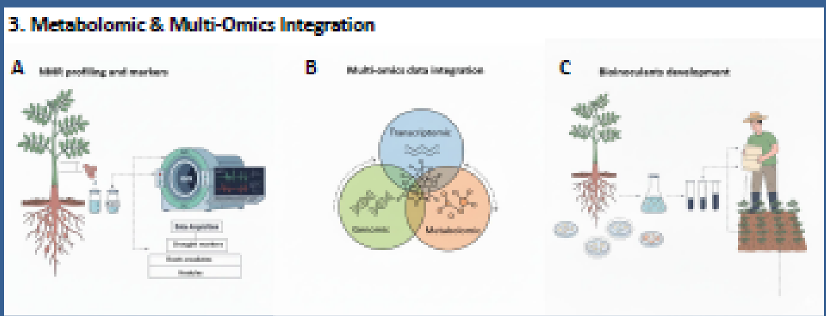

Figure 3. NMR Profiling (A)and Multi-Omics Integration (B;Genome, Transcriptome, Metabolome) guide the systematic selection of elite *Mesorhizobium* strains for rational bioinoculant development (C).

Expected Results

- Identification of *Mesorhizobium* strains with enhanced ability to improve chickpea drought tolerance.
- Characterization of symbiosis-related and stress-responsive gene clusters.
- Identification of key transcriptional regulations induced by drought.

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Characterisation of *Arbutus unedo L.* genotypes for sustainable land management and fruit production: drought tolerance, fruit quality and postharvest physiology

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Introduction

Strawberry tree (*Arbutus unedo* L.) is a Mediterranean evergreen shrub–tree adapted to shallow, nutrient-poor soils, recurrent summer drought and fire. It is increasingly promoted for restoration and fire-prone landscapes. Its fruits and leaves show a distinctive phenolic "fingerprint", very high vitamin C and polyphenol contents, and strong antioxidant capacity, underpinning growing interest in their use for functional foods and nutraceutical products. Despite this ecological and nutritional potential, *A. unedo* is still classed as an underutilised or neglected fruit species: fruit production comes mainly from wild or semi-managed stands, and domestication is only beginning, even though substantial genetic and phenotypic diversity has been documented across Mediterranean populations. Recent work shows that genotypes differ strongly in physiological and metabolomic responses to drought, highlighting real scope to select climate-resilient plant material. At the same time, postharvest studies indicate that storage temperature and surface treatments strongly affect weight loss, firmness, and sensory quality but have been tested on a narrow genetic base.

Goals:

- Characterise *A. unedo* genotypes/provenances for response to drought, phenology and growth.
- Evaluate fruit quality and sensory traits in promising genotypes.
- Describe postharvest physiology (respiration, quality changes, shelf life).
- Identify genotypes suitable for low-input fruit production, ornamental use and ecological restoration.

General overview of project activities

0) LITERATURE REVIEW

1) Plant material

Potted plants and/or field plots including seven wild provenances of *A. unedo* across Italy.

2) Drought tolerance

Controlled irrigation regimes (well-watered, stressed, re-watered). Measurements of plant water status (Ψ, RWC), gas exchange, chlorophyll fluorescence, growth and leaf traits.

3) Phenology

Season-long scoring flowering, fruit set/drop, fruit growth and ripening to compare genotypes and watering regimes.

4) Postharvest

Storage at contrasting temperatures (ambient vs cold). Time-course of respiration/ethylene, weight loss, colour, firmness and decay to define shelf-life and optimal handling

Preliminary insight

- **Year 1 experiment A – Postharvest study**

Preliminary storage test on fruits at five ripening stages (2 × 3 fruits per 5 stage, n = 6) stored at ambient temperature or 4 °C. Fruit respiration, measured with a LI-COR gas-exchange system and a flush-mounted chamber, and non-destructive traits (colour, weight loss, size, firmness) were monitored from T0 to T5 and at T7 (Fig.1).
Additional results and full statistical analysis are ongoing and will be completed and presented at a later stage

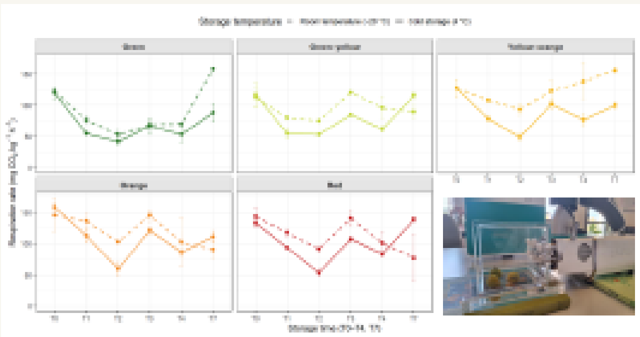
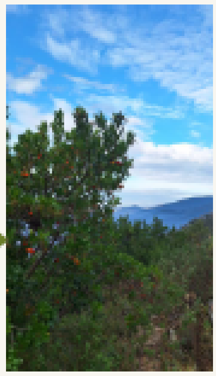


Fig. 1. Respiration rate (mg CO_2 kg^{-1} h^{-1}) of strawberry tree fruits at five ripening stages (Green, Green-yellow, Yellow-orange, Orange, Red) during storage at room temperature (°C, dotted lines) and cold storage (4 °C, solid lines). Values are means ± standard error at each sampling time (T0–T7).

NEXT STEPS



December trial: Yellow–orange fruits will be harvested from naturally grown strawberry trees at Monte Pisano (PI), i.e. the ripening stage identified as the most suitable in the preliminary trial. For each storage treatment (ambient temperature vs 4 °C), non-destructive measurements will include colour (visual scale and Multiplex® pigment indices), fruit weight and size, firmness, and respiration/ethylene release over time. At each sampling date, destructive analyses will be carried out on subsamples to determine basic biochemical traits and to quantify phenolic compounds by HPLC-DAD-Q-TOF.

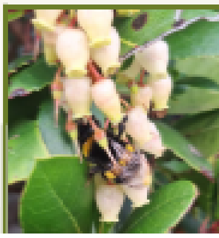
- **Year 1 experiment B – Drought study**

The central working hypothesis is that provenances originating from drier and more thermally stressed climates will combine safer hydraulic architecture, tighter control of water loss and greater cellular dehydration tolerance, thus showing higher resistance to experimental drought and better recovery after re-watering than provenances from more mesic sites

Fig. 2. Seven wild provenances (two from Sardinia) of strawberry tree targeted for drought and fruit-quality screening across Italy and contrasting climates and elevations.

Fifty potted strawberry tree plants were obtained from wild provenances at Saline di Tarquinia, Castel Porziano, Alto Tirone (Vesuvius), Montefalcone, Casal Marittimo supplied by the Carabinieri forestali (Raggruppamento Carabinieri Biodiversità). Also, two provenance from Sardinian sites (including Villacidro).
Plants are grown in pots in an experimental area and assigned to two water regimes: well-watered conditions and a progressive drought followed by re-watering. The trial combines constitutive traits measured under well-watered conditions, hydraulic safety (xylem vulnerability curves, P50), water-use strategy (minimum epidermal conductance gmin, specific leaf area) and cellular tolerance (pressure–volume parameters such as turgor loss point, osmotic potential at full turgor and modulus of elasticity), with inducible traits recorded under water stress and recovery (gas exchange, plant water status, chlorophyll fluorescence, percentage loss of conductivity and hydraulic safety margin, effective water-use efficiency, growth, and total leaf area).
The experiment tests whether constitutive traits can predict provenance performance under drought and resilience after re-watering, and links functional variability to the contrasting climates of origin.

References:



EXPECTED RESULTS

A set of physiological and morphological traits useful for screening drought tolerance in *A. unedo* genotypes.

Identification of genotypes with favourable phenology and good performance under limited water availability.

Profiling of fruit quality and potential uses (fresh market, processing). Initial guidelines on postharvest behaviour and suitable storage conditions.

Poster collettivo

Science and social responsibility: an analysis of the impacts of the Israeli occupation in Palestine

SCIENCE AND SOCIAL RESPONSIBILITY: AN ANALYSIS OF THE IMPACTS OF THE ISRAELI OCCUPATION IN PALESTINE

Anna Rita Balingt, Hari Berto, Luca de Guttry, Lorenzo Ferretti, Beatrice Fiore, Filippo Fortuna, Matthias Lorimer, Valeria Palchetti, Giovanni Pascucci, Elena Rossi, Francesco Serafini

INTRODUCTION

Science cannot be politically neutral; scientists have a social responsibility to apply their knowledge for societal benefit, maintain integrity, engage publicly, oppose misuse, and address research impacts (Bird, 2014). This principle inspired the creation of poster on Israel's occupation of Palestinian territories, highlighting dehumanization, systematic destruction, and allegations of genocide by the Israeli government. The Israeli-Palestinian conflict began with the 1917 Balfour Declaration (Marker, 2018) and intensified with the Nakba ("Catastrophe") in 1948–1949, when about 750,000 Palestinians fled or were expelled following Israel's declaration of independence. At its core, the conflict involves Israeli colonialism: settlements and de facto annexation since the 1967 six-day war (Reuveny, 2003). Policies of land confiscation, dispossession, and discrimination deny Palestinians basic rights, restricting movement, work, education, and resources (Amnesty International, 2017). Recent siege and military actions have caused "scholasticide" – the massive destruction of Gaza's education system (Giroux, 2025; Chandni, 2024; OCHA and UN, 2024). In July Israeli military forces, accompanied by bulldozers, arrived at a propagation unit of the Palestinian National Seed Bank in Hebron, founded in 2010 to preserve and share seeds, destroying stored material and future harvests. This undermines the viability of tomorrow's agriculture and the farmers who depend on it.

This poster raises awareness using scientific methods: remote sensing and literature review to demonstrate the impacts of alleged genocide on Palestinian agriculture, infrastructure, and society.

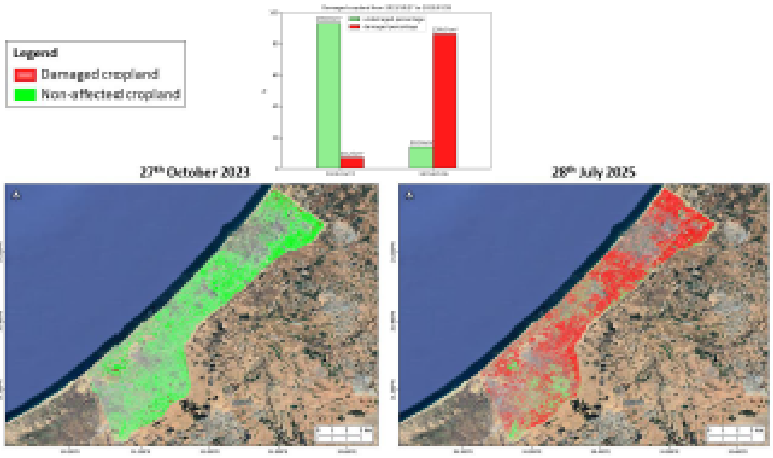
MATERIALS AND METHOD

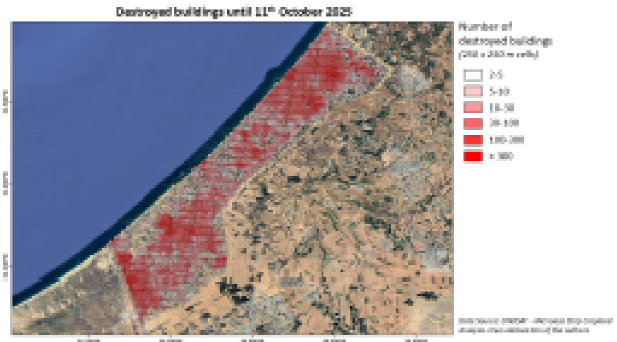
This poster does not present any original findings from a specific research project, but rather a visual summary of the impacts of Israeli military forces actions in Palestine and the occupied Palestinian territories. We focused our analysis on essential civil, environmental and agricultural aspects needed for the self-sustenance of the local populations.

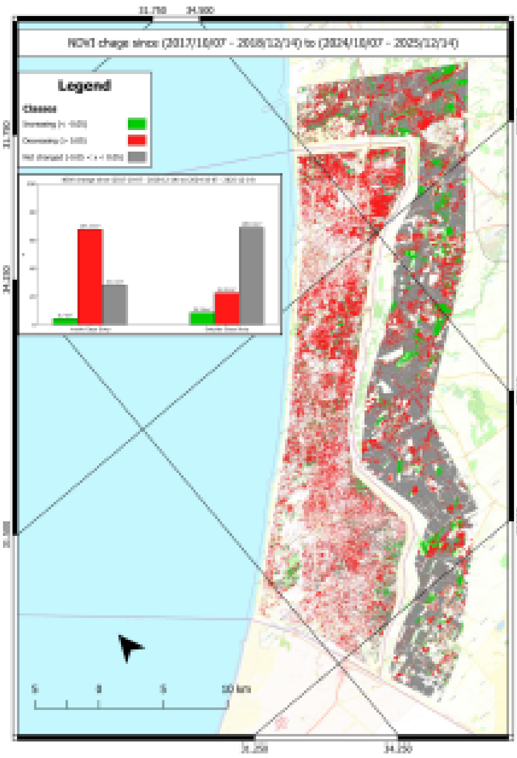
The long-term consequences of Israeli military forces actions are difficult to estimate, but easy to see, and that is the reason why we chose to show spatial representations of the conflict's impact on the territory. Figures below show how deeply and devastating the consequences of the conflict have been for the Palestinian population.

The need to present a symbolic poster during the PhD day of the SAA Doctorate follows the realization that, despite a broad and at times intense social mobilization, public and institutional attention toward the situation in the occupied Palestinian territories may decline, potentially enabling an unbalanced negotiation and a re-normalization of a critically unresolved humanitarian and socio-political crisis. Through this contribution, we aim to help sustain critical awareness and highlight the responsibility of the scientific community in promoting informed and just perspectives concerning topics which go beyond our "designed" field of work.

RESULT







DISCUSSION AND CONCLUSION

Universities and research centers must counter Israeli "dual-use" research, which risks complicity in human rights violations. Israel has received €876 million from Horizon Europe, including direct funding to military companies (e.g., Rafael). Many Israeli universities are integrated with the military apparatus, demanding clear safeguards.

Institutional and grassroots action is increasing:

- Italian Universities: Several departments (e.g., Florence/DAGRI, Naples, Pisa) have suspended agreements with Israeli universities following academic boycott pressure.
- CERN: Over 1,000 researchers are calling for a collaboration review.
- CNR: Introduced ethical filters for military risk projects.
- European Countries: Several nations (Spain, Belgium, Netherlands, Switzerland, Ireland) adopted decisive boycott measures.

The authors condemn the criminalization and isolation of students and professors who are taking action, carried out by the Italian Ministry of University and Research.

International pressure has yielded a result: in July 2025, the European Commission proposed a partial suspension of Horizon funds for dual-use projects (drones, cybersecurity, AI).

This demonstrates the effectiveness of bottom-up pressure from universities and research institutions.

However, constant monitoring is essential to ensure that institutional initiatives remain effective against third-party interests involved in the military industry.

Stand with Scientists Against War and Militarization of Science: Endorse the IUS Statement.

REFERENCE

Conclusioni

La giornata, organizzata in collaborazione con l'ODAF di Firenze e la Scuola di Agraria, non ha disatteso le aspettative ed è stata occasione di confronto e scambio tra dottorand3, oltre che di incontro tra il mondo universitario e quello della libera professione concretizzatosi nella tavola rotonda.
Si ringraziano tutte le persone che hanno partecipato attivamente e collaborato alla realizzazione di questo evento.