HIGHER EDUCATION FOR SUSTAINABLE *Food Production*

6th Joint Meeting of Agriculture-oriented PhD Programs at UniCT, UniFG and UniUD
Lesina (FG), 30 September - 4 October 2024

Università di Catania
Università di Foggia
Università degli Studi di Udine

Lesina

Lesina is a small town in the province of Foggia, Apulia, located to the north of the Gargano promontory. It is best known for giving its name to the Lesina Lagoon, a stunning brackish coastal lagoon which, together with the nearby Varano Lagoon, forms one of the most important lagoon systems in the Mediterranean. The Lesina Lagoon is longer and narrower than Varano, extending 22 kilometers in length and no more than 3 kilometers in width, with a depth of just over 2 meters. This unique ecosystem, rich in numerous species of fauna and flora, including endemic ones, is not only part of the Gargano National Park but is also included in the EU's Natura 2000 network, with two Sites of Community Interest (SCI and SPA).

The lagoon is separated from the Adriatic Sea by the Lesina Isthmus, called "Bosco Isola," a succession of coastal dunes with an extraordinary Mediterranean scrub vegetation unique in Italy for its richness and size. A true treasure trove of biodiversity, Bosco Isola hosts a wealth of flora and fascinating fauna that inhabit its diverse environments, including precious backdune ponds known locally as "fantine." Various trails and sandy paths make it easy to explore on foot, horseback, or by mountain bike.

The eastern part of the lagoon is protected by a State Nature Reserve, where dense reed beds and water mirrors are home to waterfowl, purple herons, and bitterns, while the muddy flats attract wading birds like the black-winged stilt. With its rich biodiversity and picturesque landscapes, Lesina is also a destination for fishing, birdwatching, and enjoying the local cuisine, which offers fresh fish and regional specialties.

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The authors are responsible for the content of their contributions.

The Authors wish to thank for their cooperation:

UNIVERSITÀ DI FOGGIA

HR EXCELLENCE IN RESEARCH

Dipartimento di Scienze Agrarie, Alimenti, Risorse Naturali e Ingegneria

COMUNE DI LESINA

Parco Nazionale del Gargano

Lesina Laguna di Puglia

DARe Puglia
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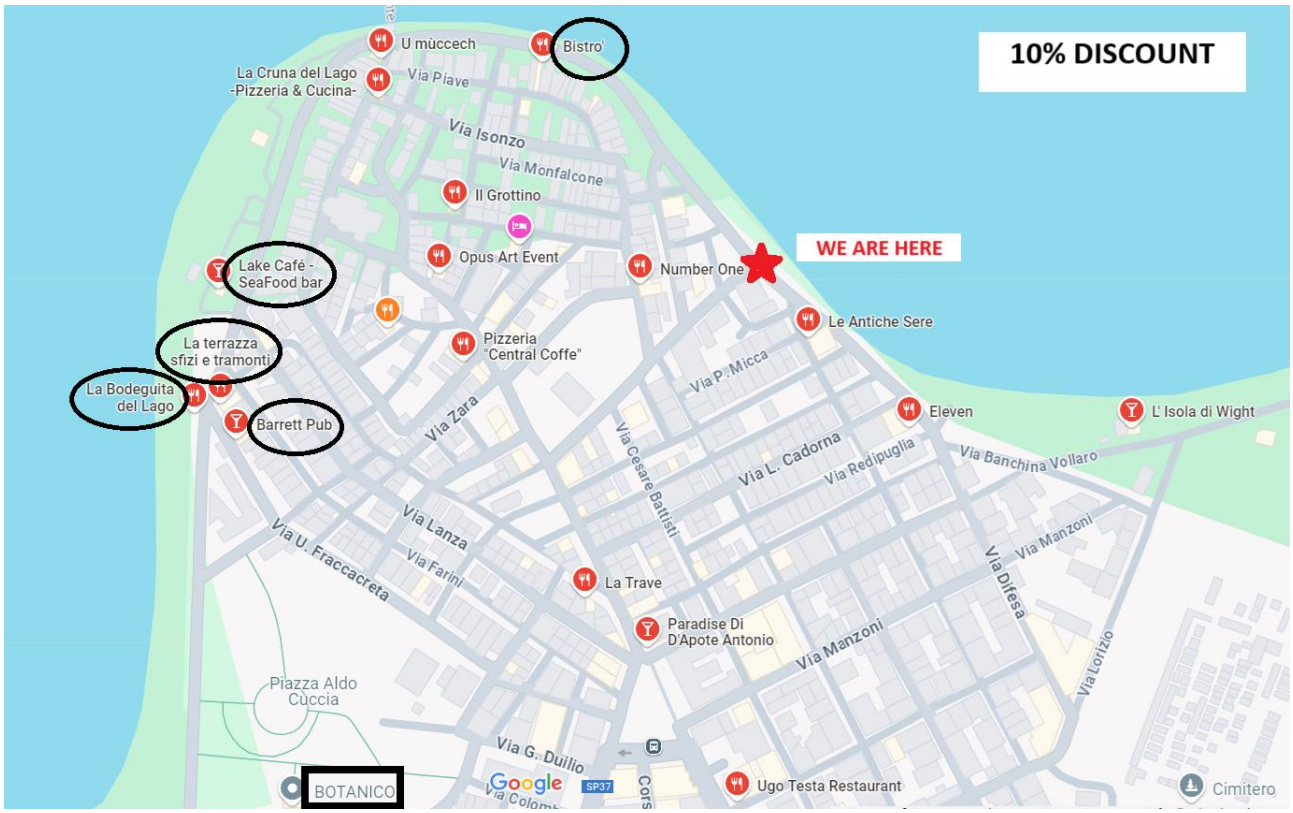
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La Cruna del Lago -Pizzeria & Cucina-
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Lake Café - SeaFood bar
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Program at a glance

6th Joint Meeting of Agriculture-oriented PhD Programs
30 September - 4 October 2024

	Monday, September 30th 2024	Tuesday, October 1st 2024	Wednesday, October 2nd 2024	Thursday, October 3rd 2024	Friday, October 4th 2024
06:30					Isole Tremiti day trip
06:45					
07:00					
07:15					
07:30					
07:45					
08:00	**Registration**				
08:15					
08:30					
08:45					
09:00		***Keynote 3***	**Session VII** **6 talks + 6 talks 1^ year**	***Keynote 4***	
09:15					
09:30	Opening session - Institutional welcome	**Session IV** **4 yalks + 6 talks 1^ year**		**Session IX** **6 talks**	
09:45					
10:00	***Keynote 1***				
10:15					
10:30	***Keynote 2***				
10:45					
11:00	Coffee break	Coffee break	Coffee break	Coffee break	
11:15					
11:30	**Session I** **6 talks**	**Session V** **4 talks + 6 talks 1^ year**	**Session VIII** **2 talks + 6 talks 1^ year**	***Keynote 5***	
11:45					
12:00				**Session X - 4 talks**	
12:15					
12:30			Daily wrap-up		
12:45					
13:00	**Lunch break**	**Lunch break**	**Lunch break**	**Lunch break**	
13:15					
13:30					
13:45					
14:00					
14:15					
14:30	**Session II** **4 talks + 6 talks 1^year**	**Session VI** **4 talks**	**Excursion to Bosco Isola**	**Session XI** **7 talks**	
14:45					
15:00					
15:15					
15:30		Daily wrap-up			
15:45					
16:00	Coffee break	Coffee break		Coffee break	
16:15					
16:30	**Session III** **2 talks + 7 talks 1^ year**	**Visit to Centro Visite Lesina**		Daily wrap-up	
16:45					
17:00					
17:15					
17:30					
17:45	Daily wrap-up				
18:00					
18:15					
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18:45					
19:00	COORDINATOR'S POINT OF VIEW (Prof. Antonio Biondi, UniCT)	COORDINATOR'S POINT OF VIEW (Prof. Stefano Bovolenta, UniUD)		COORDINATOR'S POINT OF VIEW (Prof. Maria Luisa Amodio, UniFG)	
19:15					
19:30					
19:45					
20:00			Social dinner		
20:15					
20:30					
20:45					
21:00					
21:15					
21:30					
21:45					
22:00					

Monday, 30th September 2024

8:00 – 9:30 Registration

9:30 – 10:00 Opening session – Institutional welcome

Dott. Primiano Di Mauro, Mayor of Lesina

Prof. Pasquale Pazienza, President of Ente Parco Nazionale del Gargano

Prof. Agostino Sevi, Department director of Department of Agricultural Sciences, Food, Natural Resources and Engineering, University of Foggia

Prof. Maria Luisa Amodio, Coordinator of PhD program on "Biotechnology and Smart Practices for a Sustainable Management of Natural Resources, Food and Agriculture" at University of Foggia

Prof. Antonio Biondi, Coordinator of PhD program on "Agricultural, Food and Environmental Science" at University of Catania

Prof. Stefano Bovolenta, Coordinator of PhD program on "Agricultural Science and Technology" at University of Udine

10:00 – 10:30 Keynote 1

"The management of protected areas between limits and opportunities"

Prof. Pasquale Pazienza, President of Ente Parco Nazionale del Gargano

10:30 – 11:00 Keynote 2

"Biology, chemical ecology, and management of imported fire ants"

Prof. Jian Chen, USDA, USA

11:00 – 11:30 Coffee Break

11:30 – 13:00 – Session I (Chairpersons: Ammara Asghar, UniFG - Tayyaba Gull, UniFG)

11:30 - Precision grapes harvesting: design of a deep-learning algorithm for picking point recognition

Maria Matloob, UniFG

11:45 – Developing a Bio-District: a living lab approach in Calatino SNAI Area

Giulio Cascone, UniCT

12:00 – Comparison between Liquid Immersion, Laser Diffraction, PDPA and Shadowgraphy in assessing droplet size from agricultural nozzles

Salvatore Privitera, UniCT

12:15 – Tolerance mechanisms of ornamental herbaceous species to drought stress

Luca Giovanni Leotta, UniCT

12:30 – Automated system for programmable grooves on the surface of cereal-based snacks activates the morphing during baking

Eleonora Di Palma, UniFG

12:45 – A carbon-based alternative therapy to reduce the administration of antimicrobial drugs in the treatment of postpartum uterine infections in dairy cows

Francesca Corte Pause, UniUD

13:00 – 14:30 Lunch break

14:30 – 16:00 Session II (Chairpersons: Daniele Fabbri, UniUD - Grazia Marinaro, UniFG)

14:30 – Methane Emissions and Milk Composition in Simmental Dairy Cows

Cristina Pavanello, UniUD

14:45 – Bioactivity of *Punica granatum* (L.) fruit peel extracts against two stored insect pests

Federica Lo Muzio, UniFG

15:00 – Preventive fungicide application for controlling the fungus-farming ambrosia beetle *Xylosandrus compactus* by suppressing mutualistic interactions with its main nutritional fungus *Ambrosiella xylebori*

Mariangela Benedetta Costanzo, UniCT

15:15 – Microbial biotechnologies for sustainable management of food products

Hulya Cunedioglu, UniFG

First Year Short Presentations

15:30 – Effect of almond skin on growth performance of lambs

Fabrizio Mangano, UniCT

15:35 – Root-associated microorganisms for optimizing biological control in tomato

Mariangela Milordo, UniCT

15:40 – Effects of mild abiotic stresses on agronomic, morphometric and qualitative traits of Mediterranean medicinal and aromatic plant species: a systematic literature review

Valentina Formica, UniCT

15:45 – Scalability and adaptation of nature-based solutions for wastewater treatment: GIS-based multi-criteria decision analysis and application of local innovative substrates

Juliano Rezende Mudadu Silva, UniCT

15:50 – Effect of aging temperatures on the flaking process of Provola dei Nebrodi PDO cheese: a preliminary study

Giacomo Antonio Calandra Checco, UniCT

15:55 – Artificial Neural Networks to analyze emissions from livestock buildings

Luciano Manuel Santoro, UniCT

16:00 – 16:30 Coffee break

16:30 – 17:30 Session III (Chairpersons: Gabriella Vinci, UniUD - Martino Musati, UniCT)

16:30 – Assessment of effectiveness of natural and biological means to control Fusarium Disease pathogens and weeds on wheat

Thomas Conte, UniFG

16:45 – Occurrence of virulence genes associated to *Escherichia coli* in hunted wild boars in Southern Italy – Preliminary results

Fiorenza Petruzzi, UniFG

First Year Short Presentations

17:00 – Realizing the full potential of mycoprotein biomass in the sustainable dietary shift through innovative technological solutions

Roberta Montebello, UniFG

17:05 – Evaluating fungicide sensitivity in *Alternaria alternata* isolates from Citrus in Italy

Greta La Quatra, UniCT

17:10 – Biorefinery for valorization of anaerobic digestate in order to obtain bioproducts for agriculture

Antonio Carnevale, UniFG

17:15 – Remote sensing for pasture biomass quantity and quality estimation: challenges and future prospects

Nicola Furnitto, UniCT

17:20 – Evaluating the potential of extreme environments for the isolation of biocontrol agents

Martina Lucci, UniUD

17:25 – Feeding hazelnut skin and linseed to lambs: effect on meat oxidative stability

Antonino Bertino, UniCT

17:30 - HIS imaging: develop of detection model for discriminate Fe deficiency from N deficiency on plant leaves

Michele Canciani, UniUD

17:35 – 18:05 Daily wrap-up – Prof. Stefano Bovolenta, University of Udine

Tuesday, 1st October 2024

9:00 – 9:30 Keynote 3

"Factors affecting meat quality"

Prof. Mirco Corazzin, UniUD

9:30 – 11:00 – Session IV (Chairpersons: Eleonora Di Palma, UniFG - Federica Lo Muzio, UniFG)

9:30 – Nanoplastics impair bovine granulosa cell functions *in vitro*

Susy Urli, UniUD

9:45 – The potential use of non-destructive optical techniques for the detection of physiological disorders in fruits and vegetables

Lucia Russo, UniFG

10:00 – Advantages of liquid Nitrogen as peeling agent in pistachio seeds

Fabiola Pesce, UniCT

10:15 – Microbial bioremediator isolated from human wastes

Alessandro De Santis, UniFG

First Year Short Presentations

10:30 – Adaptation to the climate crisis in table grape viticulture through multifunctional covers and implementation of precision irrigation

Nicola Gerardo Trombetta, UniFG

10:35 – Understanding graft compatibility in kiwifruit (*Actinidia* spp.) through molecular and histological analysis

Iqra Ashraf, UniUD

10:40 – *Lactiplantibacillus plantarum*, foods of plant origin and sustainability: exploring intraspecific diversity through "omics" approaches to assist the development of plant-based solutions

Ester Presutto, UniFG

10:45 – Multistage Constructed Wetlands for dairy and livestock wastewater treatment: removal efficiencies and hydraulic behavior

Salvatore Barresi, UniCT

10:50 – Application of indirect in-package cold plasma to preserve minimally processed fruits and vegetables

Giuseppe Rosiello, UniFG

10:55 – Advanced detection methods for fungal and oomycete plant pathogens and mycotoxins: unveiling the invisible threat

Rossana Parlascino, UniCT

11:00 – 11:30 Coffee Break

11:30 – 13:00 Session V (Chairpersons: Martina Lucci, UniUD - Cristina Pavanello, UniUD)

11:30 – INTEVINE: Multi-omics data integration to decode the interaction between soil and grapevine

Massimo Guazzini, UniUD

11:45 – Biocontrol of Citrus Mal secco: advances on effectiveness of BCAs based-formulations against *Plenodomus tracheiphilus* and deeply understanding of their population dynamics

Giuseppa Rosaria Leonardi, UniCT

12:00 – The ecological network of the Tratturo Magno landscapes

Maurizio Gioiosa, UniFG

12:15 – Exploring the mechanical properties of Low-Quality Wool Yarn as a resource for innovative bio-composite building materials

Giusi Midolo, UniCT

First Year Short Presentations

12:30 – Nature-Based Solutions for wastewater treatment: monitoring and modelling of a hybrid system for the IKEA store in Catania

Alessia Rizzo, UniCT

12:35 – Prediction of wheat quality parameters using near-infrared spectroscopy (NIRS)

Patrizio Spadanuda, UniFG

12:40 – Strategies to increase the presence of pollinators in Mediterranean agro-ecosystems

Marta Bonforte, UniCT

12:45 – Biological control of *Neofusicoccum parvum* associated with fruit rot of mango in Southern Italy

Laura Vecchio, UniCT

12:50 – Functional properties of lipid fraction from insect meal in aquafeed

Rosalinda Akinyi Opere, UniUD

12:55 – Bio-based fertilizers and soil improvers for the sustainability of Mediterranean herbaceous cropping systems

Vivienne Panebianco, UniCT

13:00 – 14:30 Lunch Break

14:30 – 15:30 Session VI (Chairperson: Mariangela Milordo, UniCT - Maria Matloob, UniFG)

14:30 – *Aureobasidium pullulans* formulations: evaluation of the effectiveness against grey mould of table grape

Rudy Cignola, UniUD

14:45 – Application of Multi-Criteria Decision-Making for water desalination

Hiba Chebli, UniFG

15:00 – Impact of ozone addition to gasoline surrogates combustion in spark ignition engine

Fabio Anaclerio, UniFG

15:15 – Grapevine response to different abiotic stresses

Gabriella Vinci, UniUD

15:30 – 16:00 Daily wrap-up – Prof. Antonio Biondi, UniCT

16:00 – 16:30 Coffee Break

16:30 – 18:00 Excursion to Centro Visite Lesina

Wednesday, 2nd October 2024

9:00 – 11:00 Session VII (Chairpersons: Fabrizio Mangano, UniCT - Manuel Santoro, UniCT)

9:00 – Sustainable viticulture: different strategies to enhance the resistance to the main fungal diseases on Sicilian cultivars

Valeria Ereddia, UniCT

9:15 – Genomic and phenotypic characterization of Bile Salt Hydrolase in promising *Lacticaseibacillus rhamnosus* probiotic strains

Gianluigi Agolino, UniCT

9:30 – Resilience to hot-arid climate and fruit properties of interest for food and non-food uses of local apple genotypes in the Monti Dauni area

Damiano Antonicello, UniFG

9:45 – Assessing the impact of pesticides and biopesticides on managed and wild bees in Mediterranean and tropical agroecosystems

Roberto Catania, UniCT

10:00 – Mediterranean diet and intake of microorganisms and biomolecules of microbial origin: case studies for the design of innovative trends

Ghofrane Omri, UniFG

10:15 – Towards a "0 mile" diet for ruminant feeding

Martino Musati, UniCT

First Year Short Presentations

10:30 – Enhancing Buckwheat Breeding and Agronomic Performance Through Genomic Selection and Climate Adaptation Strategies

Getalew Ayizengaw Chana, UniUD

10:35 – Characterization of novel *Citrus* rootstocks subjected to deficit irrigation techniques

Alessio Giuseppe Giuffrida, UniCT

10:40 – Role of beneficial microorganisms towards more sustainable cropping systems in the Mediterranean environment

Giuseppe Indovino, UniCT

10:45 – Circular economy principle in the EVO oil sector from the LCA point of view

Grazia Cinardi, UniCT

10:50 – Enhancing Grapevine Resistance to Flavescence Dorée through Transcriptomic Analysis, Genetic Mapping, and CRISPR/Cas9 Technology

Elias Shewabez Yassin - UniUD

10:55 – Selection of starter cultures from conventional and unconventional raw materials

Alessandra Accettulli, UniFG

11:00 – 11:30 Coffee Break

11:30 – 13:00 Session VIII (Chairpersons: Alessandro De Santis, UniFG - Suleman Khan, UniFG)

11:30 – Spatially-explicit modelling of regional cropping systems based on LPIS for agro-environmental assessment

Antonio Bruno, UniUD

11:45 – Participatory approaches to address territorial fragility in the Inner area of the Simeto Valley (Italy) though Nature-Based Solutions

Emanuela Rita Giuffrida, UniCT

First Year Short Presentations

12:00 – Use of Optimized (Bio)Sensors for analyzing priority and emerging contaminants in surface waters: preliminary analysis

Margherita Vit, UniUD

12:05 – Impact of climate change on small mammal zoonoses: the case of Friuli-Venezia Giulia

Daniele Fabbri, UniUD

12:10 – Population genomic analyses of endangered and endemic plant species

Marwen Amari, UniUD

12:15 – Consumer trends in the herbal tea market: a systematic literature review

Roberto Carbone, UniCT

12:20 – The role of wooden tools in traditional cheese production: preserving quality, authenticity, and biodiversity

Silvia Ruta, UniCT

12:25 – Effects of water stress on fungal pathogens and use of proximal sensing for stress conditions monitoring

Chiara Di Pietro, UniCT

12:30 – 13:00 Daily wrap-up – Prof. Maria Luisa Amodio, UniFG

13:00 – 14:30 Lunch Break

14:30 – 18:00 Excursion to Bosco Isola

Thursday, 3rd October, 2024

9:00 – 9:30 Keynote 4

"*Aureobasidium pullulans:* a multifaceted microorganism"

Prof. Alessandra Di Francesco, UniUD

9:30 – 11:00 Session IX (Chairpersons: Valentina Formica, UniCT - Massimo Guazzini, UniUD)

9:30 – Analysis of emerging contaminants in wastewater from Foggia city by Wastewater-Based Epidemiology (WBE)

Muhammad Usman, UniFG

9:45 – Enhancing Sustainability in Mediterranean Cotton Production: Variety Choice, Water Management, and Defoliant Strategies

Giuseppe Salvatore Vitale, UniCT

10:00 – Investigating Rht GA3-sensitive genes to improve wheat drought tolerance through QTL-seq approach

Giuseppina Angione, UniFG

10:15 – Comprehensive genomic profiling via Oxford Nanopore Technologies: from genome assembly to structural and epigenetic analyses

Mario Liva, UniUD

10:30 – Glad to know you better Ms. *Varroa destructor*

Silvia Parenzan, UniUD

10:45 – Exploring the genetic and epigenetic regulation of budbreak in grapevine

Fiamma Bunello, UniUD

11:00 – 11:30 Coffee Break

11:30 – 12:00 Keynote 5

"The Eternal Ephemeral (From Reality to Image)"

Claudio Del Fuoco, Freelance Photographer

12:00 – 13:00 Session X (Chairpersons: Juliano Rezende Mudadu Silva, UniCT - Grazia Cinardi, UniCT)

12:00 – Development of molecular markers for sweet orange traceability

Sebastiano Seminara, UniCT

12:15 – Up-cycling of Plastic Waste into Valuable Products through Microwave Assisted Co-Pyrolysis with Biochar from Residual Biomass

Tayyaba Gull, UniFG

12:30 – Exploring the interplay of European strategies and the farmer identity construction among the young generation: a qualitative case study from rural Sicily

Federica Consentino, UniCT

12:45 - Integrating alternative ingredients and technological approaches for healthier and sustainable food products

Grazia Marinaro, UniFG

13:00 – 14:30 Lunch Break

14:30 – 16:15 Session XI (Chairpersons: Mario Liva, UniUD - Rudy Cignola, UniUD)

14:30 – Plant growth-promoting bacteria in the rhizo- and endosphere of *Salicornia europea* plants

Angela Guerrieri, UniFG

14:45 – Evaluation of the potential anti-inflammatory effect of the ketogenic diet mediated by the synergistic action of β-hydroxybutyrate and MCT oil on Caco-2 cells

Maria Ida de Stefano, UniFG

15:00 – Promising legumes integration on milk production and welfare

Suleman Khan, UniFG

15:15 – Microorganisms for the environment: technological robustness of plant growth promoting bacteria for Mediterranean crops

Annalisa d'Amelio, UniFG

15:30 – Combination of different vegetable matrices to produce fermented "one shot drinks" enriched in vitamin B2

Angela Scauro, UniFG

15:45 – Improving wheat storage: the impact of heat and CO_2 on insect mortality and grain quality

Ammara Asghar, UniFG

16:00 – Insecticide selectivity on the Spotted wing drosophila and its major parasitoids

Fabrizio Lisi, UniCT

16:15 – 16:45 Coffee Break

16:45 – 17:30 Daily wrap-up – Prof. Giancarlo Colelli, UniFG

Friday, 4th October 2024

06:30 – 19:00 Excursion to Tremiti Islands

13:00 – 15:00 Lunch at "La Fenice" Restaurant, San Domino (FG)

ABSTRACTS

Index

Session I

Precision grapes harvesting: design of a deep-learning algorithm for picking point recognition

Maria Matloob- *maria.matloob@unifg.it*
Prof. Maria Luisa Amodio
University of Foggia - Department of Agriculture, Food, Natural Resources and Engineering (DAFNE)

Agriculture has gone through transformational changes because of the rapid growth of artificial intelligence (AI) technologies. To overcome the difficulties associated with using conventional fruit harvesting techniques, automated robotic fruit harvesting has become a ground-breaking alternative. It's crucial to develop robust machine vison model for automated robotic harvesting in an unstructured environment of vineyard. The heavy occlusions, overlapping of grapes cluster, complex background, changing of lighting conditions and different growing system make it challenging for robotic harvesting. The efficiency of harvesting system relies on vision algorithm i.e. how accurately robot detects the target. This study aims to design machine learning model of grape detection and optimal picking point determination on peduncle that can be integrated into robotic harvesting system. The model was developed using RGB images. The RGB images were taken in the field of Foggia using iPhone mobile camera. Then these images were annotated using bounding boxes algorithm of Robowflow software. The two classes were labelled in each image i.e. Picking Point and Grapes. The 160 annotated images then divided into training set (70%), validation set (20%) and test set (10%). The YOLOv8 deep learning architecture was used to train the object detection model. The performance efficiency of model was evaluated using 100 epochs. The results show the model achieves a maximum of mean Average Precession (mAP) of 90 %. The precession curve steadily improves across training while recall curve remains lower. This shows that that model is detecting object with good accuracy and can be improved to be adapted to any vison system. The designed program will be then integrated to a robot for real time grape picking point detection and tested on the grape vines.

Developing a Bio-District: a living lab approach in Calatino SNAI Area

Giulio Cascone – *giulio.cascone@phd.unict.it*
Prof. Giuseppe Timpanaro and Paolo Guarnaccia
University of Catania – Department of Agriculture, Food and Environment (Di3A)

Rural areas have long faced challenges such as population ageing, desertification, job losses, and the abandonment of agricultural activities. These issues have led to the emergence of innovative initiatives aimed

at revitalizing these regions from a social, economic, and environmental perspective. A notable example is the development of Bio-Districts, which seek to integrate agroecological practices and participatory methodologies. Despite progress, creating an effective framework for these territories remains a complex challenge. This study explores the potential of a Bio-District in the Calatino area, an inland region of Sicily included in the National Strategy for Inner Areas (SNAI). Using the Living Lab method, the project involved farmers, agronomists, distributors, environmental associations, and public institutions, applying the quadruple helix model to stimulate innovation and collaboration. The main challenges included managing the diverse motivations of stakeholders and the limitations of time and resources. The results show that the active involvement of all actors allowed for the development of proposals tailored to the specificities of the territory, highlighting the importance of an integrated and participatory approach. Participants in the Living Lab indicated that the Bio-District could facilitate the dissemination of agroecological practices through improved cooperation and mutual support among local actors. The creation of inclusive governance and the planning of adequate resources are essential to address future challenges. Additionally, the proposal for a food hub received broad support for its potential to improve supply chain efficiency and reduce food waste.

This research underscores the importance of a collaborative and participatory approach in defining a Bio-District, offering valuable insights for similar projects aimed at sustainability and local economic growth.

Comparison between Liquid Immersion, Laser Diffraction, PDPA and Shadowgraphy in assessing droplet size from agricultural nozzles

Salvatore Privitera – *salvatore.privitera@phd.unict.it*
Prof. Giuseppe Ezio Manetto
Prof. Emanuele Cerruto
University of Catania - Department of Agriculture, Food and Environment (Di3A)

Droplet characteristics of agricultural sprays play an important role within the Plant Protection Products application technology, as they influence the effectiveness of a phytosanitary treatment, environmental pollution factors, as well as operator safety concerns. The availability of various measurement techniques, each with its unique operating principles for evaluating droplet size spectra, can lead to different interpretations of spray droplet diameters. In this study, carried out in collaboration with the Agricultural Engineering department of the Federal University of Viçosa (UFV - Brazil) and the Flanders Research Institute for Agriculture, Fisheries and Food (ILVO - Belgium), where I spent my period abroad, four measurement techniques – Liquid Immersion (LI) at UniCT, Laser Diffraction (LD) at UFV, Phase Doppler Particle Analyzer (PDPA), and Shadowgraphy (SG) at ILVO – were used to assess the droplet size distribution of agricultural nozzles. PDPA and SG were also employed to assess the average velocity of spray droplets. In all the measurements, the same four nozzles were used. This research provided essential data for comparing the results of each measurement

technique in relation to droplet spray parameters. As a general trend, the lowest values for droplet diameters were measured using the LD technique, followed by SG. The PDPA technique provided the highest values for mean diameters (D_{10}, D_{20}, D_{30}) and numeric median diameter ($D_{n0.5}$), whereas the LI method yielded the highest values for the Sauter mean diameter (D_{32}) and volumetric diameters ($D_{v0.1}$, $D_{v0.5}$ and $D_{v0.9}$). Importantly, all measurement techniques were able to distinguish the four nozzles based on their $D_{v0.5}$ diameter. Average droplet velocity showed a similar pattern across the tested nozzles with the PDPA and the SG measurement techniques.

Tolerance mechanisms of ornamental herbaceous species to drought stress

Luca Leotta – luca.leotta@pdh.unict.it
Prof. Daniela Romano and Stefania Toscano
University of Catania - Department of Agriculture, Food and Environment (Di3A)

Drought stress is a serious problem in the Mediterranean environment, also due to global change. Among the ornamental plants used in urban greenery, it is above all herbaceous ones that suffer drought stress because they do not have efficient response mechanisms. In this context, the capacity to recover from drought stress of three herbaceous species (African daisy, ivy geranium and zonal geranium), following periodic interventions of suspension and restoration of the water supply, was analysed. Rooted cuttings of the species were transplanted in spring 2023 into 3 L pots on peat-based substrate. After a month in which the plants were irrigated at field capacity (100%), three treatments were applied for a week: control (100%) and two limiting water levels (return of 60% and 40% of evapotranspiration). After one week, the plants were subjected to one week of recovery (100%); the plants were subsequently subjected to the different irrigation regimes again for 14 days, followed by a second recovery period of 7 days. The measurements carried out were: fresh and dry biomass of the different organographic portions, chlorophyll and carotenoid content, relative water content, gas exchange, and chlorophyll a fluorescence. The results highlighted how all genotypes were able to resist conditions of recovery. The resistance mechanisms appeared connected to the reduction of aboveground biomass and, above all, of the leaf surface. Except ivy geranium, the Fv/Fm values appeared to be comparable between the treatments and often higher than the threshold of 0.80, below, however, the plants are considered to be in stress conditions. The measurement of gas exchange, together with chlorophyll a fluorescence, appears to be a suitable strategy for evaluating the response of different genotypes without resorting to destructive measurements.

Automated system for programmable grooves on the surface of cereal-based snacks activates the morphing during baking.

Eleonora Di Palma – *eleonora.dipalma@unifg.it*

Tutor: Prof. Antonio Derossi

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Morphing food represents an innovative approach utilizing stimuli-responsive materials capable of altering their morphology in response to external factors such as temperature, pH, and moisture. This methodology holds potential for creating unprecedented sensory experiences and reducing the packaging materials required for 2D food compared to 3D food. Shape-changing in cereal-based snacks was achieved through an automated system designed to imprint grooves of specified depths onto the surface of the samples using a plastic mold. The study examined the impact of four dough strip thicknesses and various groove depths on the morphological changes of physico-chemical parameters, including moisture content, water activity, color, microstructural properties, and bending characteristics. Moreover, the kinetics of the shape changing during baking were mathematically described. The results demonstrated that the suggested approach might modulate the dynamic shape changes of dough laminae during baking due to differences in the local dehydration occurring on the grooved surface. Surface grooves induced shape changes, with significant variations depending on the initial thicknesses of the samples. The depth of the grooves affected the bending angles of the baked samples. Furthermore, a reduction of 30% in packaging materials was estimated for these innovative foods.

A carbon-based alternative therapy to reduce the administration of antimicrobial drugs in the treatment of postpartum uterine infections in dairy cows

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Cows with uterine infections are typically treated with antimicrobials. However, their extensive and inappropriate use has led to the emergence of antibiotic resistance. In light of the urgent need to implement new strategies to contain both infectious uterine diseases and the spread of antibiotic-resistant bacteria, this study aims to develop an alternative treatment, composed of an ultrapure microporous carbon sorbent matrix arranged in spheres of 0.5-1 mm of diameter.

The *in vitro* results have demonstrated that the carbon matrix is capable of adsorbing and retaining *E. coli* from a suspension, even after shaking. This suggests that the carbon is likely to be effective also *in vivo* for the prevention of postpartum uterine infections in cattle.

The volume of carbon suspension to be infused into the uterus of cows has been determined based on the adsorbing surface of the porous matrix (300 m^2/g) and in accordance with a successful clinical trial in women, after the appropriate proportion between the woman's uterine anatomy and cow's volume of excreted lochia.

The *in vivo* protocol involves 200 postpartum dairy cows, randomly allocated to treatment or control group. The study period for each enrolled cows lasts for one month and it is divided into four time-points. The carbon treatment is performed at T0. Blood and milk samples are collected at T0, T7, T14, and T28; trichotomy for hair sampling is performed at T0 and T28. Uterine flushing and swabs are collected at T14 and T28. The occurrence of uterine infection and cure rate are recorded, and the cows are monitored up to 300 days of lactation by extracting information from the farm management software.

Session II

Methane emissions and milk composition in simmental dairy cows

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The aim of the study was verifying the differences in the milk fatty acids (FA) profile of high and low methane-yield of Italian Simmental dairy cows and to evaluate the relationship between methane emission (ME) measured and estimated (MEE) by the milk FA. The study considered 12 cows divided into two groups: low methane emission (LME) (339.39±21.15 g/d; mean±sd) and high methane emission (HME) (484.34±92.91 g/d) with similar milk yields (33.16±6.9 kg/d) and live weights (704±70.65 kg). The primiparous and multiparous dairy cows were equally distributed between experimental groups (Fisher's exact test; P>0.05). Methane concentration in the cows' breath was measured during feeding twice a day for three days using the LaserMethaneSmart, at a 1-meter distance for 5 minutes. Average values per animal were analyzed. On the third day, feed samples, and milk samples were collected to determine FA (GC/MS). MEE was calculated in according to Van Lingen et al. (2014, J. Dairy Sci., 97:7115). Statistical analysis considered ANCOVA (methane emission group and dry matter intake were considered as fixed factor and covariate, respectively), Pearson correlation, pair sample t-test and Bland-Altman analysis. The informative FAs for MEE, such as C16:0 (25.91±1.86%), C18:0 (10.96±1.93%), C18:2cis9,cis12 (2.15±0.215%), and C18:3w3 (0.66±0.08%), were similar between groups (P>0.05). However, HME had greater C14:0 than LME (P<0.05). Despite ME (411.9±99.28g/d) was similar to MEE (408.9±71.57g/d; P>0.05), these variables were not statistically correlated (r=0.09; P 0.05). The mean difference between ME and MEE was 3g/d with a wide CI (-226.4, 232.7g/d). These results highlight the need to increase the number of animals in future studies to allow for a more thorough investigation and comparison, including animals of different ages.

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Bioactivity of *Punica granatum* (L.) fruit peel extracts against two stored insect pests

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The pomegranate, *Punica granatum* (L.) (Punicaceae), is an important fruit plant worldwide. The peel, which represents about 40–50% of the total fruit weight, is considered a by-product of industrial processing. In this study, fruits of the Ako and Wonderful cultivars were collected from rural areas near Foggia (Italy) and their peels were dried, powdered, and extracted with acetone, diethyl ether, and *n*-hexane. The bioactivity of different peel extracts was assessed by evaluating toxic (contact and ingestion), antifeedant, and nutritional effects on *Sitophilus granarius* (L.) (Coleoptera, Curculionidae) adults.

In contact toxicity bioassays, the highest mortality rates (70-90%) of *S. granarius* adults were induced by the *n*-hexane and acetone extracts, while diethyl ether extracts showed a low toxicity. The 24-h lethal dose 50 (LD_{50}) values of *n*-hexane and acetone extracts were respectively 81.14 and 81.86 µg/adult for Ako and 129.67 and 47.75 µg/adult for Wonderful cultivars. In ingestion toxicity bioassays, the Wonderful acetone extract significantly affected insect nutritional parameters at the highest dose tested (750 µg/disk).

The Wonderful extracts were also assessed on II-instar larvae of *Ephestia kuehniella* (Lepidoptera, Pyralidae). In contact toxicity bioassays, mortality rates induced by *n*-hexane (37%) and acetone (40%) extracts were significantly higher than control. The 24-h LD_{50} values were 209.37 and 140.52 µg/larvae for *n*-hexane and acetone extracts, respectively. In ingestion toxicity bioassays, the acetone extract elicited a marked feeding deterrence (79%) at the highest dose tested. Overall, results of this study suggest the acetone extract from peels of the pomegranate Wonderful cultivar as a potential source of bioactive compounds that could represent a good IPM option for storage insect pests, even in a circular economy approach.

Preventive fungicide application for controlling the fungus-farming ambrosia beetle *Xylosandrus compactus* by suppressing mutualistic interactions with its main nutritional fungus *Ambrosiella xylebori*

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Xylosandrus compactus (Eichhoff) (Coleoptera: Curculionidae: Scolytinae) is one of the most invasive ambrosia beetle species known to cause damage to a broad range of cultivated host plants in invaded regions. However, management strategies targeting this pest have been poorly investigated and their development represent an emerging challenge. In this context, the development of innovative management approaches targeting the beetle main nutritional fungus *Ambrosiella xylebori*, with the aim of suppressing beetle/fungus mutualistic interactions, could represent an useful and alternative tool. Here, the potential of commercially available synthetic fungicides (based on the active ingredients thiophanate-methyl, azoxystrobin, and mefentrifluconazole) and microbial-based fungicides (i.e, *Trichoderma asperellum*, *T. gamsii* and *Bacillus amyloliquefaciens*) to affect the beetle development, by suppressing its fungal mutualist, was evaluated under

laboratory and semi-field conditions. The impact of different fungicides on the beetle choice behavior, host colonization, and progeny production, as well as on the mutualist occurrence (lesion length), was evaluated through different application methods, including spraying or drip irrigation. Brood size (mean number of offspring/foundress) of *X. compactus* was significantly lower in plants treated with synthetic fungicides compared to untreated ones. However, differences among treatments occurred when exposing beetles to treated plants at different timing (i.e., one, three or seven days after treatments). The greater reduction in mean brood size was achieved when testing thiophanate-methyl by spray applications. A significant reduction in vascular lesion length was observed for thiophanate-methyl and azoxystrobin when sprayed one day before insect release. Tested microbial-based fungicides showed partial or no efficacy. Overall, obtained results provide new insights towards the use of fungicides to manage ambrosia beetles through mutualism suppression.

Microbial biotechnologies for sustainable management of food products

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The potential for developing model pathways for innovation that showcase microbial biotechnologies as a driving force for promoting sustainability in food systems is being explored. In order to accelerate innovative paths, several rapid screening approaches have been evaluated as useful for improving the screening performance of lactic acid bacteria (LAB) for the development of bio-based solutions. Different microbiodiversity niches have been explored to evaluate the selection of new strains associated with the regional and national production context. These foods and beverages are also a reservoir of lactic acid bacteria that can be interesting for the design of new starter cultures and to support food biotechnologies. Raw matrices were spontaneously fermented under different conditions to selectively isolate microorganisms. Gram staining, catalase, CO_2 production analysis, and microscopic evaluation were performed to perform a preliminary characterisation of the isolates. Additionally, the antimicrobial and antifungal activities of all the isolates against several targets representative of spoilage and pathogens in the food industry were also assessed. Another relevant principal of the activities has been the design of plant-based fermented foods, including dairy-like products, improving the sensory, nutritional, and functional quality and safety standards. In addition to the general activities, a case study is also reported, where all the biological resources used in the study belong to Daunia, the northern province of the Apulian Region. This study aimed to perform a polyphasic characterisation of the microbial diversity of fermented ‘Gentile di Puglia’ sheep milk from Subappennino Dauno. Protechnological and genetic characterisations have been performed on a panel of LAB strains. Based on the results, some selected strains were used as a multi-strain starter culture to produce Pecorino cheese from ‘Gentile di Puglia’ sheep milk. Finally, a selection of LAB strains have been tested in cereal matrices to

evaluate the design of plant-based yoghurt-like products. The cereal tested in the trial were also original of Daunia region, promoting an experimental plan that valorises animal, plant and microbial biodiversity associated with a specific marginal area.

Effect of almond skin on growth performance of lambs

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The production of animal feed including cultivation, processing, and transport is one of the activities with the highest environmental and socio-economic impact. In this context, new feeding strategies in livestock farming systems and the use of by-products of the agri-food industry in the diet of ruminants, as an alternative to conventional feed, have assumed considerable importance at a global level. Almond skin (AS) represent a promising by-product of the agri-food industry due to its high availability, ease of supply, high bioactive chemical compounds and chemical composition. In this regard, the aim of the study was to evaluate the partial replacement of corn with almond skin with two different percentages to evaluate the effects on growth performance on lambs. Thirty male lambs, crossbred Valle del Belice and Comisana, were raised at the University of Catania's farm for 56 days. The lambs were divided into three groups,balanced by initial body weight (BW). Groups received the following isoprotein and isoenergetic reatments: control (CON) typical concentrate for Sicilian lamb growth,almond 14 (A14), was the control diet with 14% almond skin replacing part of the corn, and almond 28 (A28), was the control diet with 28% almond skin replacing corn. Voluntary feed intake and refused were measured every 2/3 days. Lambs' weight was recorded at the start, midpoint, and end of the trial. Additional parameters were calculated. Carcass traits were assessed at the same day of slaughter and again after 24 hours post-mortem. The diet did not affect any growth performance and carcass traits parameters ($p>0.05$). Therefore, there was no difference between the control diet and the experimental diet based on almond skin at the two concentrations. In conclusion, the almond skin allows to reduce the cost of feed, the emissions of greenhouse gases due to the importation of corn, the competition between humans and animals without compromising the health and growth of the lambs.

Root-associated microorganisms for optimizing biological control in tomato

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Tomato crops are constantly threatened by a wide range of pests. Root-associated microorganisms, such as Plant Growth Promoting Fungi (PGPF) and Rhizobacteria (PGPR), are often used to enhance plant defenses as a sustainable tool for pest control. However, the role of volatiles emitted by microbial-inoculated tomatoes on the behavior of biocontrol agents of tomato pests needs to be further investigated. The olfactory responses of three natural enemies (*Cryptolaemus montrouzieri*, *Eretmocerus eremicus* and *Nesidiocoris tenuis*) of tomato key pests to volatiles emitted by tomato plants previously inoculated with microbial showing PGP traits were studied in the laboratory. Three fungal commercial strains (the mycoparasitic *Trichoderma asperellum*, *T. harzianum* and the entomopathogenic *Beauveria bassiana* ATCC 7404), and six bacterial species (commercial strains of *Bacillus subtilis* and *B. amyloliquefaciens*, and laboratory isolates of *B. spizizenii*, *Pseudomonas fluorescens*, *P. veronii* and *P. gessardii*) were tested 3 and 7 days after inoculation, in comparison to untreated plants. In a two-way olfactometer, *C. montrouzieri* showed significant attraction towards tomato plants inoculated with *Pseudomonas* spp. and *T. asperellum*, 3 and 7 days after inoculation, respectively. By contrast, *C. montrouzieri* females were generally repelled by tomato emitted volatiles when inoculated with other microbials. A similar trend was observed with *E. eremicus*. Tomato plants inoculated with *B. bassiana* and *B. subtilis* significantly repelled *N. tenuis* both 3 and 7 days after treatment. This study may help to unravel tri-trophic interactions mediated by root microorganisms in tomato crop system. Future investigations involving further pest-natural enemy combinations will help to understand the role of volatiles emitted by microbial-inoculated plants to optimize biocontrol strategies through the use of biostimulants in the context of Integrated Pest Management.

Effects of mild abiotic stresses on agronomic, morphometric and qualitative traits of Mediterranean medicinal and aromatic plant species: a systematic literature review

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Medicinal and Aromatic Plants (MAPs) are a peculiar category of industrial crops with the potential to requalify marginal areas due to their resilience and adaptability features. MAPs are distinguished by producing many active ingredients with different proprieties, such as essential oils, that are the most attractive for the cosmetic, pharmaceutic, flavor, and food industries. The Mediterranean basin is a mosaic of diverse ecosystems, promoting the diversification of many plant species, including MAPs. However, the Mediterranean basin has suffered different climate change problems in the last decades, such as increased drought, decreased soil fertility, and increased erosion and desertification risk. The challenge lies in optimizing the yield and quality of plant products while ensuring sustainable cultivation practices. Specifically, MAPs

produce active ingredients when subjected to stress conditions, such as abiotic stress, and the possibility of exploiting this feature represents an opportunity for enhancing marginal areas with sustainable and innovative crops. Further, the literature research delves into the possibility of a new approach: applying mild abiotic stress to MAPs. This review's deep hypothesis focused on how mild stress could stimulate the production of essential oils, examining scientific literature based on abiotic stress such as water, temperature fluctuations, shading, and varying salt levels. The aim was to demonstrate that due to their resilience, MAPs could adapt well to unfavorable field conditions and produce more essential oils with high quality. The literature review showed how plant species interact with stress, influencing the secondary metabolism and essential oil production within a wide range of responses. Future research should investigate different methods of applying abiotic stresses to various genotypes and evaluate the effects on active ingredient production. Studying the relationship at the lab and field scale could help introduce MAPs in marginal Mediterranean areas and promote sustainable environmental, social, and economic development.

Scalability and adaptation of nature-based solutions for wastewater treatment: GIS-based multi-criteria decision analysis and application of local innovative substrates

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Nature-based solutions (NbS) for wastewater treatment are emerging as promising alternatives to reach the goal of global access to sanitation, as proposed in the SDGs. One of the main challenges for the large-scale adoption of Nature-based sanitation solutions (NbSS) is the assessment of their scalability and adaptability to different contexts. It requires the evaluation of important considerations for context-specific adaptation that include both environmental characteristics, such as climate and plant diversity, and socio-economic factors, such as the availability of resources and type of substrates. Assessing the adaptation and efficiency of NbSS in different contexts can help identify barriers and develop strategies for its large-scale implementation. This doctoral thesis is guided by the following research question: How can NbS design for wastewater treatment and reuse be best adapted based on local contexts? The main objective of this PhD project is to evaluate the adaptation of the NbSS to improve the efficiency of pollution control based on local environmental contexts. The specific objectives of this thesis and the relative chapters are: i) to assess the scientific evidence of the mechanism behind the key factors of NbSS design in different environmental contexts of the world (chapter 1); ii) to develop a GIS-based multicriteria decision analysis, that explores the scalability of these NbSS and to identify potential regions in the globe (chapter 2); iii) to evaluate the suitability of innovative filter substrates for application in vertical constructed wetlands (CWs) for domestic wastewater treatment in terms of hydraulic features and removal performance. The experimental activities will be carried out in a Lab-scale wetland

system (chapter 3) and Pilot-scale wetland system (chapter 4). We expect this research could contribute to a better understanding of the potentialities of the NbSS and the inclusion of these green solutions in environmental sanitation strategic planning.

Effect of aging temperatures on the flaking process of Provola dei Nebrodi PDO cheese: a preliminary study

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Provola dei Nebrodi PDO is a traditional stretched raw-milk cheese characterized by internal flaking after 4-5 months of aging. Historically, production was limited to spring for optimal environmental conditions (EC). This study compared the cheese flaking process under winter (W) and spring (S) conditions across an aging period (P) of 0, 60, 90, 120, 150, 180, and 240 days, assessing quality parameters. Under W, cheeses were aged at 8°C±1°C for 0-60 days, and at 15°C±1°C for 60-240 days. Under S, aging temperatures were 13°C±1°C for 0-60 days, and 15°C ± 1°C for 60-240 days. Three batches of curd were produced in January, each batch divided into fourteen 3-kg Provola, one for each P in both W and S. Chemical analyses included pH, moisture (M), fat on DM (FDM), total protein on DM (TNDM), and proteolytic activity. During 8 months of aging, M decreased from 45±0.3% to 34±0.4%, pH from 5.1±0.1 to 5.5±0.1, FDM increased from 45±0.3% to 47±0.2%, and TNDM increased from 45±0.2% to 48±0.2%. Proteolytic activity was calculated for each interval. The statistical model included C, P, and C X P, with significance at $p < 0.05$. Both flaking and proteolytic activity were accelerated in S compared with W cheeses indicating an increased speed of aging. Sensory analyses revealed S cheeses were spicier with more intense flavors and rich green-herbaceous, hay, and mushroom notes. In conclusion, extending the production period to include winter production is only feasible with aging rooms equipped with controlled environmental conditioning at 13±1°C.

Artificial Neural Networks to analyze emissions from livestock buildings

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In machine learning, artificial neural networks (ANNs) are connected nodes of algorithms, able to learn and make decisions in a way that emulate the human brains. Each node is called artificial neuron, and each neuron is aggregated in layer. Artificial neurons receive input data and perform computational task to give output data.

These steps are regulated by training algorithms which assess the prediction of the model through several transformation of the data assigned. ANNs' models have been used in scientific literature to analyze data and make predictions. In livestock production, ANNs have been applied to make predictions regarding concentrations and emissions of gases but the potential of the ANN's models have not been fully explored yet. No comprehensive models have been developed and a comparison between different training algorithms have not been assessed in scientific literature yet. Future development in ANN models should address livestock management challenges. In the context of precision livestock farming, ANN could be applied by using multiple parameters (i.e., environmental factors, behaviour, breed, diet, and barn management) to assess livestock performance in relation to their environment.

Session III

Assessment of effectiveness of natural and biological means to control of *Fusarium* Disease pathogens and weeds on wheat

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The environmental, economic and ethical issues linked to the traditional management enforce the need to find sustainable alternatives to the conventional management of the plant fungal diseases and weeds. Since, agricultural wastes (AWs), and biocontrol agents (BCAs), represent promising tools for the new bio-sustainable field management, the research activities have been carried out in *in vitro* and *in vivo* conditions. The pathology *in vitro* test consisted of performing dual cultures with six AWs and three BCAs strains against eight fungal pathogens. The effectiveness of AWs essayed was determined by an inhibition index (%) based on radius of mycelial growth inhibited respect to the radius achieved from the same fungal colony without the AW. The weeds control *in vitro* was evaluated via germination assay putting the seeds of several weeds on two layers of Bibula paper tilted with 5,00 mL of the infusion of the same AWs used in the pathology test. The inhibition of the germination was determined comparing the number of the germinated seed treated with the AWs to the control treated with water. Based on results obtained in *in vitro* condition, two plant wastes (bergamot and pomegranate peel), one organic product available on market (EP5), and one biological microorganism (*Streptomyces* sp. Strain Strep22), able to inhibit the mycelial growth and weed germination, were selected to perform the *in vivo* experiment. This was carried out in greenhouse to control three *Fusarium* species (*Fusarium graminearum* [F30], *F. oxysporum* [F1B], *F. solani* [F18]) and three weeds (*Lolium multiflorum* var. Italicum, *Papaver rhoeas*, *Alopecurus myosuroides*) on wheat by the setting of 80 different theses. The results confirmed that AWs used protected significantly the Fusarium infections on wheat roots and collars and reduced the weeds germination. Moreover, the *Streptomyces* strain was able to protect and promote the growth of the wheat plants.

Occurrence of virulence genes associated to *Escherichia coli* in hunted wild boars in Southern Italy – Preliminary results

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In Southern Italy wild boar is largely spread and it is hunted as large game. Game meat is often consumed by hunters and their families; in addition, the focus on more ethical and responsible meat consumption has brought consumers closer to wild game meat exposing the population to a number of foodborne pathogens. Wild boar populations are increasing in urban areas, posing an epidemiological risk for zoonotic pathogens in a One Health perspective. The aim of my study was to detect the presence of Shiga toxin producing *Escherichia coli* STEC from rectal swabs of wild boars which can have a significant impact on human health and could lead to foodborne diseases such as Hemorrhagic Colitis and Hemolytic Uremic Syndrome. One hundred and twenty-eight wild boar's rectal swabs were collected and screened by HT qPCR to investigate the presence of *Escherichia coli* STEC genetic virulence markers and for serogroups identification.

I obtained 2 samples positive for the shigatoxins markers (1,5%), 18 samples positive for *eae* (14%) and *cdgR*+, 3 samples positive to *bfpA* (2,3%). Thirteen samples were negative to all markers (10%).

In conclusion my study showed that wild boars hunted in Apulia region are carriers of potentially harmful bacteria that could affect humans by handling raw meat during the slaugther operations or by the consumption of undercooked meat or fermented salami.

Further investigations are ongoing for the detection of antimicrobial resistance genes in the same samples.

Realizing the full potential of mycoprotein biomass in the sustainable dietary shift through innovative technological solutions

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Proteins are an essential source of nitrogen and amino acids involved in all biological activities that help to maintain health and bodily functions. Most of the proteins consumed in the daily diet are derived from animal sources, which raises several ethical and environmental concerns. With the world population expected to reach 9 billion by 2050, a 70% increase in food demand is estimated. This scenario describes the urgent need of alternatives and sustainable sources of proteins.

Mycoprotein is a promising new source of protein due to its environmentally friendly, energy efficient, nutritional and health-promoting properties. The fermentation process of filamentous fungi produces the mycoprotein biomass, which is primarily composed of protein (including all essential amino acids) and fiber (chitin and beta-glucan), and with low amounts of carbohydrates and fatty acids (mainly mono- and polyunsaturated).

Given its nutritional composition, mycoprotein could help control glucose, insulin and cholesterol levels in the blood, and modulate satiation and satiety.

While most experiments focus on the primary stage - i.e. the fermentation process - there is a lack of information regarding strategies for prolonging the shelf life of mycoprotein biomass without compromising nutritional and technological performances. In addition, the use of the biomass in food manufacturing is still limited to the preparation of refrigerated or dried and freeze-dried food formulations.

This PhD project aims to extend the use of mycoprotein by prolonging the shelf life of the biomass and extending its application in food manufacturing and gastronomy through innovative technologies.

To achieve this goal, an ensemble of non-thermal technologies (NTT-s) (e.g. cold plasma, UV irradiation) will be explored to extend the shelf life of g mycoprotein while preserving its nutritional and technological properties.

Furthermore, mycoprotein biomass will be used in different forms (powder and paste) to design and develop innovative food products with high nutritional and sensory quality using emerging technologies such as 3D printing and high moisture extrusion.

Evaluating fungicide sensitivity in *Alternaria alternata* isolates from Citrus in Italy

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Alternaria alternata, responsible for Alternaria Brown Spot (ABS) in citrus crops, is one of the major causes of annual production losses. As chemical fungicides represent the primary method for ABS management, this study assessed the sensitivity profile of several *A. alternata* isolates to pyraclostrobin and fludioxonil fungicides. Spore germination and mycelial growth assays were conducted and the effective concentration to inhibit 50% of fungal growth (EC50) was calculated for each isolate. Based on the discriminatory rate of 100 µg mL^{-1}, the majority of our isolates was sensitive to pyraclostrobin using the growth inhibition while in the spore germination assay the frequency of sensitive isolates increased. Furthermore, our results showed that all isolates were sensitivity to fludioxonil, as evidenced by their EC50 values in the mycelial growth assay. Additionally, i*n vivo* trials were conducted by inoculating both the sensitive and less-sensitive isolates on detached citrus leaves treated with pyraclostrobin at the maximum recommended label rate. This treatment significantly reduced disease incidence (DI) and symptom severity (SS), although less reduction was observed in leaves inoculated with less-sensitive isolates. No correlation was found between fungicide sensitivity and fitness parameters (mycelium growth and sporulation rate) assessed *in vitro*. Sequencing of the cytochrome b gene region in isolates with different sensitivity profiles revealed no G143A, G137R or F129L mutations.

These results are valuable for establishing resistance monitoring programs and designing effective long-term strategies for managing ABS in citrus orchards.

Biorefinery for valorization of anaerobic digestate in order to obtain bioproducts for agriculture

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This Ph.D. project aims to establish a biorefinery system, aligned with green chemistry principles, that explores the potential of digestate, a byproduct of anaerobic digestion (AD). By converting this organic substrate into valuable bioproducts for agriculture, the project seeks to not only promote sustainable practices and a circular economy but also increase the attractiveness of AD technology, in order to reduce dependence on fossil fuels and greenhouse gas emissions. Indeed, AD processes organic matter into biogas (which can be upgraded to biomethane), leaving behind nutrient-rich digestate fractions (liquid and solid). The project will delve into the chemical composition of these fractions to identify and extract valuable biomolecules. The solid fraction will be investigated for conversion into biochar through pyrolysis and hydrochar via hydrothermal carbonization. Both biochar and hydrochar have applications in soil amendments, water purification, and energy storage due to their unique properties.The liquid fraction will undergo extraction of phenolic compounds, which could potentially harm soil microbes. These compounds will be extracted using eco-friendly solvents or separated using filtering systems. They will then be assessed for their potential as biopesticides, offering a sustainable alternative to chemical pesticides. Furthermore, the project will explore the recovery biostimulants like humic substances and phytosterols, able to enhance plants growth and nutrient uptake. By transforming digestate into a range of valuable agricultural products, this biorefinery system fosters a circular economy, promotes sustainable practices, and unlocks the full potential of AD technology, contributing to a more sustainable future.

Remote sensing for pasture biomass quantity and quality estimation: challenges and future prospects

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The benefits of using pasture for meat and milk production have been widely demonstrated from a livestock perspective. However, grazing has very significant environmental, social and economic significance, contributing to the achievement of several Sustainable Development Goals under Agenda 2030. In order to maintain adequate grass quality and, to avoid excessive soil compaction, it is necessary to rationally manage the area devoted to grazing in order to allow the topsoil to recover from the damage of trampling and the more palatable species to regrow. Maximizing grass utilisation and accurately measuring grass quantity and quality by adopting precision agriculture technologies, including satellite and UAV sensors, are key aspects to improve production efficiency and reducing environmental impact. With these goals, the review explores the crucial role of biomass quality and quantity estimation in pasture-based agricultural practices, with a focus on the potential offered by remote sensing technologies. These can be also used to assess pasture quality by analyzing factors such as nutrient content and plant health that directly affects livestock nutrition and overall farm productivity. However, some challenges remain, including the spatial and temporal variation of pastures, the lack of standard protocols for grass measurement, and the need to integrate and optimize the use of satellite or UAV technologies with field survey. The review explores recent advances and ongoing challenges in the area of grassland estimation, providing an overview of key research. Through the integration of innovative technologies and refined measurement protocols, the full potential of more sustainable and productive pasture-based agriculture can be performed.

Evaluating the potential of extreme environments for the isolation of biocontrol agents

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Extreme environments are a largely unexplored reservoir of microbial diversity, with a remarkable exploitation potential for application in agriculture. Accordingly, the aim of this study was to isolate and characterize *Aureobasidium* spp. strains from different extreme ecosystems ranging from glaciers to deserts. A total of 117 strains were isolated and molecularly identified by internal transcribed spacer (ITS) region sequencing. The most represented yeast genera were *Aureobasidium* (57%), *Cryptococcus* (12%), *Vishniacozyma* (7%) and *Naganishia* (6%). For *Aureobasidium* spp. strains, a phylogenetic analysis was performed using multi-locus sequence typing (MLST), based on ITS, elongase (ELO) and elongation factor (EF-1alpha). To investigate *Aureobasidium* extremophilic or extreme-tollerant behaviour, five different temperatures (0°C, 5°C, 10 °C, 25 °C, and 45°C) were assayed for the colony growth and conidiation on two different media (NYDA and Czapek). Growth rate was measured on medium with different salt-concentrations (5%, 10%, 15% NaCl) and different pH (2, 4, 6, 8, 10, 12). Preliminary results displayed a great variability for growth and conidial production by *Aureobasidium* strains depending on culture conditions, and a remarkable thermotolerance

aptitude. The displayed adaptation and versatility of *Aureobasidium* strains represent a promising starting point for investigating the role of genes and metabolites in microbial antagonism in a climate change scenario.

Feeding hazelnut skin and linseed to lambs: effect on meat oxidative stability

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This study aimed at investigating the effect of the combined inclusion of hazelnut skin and extruded linseed, in the diet of lambs as partial replacer of corn and soy, on the oxidative stability of meat. Forty male lambs were randomly assigned to 4 groups and fed *ad libitum* for 60 days with: a conventional diet (CON); a diet with 15% of hazelnut skin (H); a diet with 8% of linseed (L); a diet with 4% of linseed and 7.5% of hazelnut skin (H+L).

Fatty acid (FA) profile, fat-soluble vitamins, and hydrophilic antioxidant capacity were assessed in fresh meat, while colour and lipid oxidation were evaluated over 7 days of refrigerated storage. No effects of dietary treatment were observed on meat colour and metmyoglobin development ($P>0.05$) during storage. Similarly, antioxidant capacity assays (i.e., TEAC, FRAP, FICA, Folin-Ciocalteu, DPPH) performed in meat hydrophilic fraction showed no differences between treatments ($P>0.05$).

The inclusion of H+L enriched the intramuscular fat of α-linolenic acid (3.75-fold) and other n-3 FA (+40%), notable for being health-promoting but also for their higher oxidative susceptibility. Despite a higher polyunsaturated FA content, lipid oxidation was reduced during storage in the H and H+L groups ($P=0.001$). Vitamin E content was higher ($P<0.001$) in meat from lambs fed H and H+L.

The lack of the differences in the hydrophilic extract and the higher content of vitamin E could suggest that the latter compound may had a fundamental role in delaying lipid oxidation. In conclusion, feeding H+L improved the meat oxidative stability by delaying lipid oxidation probably due to vitamin E contained in hazelnut skin, even though the FA profile was improved with a higher content of polyunsaturated FA provided by linseed.

HIS imaging: develop of detection model for discriminate Fe deficiency from N deficiency on plant leaves

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The quick and accurate identification of nutrient deficiency symptoms has a pivotal role for a sustainable precision agriculture. Hyperspectral imaging (HIS) is a technique that offer great prospective in this context. Hyperspectral imaging allows to detect, in a few seconds, the reflectance signal from few nanometers large bands from a wide spectrum of wavelengths (from UV to NIR). Ratios of reflectance values from different wavelength bands are used to calculate Vegetation Indexes (VIs) that are correlated to different molecular content in plants. Some indexes are known to be correlated with nitrogen deficiency, and they are calculated using the bands of maximum chlorophyll reflectance. However, other nutrient deficiencies like iron, boron and magnesium alter the reflectance of the same bands. Hence, these indexes are not always correlated with nitrogen content in plants.

The aim of this study is to uncover new indexes/models to detect and discriminate between nitrogen and iron deficiency in leaves of monocot and dicot plants.

Maize (*Zea mays*) and barley (*Hordeum vulgare*) as grass species and tomato (*Solanum lycopersicum*) and cucumber (*Cucumis sativus*) as dicot species, were grown in different nutrient deficiency: control (+N+Fe), N deficiency (-N+Fe) and Fe deficiency (+N-Fe). When plants showed the visible symptoms, physiologic, ionomic and HIS data (from 400 to 1000 nm) were collected. To create a detection model, we applied Partial Least Square (PLS) algorithm on whole datasets and a confusion matrix was elaborated to evaluate its accuracy.

The new model highlighted that using the whole spectrum dataset of leaves, N and Fe deficiency can be discriminated using HIS.

Session IV

Nanoplastics impair bovine granulosa cell functions *in vitro*

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Plastic pollution poses a serious threat to humans and animals. However, there are still numerous unexplored aspects that need to be investigated to elucidate the pathophysiological consequences of exposure to nanoplastics within the mammalian system, particularly with respect to reproductive functions. This study aims to investigate the effects of different concentrations (5, 25, and 75 µg/mL) of nanoplastics (NPs) with a size of 100nm and made of polystyrene in an 8-day serum-free culture of bovine granulosa cells (GCs). The study focuses on assessing cell viability, steroidogenic activity and cytokine production. The first results showed a significant decrease in GCs viability (mean ± SD) as measured by the MTT assay, compared to the control (Ctrl). The viability was found to be only 25.25% ± 6.15%, 24.91% ± 7.46% and 27.64% ± 8.05% ($p<0.0001$) for the concentrations of 5, 25 and 75 µg/ml of NPs, respectively. Instead, 17β-Estradiol (mean ± SD) secretion, measured using ELISA, was significantly enhanced by NP treatment. After 8 days of culture, we detected 2.0 ± 0.3, 14.2 ± 3.3 ($p<0.05$), 17.6 ± 1.7 ($p<0.01$), 63.8 ± 1.0 ng/ml ($p<0.0001$) for Ctrl, 5, 25 and 75 µg/ml of NPs, respectively.

Since, so far, little is known about the possible interaction of NPs with the available assays, we aim to explore different analytical approaches to obtain more reliable and robust results. Additionally, further studies, especially related to inflammatory and molecular status are needed.

The potential use of non-destructive optical techniques for the detection of physiological disorders in fruits and vegetables

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The increasing concern and awareness of the modern consumer regarding food-related attributes, including fruit and vegetables, has driven research in the food industry toward the development of non-destructive, rapid, reliable, and cost-effective methods for quality assessment. Traditional analysis methods, often slow, expensive, and labor-intensive, are increasingly being replaced by non-destructive techniques that are gaining widespread use. Hyperspectral imaging is emerging as a cutting-edge technology for quality assessment, enabling real-time interventions and improving post-harvest management, thus reducing post-harvest losses

and extending shelf-life. This technique has been proven to be effective for the detection of fruit defects, classify fruit and vegetables based on variety, maturity stage, origin, and storage conditions, and predict their key internal components. In this work of thesis, we explored the application of hyperspectral imaging to detect physiological disorders in fruits and vegetables, including zucchini and pomegranates. Hyperspectral line-scan scanner (Version 1.4, DV srl, Padova, Italy) in Visible-Near Infrared (VIS-NIR) ranging (400–1000 nm) and NIR ranging (900-1700nm), combined with PLS-DA and several machine learning algorithms (i.e., Super Vector Machine and xG-Boost) was applied to discriminate sound and damaged fruit. In particularly we focused on chilling injury disorders and fungal infection. Reliable results reaching high accuracy in calibration and prediction were obtained in both of the experiments, indicating promising potential of using non-destructive techniques for the optical sorting of defective fruit and vegetables.

Advantages of liquid Nitrogen as peeling agent in pistachio seeds

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The traditional nuts' peeling lead to a reduction in product quality and requires significant amounts of hot water (90-95°C) with considerable impact for the environment. For these reasons, more sustainable peeling methods are needed. This study aims to evaluate liquid nitrogen (LN) in an alternative peeling process, in order to obtain high quality pistachios seed and to characterize the resulting skin, generally considered a little value by-product. Two pistachio cultivars, from Bronte (B) and Spain (S), were subjected to traditional hot water peeling (TP) and to experimental peeling method (EP) that involve the use of LN. Physico-chemical parameters were evaluated on pistachio kernel, while skins obtained from both methods were evaluated for bioactive compounds and as potential inhibitor of α-glucosidase activity. Pistachio from EP exhibited significantly ($p < 0.05$) lower M % and Aw in comparison to that subjected to TP. Both cultivar B and S peeled trough LN evidenced a Peroxide Value (PV) (respectively equal to 8.56±3.29 and 6.61±0.87 meqO_2/Kg of oil) comparable to the values recorded in unpeeled samples (7.33±0.36 and to 6.86±0.05 meqO_2/Kg of oil). Conversely, notably high PV were recorded in both B and S cultivar obtained from TP, registering the value of 26.41±0.05 and 12.93±0.87 meqO_2/Kg of oil. Moreover, skin obtained from EP evidenced a significantly ($p < 0.05$) higher bioactive compounds and antioxidant activity, in comparison to that resulting from TP. Anthocyanin content of both B and S cultivar subjected to EP were sixteen time higher (406.65±39.96 and 429.87±61.98 Cy-GE/g of dw, respectively) than that registered in the same cultivar treated with TP (24.75±4.04 and 22.48±2.09 Cy-GE/g of dw, respectively). The inhibition activity of α-glucosidase was mainly observed in skin extract

obtained from EP. Results suggest the use of LN to obtain high quality pistachio kernel and skin reusable to improve food matrices.

Microbial bioremediator isolated from human wastes

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The current practices used for waste disposal usually cause considerable damages to environment, reducing the disponible land for agriculture; furthermore, the constant use of pesticides, phytochemicals and antibiotics to improve productivity is negatively impacting the health of soils. This work aims to search a microbial solution which can improve the current situation of soil health with direct consequences on human health by using selected microorganisms able to reduce harmful substances.

From a chemical perspective, the health profile of soils was studied, with a focus on heavy metals and micronutrients to understand the main chemical conditions that the isolated strains have faced. About the heavy metals pattern, all the soil samples showed a critical situation, but the worst situation was the sample showing an amount of cadmium of 1.75 mg/kg, chrome of 152.90 mg/kg and lead of 176.84 mg/kg. The characteristics of selected microbiota were studied, as technological and growth parameters. More than 75% of the strains showed the ability to produce esopolysaccharides, and more than 50% of the microbiota can use alternative source of carbon like Sodium Dodecyl Sulphate. The growth profile was passed by variating different growth parameters like water lack, pH, temperature, and quantity of heavy metals. Most of the selected strains can growth in severe water lack conditions (up to 10% of PEG3000) with some strains showing a stimulation compared to control (+17%, +6%, +5%); in addition, a growth enhancement was found at low temperature (15°C) and sub-lethal pH (5.5 and 8.5). Heavy metals, as expected, had an inhibitory effect, but many strains could survive to very critical conditions like cadmium and cobalt concentrations higher than 100 mg/kg.

The information acquired from the chemical and microbiological parameters were statistically analysed to cluster the selected microbiota into representative groups that will be studied from a genomic perspective.

Adaptation to the climate crisis in table grape viticulture through multifunctional covers and implementation of precision irrigation

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Table grape cultivation is particularly significant for Italy's agricultural economy, producing approximately 1.1 million tons annually, primarily from the hot-arid regions of Puglia and Sicily. Nearly all vineyards in these areas utilize protective coverings, including anti-hail nets, shading nets, and plastic films, to mitigate losses from adverse environmental and biotic factors and control harvest timing. Research run in Puglia has shown that plastic films increase air temperature and relative humidity while decreasing wind speed and solar radiation, and finally reduce vineyard evapotranspiration. Understanding these savings is crucial for effective irrigation management. This research project aims to determine locally calibrated crop coefficients (Kc), which are essential for calculating water consumption through the FAO's two-step approach (ETc= ETo x Kc), and a specific "coverage coefficient" (Kne) to recalibrate reference evapotranspiration (ETo) under cover. Concurrently, the ecophysiological and vegetative-productive performance will be evaluated to provide a comprehensive impact assessment of the covered vineyard. Particularly, Transpiration (T) will be measured using sap flow sensors, while evaporation (E) will be assessed with weighing micro-lysimeters, allowing for the calculation of crop evapotranspiration (ETc= E + T). The Penman-Monteith equation will be used to determine external ETo and adjust it within the vineyard using Kne, with data collected from two weather stations: one outside and another inside the vineyard. Kc will be derived as ETc/ETo. Subsequently, the coefficients will be correlated with parameters such as intercepted solar radiation (ISR), Leaf Area Index (LAI), and satellite-derived indices like NDVI, EVI, and NDRE. The derived mathematical relationships could facilitate the adoption of proximal and remote sensing methods for vineyard precision irrigation.

Understanding graft compatibility in kiwifruit (*Actinidia* spp.) through molecular and histological analysis

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Kiwifruit (Actinidia spp.) cultivation has attracted consumers due to its unique flavor, nutritional value, and economic importance. Recently, due to the appearance of the kiwifruit vine decline syndrome (KVDS), grafting is a mainstay propagation technique in kiwifruit cultivation, but success hinges on graft combability. Evidence shows that *Actinidia macrosperma* and *A. valvata* can overcome the KVDS. Therefore, the work aims to investigate the grafting compatibility among three kiwifruit species: *A. macrosperma*, *A. valvata*, and Soreli (*A. chinesis* var. *chinesis*). Understanding the compatibility between these species is crucial for developing resilient kiwifruit plants capable of withstanding KVDS, ensuring sustainable production of kiwifruit. We will focus on the potential link between graft success and antioxidant and auxin biosynthesis gene expression. These genes mitigate grafting-induced oxidative stress and promote vascular development, respectively. We will perform gene expression analysis by using quantitative PCR. This will help to identify

the marker associated with grafting success or failure. In parallel, we will conduct histological studies to examine the anatomical features of grafting. To observe cell differentiation, vascular connections, and formation of callus tissues sections of the graft interface will be prepared and observed under electron microscopy. These histological observations will complement the molecular data and offer a deep understanding of structural and functional integration at the graft junction. This research will elucidate the genetic and physiological basis of graft compatibility in kiwifruit. Furthermore, it will offer valuable insights for selecting optimal graft combinations, potentially leading to improved grafting efficiency and enhanced productivity.

***Lactiplantibacillus plantarum*, foods of plant origin and sustainability: exploring intraspecific diversity through "omics" approaches to assist the development of plant-based solutions**

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The present PhD project aims to preserve and study microbial biodiversity in foods of plant origin through comprehensive "omics" approaches, with the aim of assisting the development of new biotechnological solutions, promoting the green transition in food systems. *L. plantarum* emerges as a key model for metabolic versatility, potential in stress response, and ecological diffusion, with a positive impact on food production, where it is used as a protechnological microbe, starter culture, probiotic culture, and biocontrol agent. The research will focus on new selections of *L. plantarum* from unexplored or partially considered fresh fruit and vegetable matrices, with particular reference to the area of Northern Puglia. A small collection of *L. plantarum* from different origins in terms of matrices and geographical level will be developed, also integrating strains from collections and from other studies. The collection will be characterised at the genotypic level by selecting strains representative of intraspecific diversity. On selected strains, phenomics strategies will be adopted as primary screening activity to guide genomic insights and multi-omics approaches to improve the biological understanding of isolates of particular interest. By integrating these 'omics' technologies, the project will explore original approach of how different new selections contribute sustainably to fermentation processes, flavour development and label improvement and ‘cleaning’ the ingredient list, using *L. plantarum* as model organism for lactic acid bacteria. The project objective is the development of biotechnological solutions "*inspired by nature*" through the use of the best phenotypes for potential application in food systems. These solutions will aim to contribute to the green transition and promote a plant-based diet with high added value in terms of sensory, nutritional, functional and sanitation quality. With the growing demand for sustainable

food production, this research responds to the critical need for healthier dietary options and greener production methods.

Multistage Constructed Wetlands for dairy and livestock wastewater treatment: removal efficiencies and hydraulic behavior

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Huge volumes of cattle wastewater (WW) are produced annually from the dairy farms, which is a potential source of many major environmental pollution problems. In this regard, an experimental campaign was carried out in two multistage constructed wetlands (CWs), used for the treatment of dairy and livestock WW. The main goals of this study were to assess: (i) the performances of two CWs serving two small dairy farms, (ii) the hydraulic conductivity variability in horizontal sub-surface CWs. The CWs are located in two dairy cattle-farms (Gulino [G] and Mezzasalma [M]) in the South-East of Sicily (Italy). In each farm the WW produced by the milking parlor and dairy (3-5 m^3/day) are treated by a plant having the following configuration: pre-treatment stage (degreaser tank and Imhoff tank); equalization tank; hybrid CW (vertical sub-surface flow [VF] and horizontal sub-surface flow [HF]). The CW surface areas are about 355 m^2 (M) and 270 m^2 (G). VFs and HFs were planted with *Phragmites australis* and *Canna Indica*, respectively. Chemical-physical and microbiological analyses were carried out on WW samples collected at the inlet and outlet of each stage of the CWs and the removal efficiencies (REs) were calculated. The hydraulic behavior of the HF units was determined by the saturation hydraulic conductivity (*Ks*), using the 'Standpipe' method. The results have highlighted average of TSS, COD, BOD_5, TN and TP removal performance of about 89%, 92%, 93%, 77% and 78%. The *Ks* measurements showed a general reduction and variability of the value, probably due to the presence of sludge (inlet) and inhomogeneity of the gravel and the density of the vegetation (outlet). The results obtained confirm the high potential of CWs for the dairy and livestock WW treatment in small and medium-sized farms, capable of reducing the anthropic pressure on the environment.

Application of indirect in-package cold plasma to preserve minimally processed fruits and vegetables

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The growing demand for chemical -free fruits and vegetables has driven the development of non-thermal technologies that can extend the shelf life of minimally-processed produce without increasing temperature.

These technologies are typically applied before packaging, with a potential risk of cross-contamination at later stages of the value chain. Cold plasma, however, is an emerging non-thermal technology that is evolving for direct in-packages application, making it easier to integrate into a company's production line and reducing the risk of cross-contamination. The aim of this project is to evaluate the potential of indirect in-package cold plasma for generating high levels of ozone in a short treatment time, useful for delaying the growth of spoilage microorganisms, and potentially degrade plant hormone ethylene. Additionally, the effects on packaging materials and the quality of minimally processed fruits and vegetables will be studied. Initially, an in vitro antimicrobial activity test will be conducted against prevalent spoilage microorganisms found in minimally processed produce. This will involve evaluating the key factors that impact treatment efficacy. The fruits and vegetables will then be packaged using different materials to simulate optimal storage conditions, treated with a plasma source, and cold-stored. Their chemical, physical, microbiological, and physiological characteristics will be monitored over time. Furthermore, the release of non-intentionally added substances (NIAS) will be analyzed through migration tests using HPLC-MS and GC-MS systems. Preliminary results on grapes packaged in LDPE bags suggest that the treatment is effective in slowing down microbial growth but also increases the release of NIAS. These findings highlight the potential of indirect in-package cold plasma technology in enhancing food safety and extending shelf life, while also pointing to the need for further research on packaging material interactions.

Advanced detection methods for fungal and oomycete plant pathogens and mycotoxins: unveiling the invisible threat

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Early detection of quarantine fungal and oomycete pathogens and their associated mycotoxins is a key factor in maintaining health and productivity in a global agricultural scenario. In this review, the progress and performance of various detection methods are explored, highlighting traditional, serological, modern, and innovative molecular techniques. Although essential, traditional methods, such as visual examination and culturing, have limitations that require the adoption of faster and more accurate technologies. Molecular methods, mainly polymerase chain reaction (PCR) and its variants, together with isothermal amplification techniques, such as loop-mediated isothermal amplification (LAMP) and recombinant polymerase amplification (RPA), have significant advantages in sensitivity and specificity. This review points out the groundbreaking impact of DNA hybridization and next-generation sequencing (NGS) in providing detailed information on pathogen populations and dynamics. Additionally, biosensors and fluorescent array sensors are emerging as promising tools for real-time, on-site pathogen detection. A comprehensive analysis of the citrus

supply chain highlights the severe impact of quarantine and emerging pathogens, including *Plenodomus tracheiphilus, Phyllosticta citricarpa,* and oomycetes like *Phytophthora hibernalis* and *Phytophthora syringae*. These pathogens not only jeopardize crop yields, but also compromise international trade. The review emphasizes the need of managing mycotoxigenic fungi to prevent food contamination and protect human health. Integrating advanced diagnostic tools, stringent quarantine measures, and effective management practices are essential for mitigating the impact of these pathogens. This comprehensive approach is especially critical for the citrus industry, where early detection and rapid response can avoid substantial economic losses. Ongoing innovation and collaboration among researchers, regulators, and industry stakeholders are crucial for addressing emerging challenges in plant pathogen management and ensuring the sustainability of global agriculture.

Session V

INTEVINE: Multi-omics data integration to decode the interaction between soil and grapevine

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Vitis vinifera demonstrates a fascinating relationship with the soil microbial community, both of which are heavily influenced by the edaphic properties of the soil. This project aims to unravel the interplay between soil composition, soil microbiome, and root transcriptome in grapevines. By comparing the rhizosphere microbiome of grapevine plants grown in different soil types through metagenomic analysis and integrating this data with root transcriptome analysis, we seek to understand how soil composition and root transcriptome influence each other. Additionally, this study aims to be a starting point for future research applying this multi-omic approach to grapevine health and productivity.To capture the complexity of soil-plant interactions, our study incorporates additional data from various fields, including soil chemical properties, multispectral imaging, and ionomics. Through bioinformatics, we integrated these data sets to gain a comprehensive understanding. We considered soil type, soil autoclaving, and root heat treatment. Soil autoclaving assessed the importance of the starting microbial population, while root heat treatment is a common industry practice to combat grapevine disease.Our findings indicate soil type is the primary factor influencing the analysis. Still, differences are observed in the root transcriptome of plants subjected to root heat treatment compared to those that were not. Additionally, differences are evident in the rhizobial bacterial microbiome between autoclaved and non-autoclaved soil samples. These insights underscore the necessity of a comprehensive multi-omic analysis that includes plant, soil, and microbial components to fully understand the intricate relationships between soil properties, microbial communities, and plant health.

Biocontrol of Citrus Mal secco: advances on effectiveness of BCAs based-formulations against *Plenodomus tracheiphilus* and deeply understanding of their population dynamics

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Mal secco, caused by *Plenodomus tracheiphilus*, is an economically important fungal vascular disease in citrus-growing countries of the Mediterranean basin. Limited control measures and further restrictions on the

use of copper led to investigate on alternative sustainable management solutions. The effectiveness of commercial products based on different BCAs and resistance inducers was evaluated against *P. tracheiphilus* through *in vivo* experiments and compared to Cu-compound and fludioxonil. Although *Bacillus* spp. and *Pythium oligandrum* showed good activity, comprehensively, *Trichoderma* was the most effective in reducing the disease parameters, suggesting their potential application within an integrated management strategy. Four *Trichoderma*-based commercial products were therefore tested through *in vitro* and *in vivo* experiments to determine the most effective formulate. Since understanding the population dynamics of BCAs within plants represents a crucial step to assess their effectiveness and scheduling their application in the field, *Trichoderma gamsii* strain ICC 080 and *T. asperellum* strain ICC 012 (Remedier®) and *Bacillus amyloliquefaciens* strain QST 713 (formerly *B. subtilis*) (Serenade® Aso) were selected among the BCAs that have previously shown potential antifungal activity against *P. tracheiphilus*. Specifically, *Trichoderma* spp. and *Bacillus* sp. from internal wood and leaf tissues of treated citrus plants were detected and quantified using both the agar dilution method, which is based on the assessment of colony forming units (CFU), and qPCR assay for the DNA estimation by using specific primers set for *Trichoderma* and *Bacillus* strains. Overall, these findings offer practical applications in the sustainable management of *P. tracheiphilus* by promoting the use of biological control agents and minimizing the use of fungicides.

The ecological network of the Tratturo Magno landscapes

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The main objective of this work is the creation of a local ecological network of the landscapes of the Tratturo Regio 'L'Aquila - Foggia' (the so-called Tratturo Magno), with the aim of connecting the existing natural systems, improving the functionality of the habitats and counteracting their fragmentation.

Study area is in the upper Tavoliere region of Apulia and focuses on the seven municipalities of the 'GAL Daunia Rurale 2020'. It fits into the context of the Puglia Regional Landscape Plan (PPTR), which uses the Ecological Biodiversity Network (REB) as its main tool.

The relationships between the sheep-track network and the ecological network were explored, identifying existing natural areas and areas of potential connectivity, without neglecting critical environmental issues.

The work also includes a census of existing natural areas, classification of vegetation and proposal of ecological reconnection measures. The project area is characterised by a variety of biotopes, including forests, grasslands, wetlands and watercourses, which are key elements of the REB. The study identifies and classifies

390 new natural areas (biotopes), highlighting a significant fragmentation of habitats that requires targeted interventions for ecological reconnection.

In summary, the study proposes an integrated approach to landscape and biodiversity conservation in the Tratturo Magno area, with specific actions to improve and restore natural habitats.

Proposed actions include planting rows of trees, restoring river banks or canals and creating wetlands, all of which aim to improve the functionality of the ecological network and increase the environmental quality and biodiversity of the area.

This work is part of the feasibility study financed by the 'GAL Daunia Rurale 2020' and carried out by the Municipality of San Severo (lead partner).

Exploring the mechanical properties of Low-Quality Wool Yarn as a resource for innovative bio-composite building materials

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The imperative to address environmental challenges through sustainable practices, in alignment with the 2030 Agenda goals, has intensified interest in waste management and valorization. The agricultural sector generates substantial waste and by-products, often undervalued and poorly managed, resulting in significant environmental issues due to illegal disposal. One notable example is low-quality sheep's wool from Sicily, typically deemed unsuitable for the textile industry and currently posing an environmental concern due to large quantities produced without designated use and improper disposal. However, its unique mechanical, thermal, and acoustic properties, along with its renewable and recyclable nature, have recently led researchers to recognize its potential as a reinforcing fiber in bio-composites such as bricks, insulating mats, and mortars. This study aims to explore the use of low-quality wool fiber in sustainable construction, promoting eco-friendly practices and facilitating the transition towards a circular economy that leverages the synergy between these two economic sectors. The primary objective was to analyze the mechanical properties of yarn produced from low-quality wool. To this end, 5 kg of raw wool were collected and processed to produce yarn with a cross-section of 3.5 mm and a yarn count of 3/500. While further research is necessary to determine the practical applications of this type of wool in manufacturing building components, the findings of this study represent a significant step towards developing eco-friendly building materials.

Nature-Based Solutions for wastewater treatment: monitoring and modelling of a hybrid system for the IKEA store in Catania

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In the last decades, particular importance is given to systems and management strategies that achieve water pollution control, energy savings and food security. When focusing on water pollution control, Nature-Based Solutions including treatment wetlands (TW), green roofs and vertical greening systems have proven to be an effective solution for different kinds of wastewaters. TW systems offer a promising approach to the sustainable wastewater management, helping to conserve water, reduce fertilizer needs and create more sustainable agriculture systems. One of the main benefits of TWs is their robustness for variable influent conditions which make them well suited for different wastewater types as well as event driven operational conditions. This is especially of interest for systems applied in industrial, touristic or commercial applications where high fluctuations of loads are occurring. Monitoring the internal processes during changing of loads is often complex and time expensive. During the last years, process-based models with different complexities have been developed to better understand the occurring internal processes in TWs. For the biokinetic reactions, two main multi-component biokinetic models are available, namely CW2D and CWM1, both integrated in the HYDRUS Wetland Module. Main study aims are: (i) the validation of the HYDRUS software in some Sicilian TWs; (ii) the assessment of TWs effluents environmental impacts for vegetable crop irrigation; (iii) better understanding of spatial and temporal variations of main processes occurring in TWs during their life span; (iv) optimization of the management and the design of TWs in Mediterranean environment. Preliminary results are achieved for the case study of the hybrid-TW system at the IKEA store, Catania. The research could contribute to demonstrate the effectiveness of modelling as a tool for understanding TW response to changing conditions and also to plan coherent sampling campaigns and tests field, in order to manage TWs performance.

Prediction of wheat quality parameters using near-infrared spectroscopy (NIRS)

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Quality assessment of wheat is time-consuming and requires the determination of many complex characteristics. In addition, wheat breeding is also constrained by the reduced quantity of grain samples available during the early selection generations. Therefore, there is a high demand for nondestructive, high-throughput, and cost-effective phenotyping methods. Predictions based on spectroscopic methods can meet the requirements of the wheat value chain if the prediction accuracy is sufficiently high. In the present study, we

investigate the grain quality traits of a large sample set of genotypes belonging to the Italian durum wheat network of variety trials, to provide an improved quality screening based on near-infrared spectroscopy (NIRS) compared to standard quality assessment methods. This does not mean an accurate prediction for protein, but a better assessment of complex traits compared to the accurate protein prediction combined with low correlations of these traits. Results of my first year of PhD activities indicate that NIR reflectance spectra of wholegrain flour can successfully be used to predict the complex quality parameters of durum wheat.

Strategies to increase the presence of pollinators in Mediterranean agro-ecosystems

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Solitary and social bees are a large group that have a key role in the environment by pollinating plants. The intensification of agriculture and the fragmentation of habitats have a negative impact on bee populations and are among the main causes of their decline. In this context, it would be useful to adopt some strategies, such as planting flower strips or increasing nesting sites and creating suitable habitats for pollinators, to reduce the fragmentation of cultivated areas, increase food-webs and improve environmental quality, especially in those crops that depend on entomophilous pollination. The use of flower strips is widespread in Europe but is less common in Mediterranean areas. The main objective of this research is to study the pollinators in Mediterranean agro-ecosystems, through plant-insect interactions in order to understand the strategies to be used to increase their presence and consequently the yield and to improve the environment. During the first year, ad hoc floral strip schemes were drawn up, selecting plant species based on their known attractiveness. Berseem clover, sulla, vetch and field bean were planted in monofloral strips in rows spaced between the rows of lime trees (*Citrus aurantifolia*) on a farm located in Carlentini (SR). Sampling was carried out, using the transect walk and pan trap methods, on a weekly frequency during the flowering period. Data on wild flowers in the surrounding area also collected. Plant-insect interactions were studied through the analysis of pollen collected from *Apis mellifera* hives on the farm. The collected specimens were prepared for identification and the pollen dried for subsequent analysis. Future activities about plant-insect interaction will be conducted at the Universidade Federal de Viçosa (Brazil).

Biological control of *Neofusicoccum parvum* associated with fruit rot of mango in Southern Italy

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In Italy, the Botryosphaeriaceae family has been identified as a causal agent of reduced mango production. A survey conducted in several orchards in eastern Sicily allowed us to ascertain the widespread presence of mango fruit samples that showed stem-end symptoms on the fruit epicarp. Isolations were conducted on mango fruit cultivars 'Glenn', 'Kent', 'Irwin' and 'Palmer' and fruit collected by rootstock 'Brokaw 2' and 'Gomera 3'. A molecular analysis of the ITS and *tub2* regions on representative forty-one isolates identified the prevalence of *Neofusicoccum parvum* (forty isolates) and occasionally *Botryosphaeria dothidea* (one isolate). Pathogenicity tests were conducted for testing the aggressiveness of the isolates using *N. parvum* population on ripe and unripe mango fruit. A total of 240 mango fruit were used to assess the aggressiveness of the forty *N. parvum* isolates. *In vivo* tests on mango fruit cultivar Gomera 3 were conducted to evaluate the efficacy of biological treatments for reducing the infection caused by the most virulent and the least virulent isolate, using different timing of treatment than pathogen inoculation. These tests showed that the two yeasts (*Wickerhamomyces anomalus* WA-2 and *Pichia kluyveri* PK-3) tested followed by the commercial product Serenade™ were the most effective biological control agents in reducing lesion area caused by both isolates. Whereas T34 Biocontrol™, Prevatect™, Remedier™ and Amylo-X™ were the least effective treatments since they were not always able to reduce disease severity caused by *N. parvum*. The present study demonstrates the efficacy of biological control agents in the management of mango post-harvest infections caused by these pathogens.

Functional properties of lipid fraction from insect meal in aquafeed

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Over the past forty years, the production of fish and other aquatic products through aquaculture has markedly risen, substantially boosting the availability of fish for human consumption. Simultaneously, with the expansion of the aquaculture industry, the demand for aquafeeds whose main ingredient is fish meal has also been on the rise. However, with this tremendous growth in aquaculture, there have been social, economic and environmental challenges. It has been reported that using conventional protein sources for fishmeal production is no longer ecologically sustainable. Therefore, the use of insect meal, particularly Black Soldier fly *(Hermetia illucens)*, in aquafeeds has gained prominence due to its nutritional profile and sustainability. Insect meal derived from black soldier fly comprises a variety of bioactive and immunostimulant substances, including antimicrobial peptides, fatty acids such as lauric acid, and polysaccharides such as chitin and chitosan. It has

been established that chitin and lauric acid increase fish's tolerance to diseases and are important for their innate immune responses. The lipid fraction of insect meal has received significant attention for its potential functional properties when used in aquafeed formulations. Medium-chain fatty acids such as lauric acid have antimicrobial properties, promote intestinal health, and improve fish's immunity against pathogens. Given the documented beneficial properties of lauric acid, we will study its potential application as a dietary additive for rainbow trout *(Oncorhynchus mykiss)*, a species of importance in Italian aquaculture. The beneficial effects of lauric acid will be investigated in rainbow trout through a feeding study by increasing its dietary inclusion levels from 0.1% to 0.2% using a semi-purified diet. After 12 weeks of feeding, the intestinal physiology, gut morphology and functionality, and immune and antioxidant response will be explored.

Bio-based fertilizers and soil improvers for the sustainability of Mediterranean herbaceous cropping systems

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Nowadays the agricultural systems are based on two priorities, firstly to maintain or increase crop yield and to reduce the impact on the environment as a consequence of the use of fertilizers. So it is very important to develop new ecofriendly technologies. Currently, it is estimated that 50% of the total population is fed thanks to mineral fertilizers. The increasing demand for food supplies will significantly boost the region's demand for high-quality fertilizers, ultimately having a favorable influence on the agricultural sector. The utilization of bio-waste will convert waste management challenges into economic opportunities by establishing a viable internal market for secondary raw materials of biological origin in the EU. The PhD project aims to assess the quantity and quality of production, as well as the quality and fertility of soil in typical Mediterranean farming systems with herbaceous crops, including cereal crops (wheat), industrial crops (hemp), and forage crops (barley, cocksfoot, and fescue), through a multidisciplinary approach. This will be achieved also by applying fertilizers derived from various by-products and residues of the agri-food chain. These include sludge from small wastewater treatment plants (excluding industrial wastewater), sludge from large wastewater treatment plants (including industrial wastewater), sludge from freshwater fish farms, residual paste from full-scale microalgae-extracted products, digestate from agricultural residues, residues from orange-based industrial productions, and Etna volcanic ash. This innovative strategy promotes sustainability and resource efficiency by recycling waste materials and reducing dependence on synthetic fertilizers. Furthermore, this circular and multidisciplinary approach aims to reduce CO2 emissions, increase the organic matter content in Mediterranean soils, which are notoriously deficient.

Session VI

Aureobasidium pullulans formulations: evaluation of the effectiveness against grey mould of table grape

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Antagonism against *Botrytis cinerea* is often carried out using yeast as direct antagonists. *Aureobasidium pullulans* strain AP1 was tested in two different formulations wettable powder (WP) and oil dispersion (OD). By *in vitro* assays, the viability of the strain cells was constantly evaluated for seven months, and the OD formulation ensured the highest cells viability. The efficacy of the formulations was assayed by evaluating the production of volatile and non-volatile metabolites. Results showed that the formulation affected the non-volatile less than the volatile metabolites. Both AP1 WP and AP1 OD non-volatile metabolites displayed almost 50% of mycelial pathogen inhibition. Comparing the two products, the lowest EC_{50} value (518.15 mg L^{-1}) was detected for the AP1 OD formulation that was thus chosen for postharvest *in vivo* assays. The preventative treatments (200, 400, 800 mg L^{-1}) were active in reducing the pathogen incidence on table grape on average by 52%. Instead, in the curative application assay, the highest concentration (800 mg L^{-1}) reduced grey mold incidence by 86%. The present study reported the potential of two new formulations to use against the postharvest grey mold of table grape for a possible further commercial product development.

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Application of Multi-Criteria Decision-Making for water desalination

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The availability of fresh water resources for drinking and usage is extremely scarce worldwide. Moreover, these limited fresh water resources are dwindling due to factors such as climate change, industrialization, and population growth. As the water demand continues to rise, the insufficiency of the resources has made it crucial to look for alternative methods for fresh water production. Desalination is one the most important alternatives to guarantee water supply mainly in the driest countries. Several technologies have been proposed during the last decade. They can be classified into two primary categories: thermal technologies, which are mainly heat-consuming, and membrane technologies, which require electrical energy. In the last decades, thermal and

membrane technologies have benefited from technical development, leading to improvements in their efficiency and performance. Despite these advancements, they are still considered energy-intensive processes. This high energy consumption poses environmental and economic challenges, emphasizing the critical need to develop and implement sustainable desalination techniques. In this context, combining thermal and membrane desalination technologies and integrating renewable energy sources into desalination systems are essential in solving this issue. Selecting the best desalination configuration system necessitates applying Multi-Criteria Decision Making (MCDM) methods. In this research, MCDM will be used to regional case studies in Europe, North Africa, and India. Among desalination technologies, the focus will be on processes designed to achieve high-concentration factors and minimal or zero liquid discharge. The research will compare state-of-the-art batch reverse osmosis technology, developed at the University of Birmingham, against other desalination technologies. Processes that combine membrane and thermal processes to achieve high concentrations will also be considered.

Impact of ozone addition to gasoline surrogates combustion in spark ignition engine

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Based on the experimental results, a 3-D Computational Fluid Dynamics investigation is carried out to evaluate the influence of ozone on the combustion process in spark ignition engine fueled with gasoline/air mixtures. Ozone (O_3) is a chemically reactive species capable of improving the laminar flame speed, reducing the ignition delay time, and stabilizing combustion variability. With the aim of proposing a 3-D numerical model to simulate combustion of fuel mixtures under ultra-lean conditions, two numerical correlations are proposed to reproduce the chemical properties of gasoline/air/ozone mixtures in terms of laminar flame speed. A chemical kinetic mechanism for Toluene Reference Fuel oxidation (*iso*-octane, *n*-heptane, toluene, 63/20/17% by mol.) modified with an ozone sub-mechanism is used to perform several 1-D numerical simulations. The laminar flame speed correlation estimates an enhancement of 3.4% at 600 K and 10 bar under ultra-lean condition $\varphi = 0.6$). For the 3-D numerical simulations, the G-Equation model is used to reproduce the premixed combustion process in internal combustion engines. The results suggest that the numerical correlations can predict the combustion properties of gasoline/air mixtures without and with ozone addition. The presence of ozone traduces in a higher laminar flame speed, leading to an increase in the in-cylinder pressure peak and the rate of fuel consumption. Furthermore, the numerical analysis reveals that the greatest improvement is observed for fluid regions within the cylinder characterized by low turbulent flame speed.

Grapevine response to different abiotic stresses

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Climate change critically affects the Mediterranean viticulture. Water and nutrient availability significantly impact crop yield, thus the application of sustainable strategies towards an efficient water use and nutrient absorption by plants is imperative. Moreover, it has been demonstrated that microorganisms can promote plant tolerance to abiotic stresses and contribute to plant fitness.

The aim of the present study is to assess the physiological and biochemical responses of two grapevine cultivars under different edaphic conditions, specifically water deficit and nutrient limitation, and the effect of arbuscular mycorrhizal fungi (AMF) application. Two-year-old *Vitis vinifera* cv. Cabernet Sauvignon and Grenache grapevine plants were transferred in pots under semi-environmental conditions. During the growing season, plants were either maintained well-watered or subjected to a controlled water deficit irrigation. Two separate experiments were conducted, in which, together with the water treatment, plants were treated with different nitrogen (N) and potassium (K) fertilization doses and AMF in the first and second trial respectively.

Water deficit caused a significant reduction in plant growth and several physiological parameters such as transpiration rate and stem water potential. Multi-elemental data at flowering stage showed that plants mainly separated in response to irrigation treatment. Conversely, the nutrient composition at the maturity stage was strongly influenced by N fertilization. Finally, the effect of the mycorrhizal treatment has been shown to be more pronounced under water deficit conditions. The obtained results will improve the comprehension of the mechanisms involved in the signaling network of the interplay among water and nutrient acquisition.

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Session VII

Sustainable viticulture: different strategies to enhance the resistance to the main fungal diseases on Sicilian cultivars

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The research project is aimed at the obtainment of new grape varieties, resistant to *Erysiphe necator* and *Plasmopara viticola*. Both Traditional breeding and New Plant Breeding Technologies (NPBTs) have been employed on some of the most relevant grape cultivars in Sicily, 'Carricante', 'Catarratto lucido', 'Grillo', 'Nero d'Avola' and 'Nerello mascalese', to improve the desired traits. Controlled crosses with pollen from resistant hybrids have been performed for three consecutive years. Within the obtained progenies, 23 genotypes resulted positive for the segregation of the SSR molecular markers related to resistance. On the other hand, a reliable protocol for the obtainment of embryogenic calli was developed for the selected varieties aimed at the future application of NPBTs. All genotypes were sequenced employing an Illumina technology leading to the generation of a total of 85 GB data. The reads were aligned against the PN40024 v4 reference genome. From an initial set of 20 million SNPs, 3,849,126 robust SNPs were selected for downstream population genetic analysis. Admixture analysis revealed the occurrence of two subpopulations with 'Grillo' showing a high predominance of subpop1 and 'Carricante' characterized by an opposite genetic configuration and a clear predominance of subopop2. 'Nero d'Avola' was characterized by low admixture with a clear prevalence of subpop1 (0.93) and 'Nerello mascalaese' showing a higher presence of subpop2 (0.38) compared to the other sample. In parallel a principal component analysis was conducted on the set of robust SNPs. The first two principal components (PCs) explained a cumulated genetic variability of 46.8%. Overall, the results agreed with the admixture analysis, with 'Carricante' being genetically different from all the other samples except for 'Nerello mascalese' (characterized by a higher admixture compared to the remaining two genotypes). The application of molecular breeding, NPBTs and advanced sequencing, make this research such a promising and ambitious project for the obtainment of new Sicilian grape genotypes with good agronomic traits and improved resistance to powdery and downy mildew.

Genomic and phenotypic characterization of Bile Salt Hydrolase in promising *Lacticaseibacillus rhamnosus* probiotic strains

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Bile salt hydrolase (BSH; EC 3.5.1.24) is a well-known enzyme that plays a crucial role in selecting promising probiotic lactobacilli with cholesterol-lowering activity. Microbial BSH catalyzes the reaction that converts primary bile acids (BAs) into secondary ones, acting as signaling molecules in the regulation of cholesterol homeostasis and lipid absorption, as well as conferring gastrointestinal tract tolerance to BAs. In the present study, a genomic survey coupled with *in vitro* BSH activity and BAs tolerance was conducted on two potential probiotic strains belonging to *Lacticaseibacillus rhamnosus*. The complete genome of *L. rhamnosus* VB4 and VB1 strains predicted a total of 2,790 and 2,704 CDSs, respectively. Gene annotation revealed numerous strain-specific genes involved in various functions, such as amino acid transport, DNA recombination, metabolism and bacterial structure biogenesis. Moreover, safety assessment indicates both strains as safe concerning antimicrobial resistance gene checking. *In silico* and phylogenetic analysis were conducted to explain the relationship between *bsh* gene expression and BSH ability. Genome analysis showed that putative *bsh* gene was included in each bacterial genome, predicted by the BSH proteins analysis. The results showed a high similarity in BSH protein sequences between the tested strains, and the same behavior during BAs exposure. Additionally, remarkable differences between VB4 and VB1 in *bsh* gene expression and BAs profile were revealed. Specifically, VB4 was highly active in deconjugating BAs compared with VB1, which presented a deconjugation profile more peculiar to BSH-active lactobacilli (preferential deconjugation of glyco-conjugated), suggesting that both strains probably differ in detoxifying unconjugated BAs. The gene expression of *bsh* gene differed from the BAs profile, suggesting that BSH-positive phenotypes also depend to other gene pathways, which are different in VB4 and VB1 strains.

Resilience to hot-arid climate and fruit properties of interest for food and non-food uses of local apple genotypes in the Monti Dauni area.

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Genotypes traditionally grown in inland areas cope with difficult climates and low-input farming techniques thanks to the ability to eco-physiologically tolerate stress and/or react by increasing protective metabolites, such as phenolics known for the health benefits mainly attributed to their antioxidant properties. In the Monti Dauni area, the local apple genotypes Limoncella, Limoncella rossa and Sergente were compared with the "standard" cv Golden delicious as for eco-physiological behavior, demonstrating the ability to maintain a better water status and leaf gas exchange in the hot-and-dry summer 2023. Mature fruits of these local varieties, extracted in methanolic-solution, showed a higher total phenol content and antioxidant activity (by TEAC

assay) over two years. Fruitlets from those four genotypes, plus 'Gelata' (a local variety), Renetta del Canada (a minor variety known for its high phenol content) and the "standard" cvs Pink Lady and Granny Smith, all thinned according to the cultural-technique and constituting a waste-product, were extracted in methanol solution and then properly treated to test their antioxidant activity and antimicrobial effect against *Listeria monocytogenes* and *Salmonella* spp. by agar disc diffusion method. The best results came from Limoncella extract, which showed a bactericidal effect. Sergente, Limoncella rossa, Golden delicious and Pink Lady showed a variable antimicrobial activity depending on the strain. Renetta del Canada and Granny Smith did not inhibit *Salmonella* spp.; the activity of Golden delicious against the same bacterium was not univocal. Public concerns about the use of synthetic antimicrobials are increasing industry interest in natural antimicrobials and their potential to provide safety benefits to many materials that come into contact with humans.

Assessing the impact of pesticides and biopesticides on managed and wild bees in Mediterranean and tropical agroecosystems

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Bees are the main animal pollinators for wild and cultivated plants, being of crucial environmental and economic importance. Their global decline, driven by anthropogenic factors, including the use of synthetic pesticides, is an alarming concern. Biopesticides can be a viable alternative for the protection of cultivated plants due to their high selectivity and short environmental persistence. Despite their natural origin, biopesticides can cause lethal and sublethal effects on non-target organisms. During this PhD project, we studied the toxicity of synthetic pesticides and biopesticides on wild and managed bees, using different products commercialized in Mediterranean and tropical areas. Lethal and sublethal effects caused by pesticides commonly used in Italian and Brazilian agroecosystems, including greenhouses, were evaluated, with particular attention to some biopesticides of botanical origin, such as essential oils (EOs). Synthetic and botanical pesticides caused lethal and sublethal effects on social (honeybees, bumblebees, Neotropical stingless bees), and solitary bees. Specifically, EOs caused lethal effects after topical and oral exposure to *Apis mellifera*, *Bombus terrestris*, *Osmia bicornis*, and *Melipona mondury*. Changes in feeding behavior and locomotor alterations caused by exposure to EOs were observed on the stingless bee *M. mondury*. Commonly used pesticides and biopesticides caused reduced survival of ground-nesting *Andrena* and *Eucera* species and altered the locomotor behavior of managed bees. Synthetic insecticides used to protect greenhouse tomato

plants reduced the survival and caused changes in feeding behavior, and midgut alterations in *B. terrestris*. These results may be important for the appropriate use of pesticides and biopesticides in integrated pest and pollinator management, providing crucial data for the conservation of pollinating insects.

Mediterranean diet and intake of microorganisms and biomolecules of microbial origin: case studies for the design of innovative trends

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The Mediterranean diet, characterized by an abundance of fruits, vegetables, whole grains, legumes, and olive oil, alongside moderate consumption of fish and poultry, is associated with numerous health benefits, including lower risks of cardiovascular diseases, cancer, and neurodegenerative conditions. Recent studies have highlighted the significance of dietary microbes in promoting human health. Our research consolidates existing knowledge about the microbial content of key Mediterranean diet components such as fermented dairy products, fermented table olives, and fruits. By categorizing these foods based on their microbial profiles—low ($<10^4$ CFU/g), medium (10^4–10^7 CFU/g), and high ($>10^7$ CFU/g)—we identified substantial variations in microbial presence. This enabled us to design two isocaloric daily diets: one microbe-depleted and one microbe-rich, showcasing the impact of food processing and ingredient selection on dietary microbe load.
The role of dietary microbes in gut health is vital, influencing digestion, immunity, and metabolism. Food processing techniques, including pasteurization, cooking, and handling, significantly alter the microbial content of foods. Our study delves into case studies on how various food processing methods affect microbial content, focusing on pasteurization of fermented food (e.g. fermented olives), different preparation (including cooking) of a product rich in microorganisms (e.g. cheese), and the minimal processing of fruit and vegetables (e.g. salad). Using culture-dependent methods, we examined the microbial diversity and loads in different food matrices. These case studies underscore the importance of food processing in determining microbial loads in dietary components. Further research is essential to investigate these dynamics across a wider range of foods and processing conditions. This research aims to develop strategies in food science and nutrition to preserve or enhance the presence of beneficial microbes in our diets.

Towards a “0 mile” diet for ruminant feeding

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Livestock production must move toward more sustainable systems in a circular economy approach. Using agro-industrial by-products in replacement of conventional feedstuff could be a strategy to reduce the environmental impact of feed production and transport, and the feed-food competition. The industrial transformation of nuts generates an abundant amount of by-products, that are a source of bioactive compounds with potential beneficial effects on animals' health and product quality. Most of the bioactive molecules of the nuts, such as antioxidant vitamins, polyphenols, and unsaturated fatty acids, are contained in the skins. In the first part of the project, an *in vitro* trial was performed to verify that almond, hazelnut, and pistachio skins in replacement of maize would not exert negative effects on rumen digestion and to select the most convenient dose (70, 140, or 210 g/kg) were to be later tested *in vivo*. Low doses of skins can be substituted for maize without adversely affecting *in vitro* ruminal fermentation. To reduce methane production, it would be advisable to use nut skins at higher doses, but this would reduce VFA production. In the second part of the project, 40 lambs were divided into 4 groups and fed for 60d with hazelnut skin and linseed, alone or in combination. Dietary treatments did not affect growth performances, carcass traits, and ruminal fermentation. The combined effect of hazelnut skin and linseed enriched the intramuscular fat with health promoting FA (α-linolenic, long-chain n-3, rumenic, and vaccenic acids) and tocopherols, while reducing lipid oxidation during 7 days of refrigerated storage. These results suggest that nut skins can be successfully included in the lamb diet, furthermore tocopherols provided by the hazelnut skin delayed meat lipid oxidation, despite the higher concentration of n-3.

Enhancing Buckwheat Breeding and Agronomic Performance Through Genomic Selection and Climate Adaptation Strategies

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This PhD project addresses critical challenges of improving the breeding strategies and the agronomic performance of common buckwheat (*Fagopyrum esculentum*), a key crop for sustainable agriculture and a valuable source of plant proteins that requires limited input, in a context of climate change. Buckwheat's reproductive system prevents the generation of inbred lines and the exploitation of heterosis. Still, this crop is amenable to be tackled with a modern approach to speed up breeding by means of genomic selection (GS). GS consists of building phenotype prediction models based on phenotypic and genotypic data from training populations, allowing for reducing the burden of phenotyping multiple generations. In this project different approaches will be implemented to further facilitate the application of GS to buckwheat, including (i) exploitation of the genetic diversity in the available germplasm and (2) innovative technologies, such as hyperspectral imaging, for better predictive models. These are expected to significantly streamline the breeding

process for varieties that are superior of drought tolerance, yield, and nutritional value. The second part of the project involves extensive variety adaptation trials to remodulate sowing times to adjust the crop to the challenges posed by climate changes such as spring frosts and summer heat waves. This study will evaluate various varieties under different scenarios. Comprehensive evaluation of growth patterns, yield, and quality attributes will be conducted to identify varieties that offer consistent performance, resilience, and reliable options for different sowing seasons. Altogether, these methodologies aim to revolutionize buckwheat cultivation. By integrating cutting-edge selection techniques with agronomic trials, we will strive to produce resilient, high-yielding varieties, contributing to global efforts toward sustainable food production and security.

Characterization of novel *Citrus* rootstocks subjected to deficit irrigation techniques

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In recent years, due to climate change and increase in temperature, agriculture, and especially fruticulture, are facing several environmental problems and among these, the reduction of water availability is certainly the most concerned, especially in the Mediterranean basin, where *Citrus* are one of the most cultivated fruit crops. Modern citriculture relies on the use of rootstocks to guarantee adaptability to environmental and biotic constraints and to speed up the establishment of a potentially unlimited number of homogeneous plants of a specific clone, which in turn ensures uniformity in the production of high-quality fruit, so it is of pivotal importance the characterization of novels citrus rootstocks. In this context, the evaluation of newly introduced or newly originated citrus rootstock subjected to Deficit Irrigation (DI) techniques will be evaluated through morphological, biochemical and physiological analysis. Citrus plants have been planted in the summer of 2021 and after a year, a DI of 30% was applied in the selected scion/rootstock combination. For testing the ability of these plants to withstand drought stress, a small dataset was chosen because they are used in other countries, as well as their good performance obtained in the morphological analysis. During the summer season (May-September) these genotypes will be subjected to physiological measurements, which are the determination of midday-stem water potential (ΨStem), leaf photosynthetic parameters, photosystem photochemical efficiency and the level of chlorophyll and flavonols. At the same time, two leaves per plant will be collected to carry out the biochemical analysis.

During the ripening period, pomological analysis will be conducted on fruits (TDV and Meli Tarocco), for understanding if these rootstock/scion combinations are suitable for the Mediterranean market. The analysis will also allow us to understand whether the rootstock/scion combination influences the qualitative characteristics of the fruit and the productivity of the plant.

Role of beneficial microorganisms towards more sustainable cropping systems in the Mediterranean environment

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Environmental stresses such as extreme drought and heat, as well as soil degradation caused by intensive agriculture, are significant global challenges that harm crop productivity and food security. Beneficial soil microorganisms (BSM), including plant growth-promoting rhizobacteria (PGPR) and mycorrhizal fungi, are gaining attention because they improve yield potentials and enhance plants' tolerance to biotic and abiotic stresses. The research presented here explores the effects of applying BSM (alone and with other sustainable agronomic practices) on the agronomic and quality features of the most important Mediterranean crops, such as cereals, legumes, tree crops, and vegetables. A systematic literature review was conducted following the PRISMA guidelines by searching for the keywords *'beneficial soil microorganisms, field inoculation, native microorganisms, productivity, agronomic, and crop'* on three databases: Science Direct, Web of Science, and Scopus. The results confirmed the positive impact of beneficial soil microorganisms on enhancing crop productivity, nutrient uptake, and stress tolerance. Some gaps in the current knowledge were also identified, including a limited understanding of the complex interactions between different microbial strains and a lack of investigation into the long-term ecological consequences of introducing non-native microorganisms. In addition to the literature review, a multi-site agronomic trial was conducted to study the effects of BSM, alone and in combination with different types of organic fertilizers, on Broccoli's agronomic and quality characteristics. Based on the preliminary results, the BSM application led to a slight improvement in the productive and morphological traits, but not in a statistically significant way. For most of the traits, significant interactions were found between environment, BSM, and fertilization, thus suggesting it may be possible to find the best combination of BSM and agricultural technique based on the specific growing environment. However, these findings need to be confirmed by repeating the trial next year.

Circular economy principle in the EVO oil sector from the LCA point of view

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Life Cycle Assessment (LCA) is increasingly recognised in the literature as a suitable tool for exploring strategies and methodologies for Sustainable Development Goals (SDG) implementations. This is mainly because it allows for in-depth analyses of the input/output inventories, and the environmental hotspots associated with the system investigated. Indeed, LCA is effective in supporting company management, and in prioritising sustainability-oriented improvements that make it possible for companies to achieve the SDGs that are most connected with their operational fields. The present study explored applications of the circular economy (CE) principles in the olive oil sector, with the lens of Life Cycle Assessment (LCA). To that end, a systematic literature review (SLR) was performed, and to facilitate a comparative analysis of the findings from reviewed studies, the latter were grouped into clusters, considering their characteristics and methodological approaches. Five articles were classified as dealing with 'closed-loop' systems wherein the resources from the valorisation of by-products were reintegrated into the same production system. The remaining articles were categorised as related to 'open loop' systems since by-products were utilised in processes and systems outside olive oil production. Notably, the 'closed-loop' systems showed the best LCA outcomes. Although comparing LCA applications is challenging due to the inherent nature of the method and researcher autonomy in selecting basic characteristics, valuable best practices emerged from the analysis of the current state of the art. These practices included valorisation of olive pomace (OP) by converting it into biogas to meet the energy needs of the system processes themselves, the collection of waste cooking oil to convert it into biodiesel, and the use of organic farming techniques in olive production. OP oil extraction emerged as a widespread practice enhancing system sustainability.

Enhancing Grapevine Resistance to Flavescence Dorée through Transcriptomic Analysis, Genetic Mapping, and CRISPR/Cas9 Technology

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This PhD research aims to enhance grapevine resistance to Flavescence Dorée (FD) using advanced biotechnology tools. The project is divided into three main sections. The first section involves understanding resistance mechanisms through transcriptomic analysis. RNA sequencing is used to identify differentially expressed genes and pathways in resistant versus susceptible grapevine varieties, with GAPDH as a reference gene for accurate comparisons. Data collection, initiated in 2023 and continuing into 2024, examines phytoplasma distribution in one-year-old canes, scions, rootstocks, and roots. The second section focuses on identifying FD-resistance genes using different grapevine hybrids. This includes genetic linkage and QTL mapping, alongside transcriptomic analyses to pinpoint resistance loci. So far, genotypic analysis and one-year

phenotypic characterization have been completed for 110 genotypes of the Chardonnay x Tocai Friulano hybrid. Phenotypic and genetic characterization for 130 genotypes of the Chardonnay x Moscato Bianco hybrid is scheduled to begin in late 2024. The third section employs CRISPR/Cas9 technology to enhance FD resistance by targeting the Glutathione S-Transferase 25 (GST25) gene, identified as a resistance gene by previous research. Progress includes constructing and validating a plasmid vector containing the Cas9 gene, producing 5000 plantlet calli from another culture for transformation, and scheduling CRISPR-Cas9 calli transformation via Agrobacterium-mediated transformation for October 2024. Post-transformation steps will involve selecting transformed cells using selectable markers, regenerating whole plants through tissue culture, and conducting molecular screening to verify CRISPR-Cas9 component integration and expression. Through these integrated approaches, this research aims to significantly improve resistance to Flavescence Dorée in Chardonnay grapevine varieties, contributing to more sustainable viticulture practices.

Selection of starter cultures from conventional and unconventional raw materials

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Food fermentation has been used for centuries as a preservation method. The raw materials traditionally used for fermentation can be very different; therefore, a wide variety of food products can be obtained by selecting different raw materials, starter cultures, and fermentation conditions. Starter cultures are defined as selected microbial preparations used to increase the efficiency of fermentation processes by contributing to their uniqueness. Unlike other processed foods, the successful production of fermented foods and beverages relies precisely on biologically active microorganisms without which these foods could not be produced.

The purpose of this research is based on the isolation and characterization of the indigenous microbiota of two different food matrices, such as cereals and onions, in order to obtain starter cultures with particular characteristics or to be exploited to initiate natural fermentation processes. For cereals, the isolation of microorganisms was carried out from hamoum samples of traditional Algerian fermented wheat, while the other starting matrix was the white onion of Margherita di Savoia, particularly known for its sweetness. Following the isolations, phenotypic and technological characterization tests were carried out to select the best strains among the 29 strains from cereals and 25 from onion; by multivariate analysis, in fact, 5 strains with probiotic and protechnological characteristics were selected for hamoum and 5 strains for onion, which were exploited to initiate pilot fermentations.

Session VIII

Spatially-explicit modelling of regional cropping systems based on LPIS for agro-environmental assessment

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The management of environmental resources is becoming a strategic question in a context of increasing population and climate change. Agricultural activities have a significant role as sink of environmental resources, but also as source of Ecosystem Services (ES). Analyzing the role of agriculture requires a spatially-explicit knowledge of cropping systems (CS) at territorial level. However, a major constraint regards the availability of spatially-explicit and annually updated data to identify and map CSs. That's why in this work we investigated the potential of land parcel identification system data. 1) Use of LPIS in scientific literature to assess CSs at territorial level. We highlighted two general ways of use: as ancillary source of data when using other data sources and as direct source of land cover data. 2) Identification and mapping of CSs at territorial level in FVG region. We mapped the different agricultural land uses in FVG region starting from LPIS data of 2019 and 2020. Once we will dispose of updated data, we will model the main crop rotations at regional level; 3) As double cropping (DC) is one of the main features of FVG cropping systems, we investigated for the first time the types and location of double crops in the region in 2019, 2020 and 2023. The most abundant combination main-second crop is "cereal-soybean" (53,5%).4) Impact of CSs on water availability/use. In this last part we will assess the variability of crop rotations as a proxy of ES, particularly water regulation. Considering the low regional crop variability in CSs, LPIS data could be used to support spatially explicit scenario analysis to model the introduction of new crops to reduce impact on water consumption

Participatory approaches to address territorial fragility in the Inner area of the Simeto Valley (Italy) though Nature-Based Solutions

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Growing socio-economic inequalities have impacted many aspects of life, including quality of life (QoL), which encompasses the natural living environment, health, and access to social services, influencing social

inequalities and exclusions as well as individual happiness and satisfaction. In Europe, particularly in Mediterranean countries such as Italy, the concept of QoL is intertwined with spatial marginality, which transcends spatial aspects influenced by socioeconomic variables and patterns of (im)mobility. The concept of "inner peripheries" (IP) was introduced to describe such areas, linking the concept to territorial marginality, to identify a set of policies aimed at promoting territorial cohesion by countering territorial disadvantages through local development. Italy has been proactive in defining these areas as "Inner Areas" (IA) through a series of indicators identified the National Strategy for Inner Areas (SNAI). However, the loss of resources and the presence of environmental fragility pose a threat to societal well-being, underscoring the need for sustainable solutions like "nature-based solutions" (NBS). By integrating social, environmental, and engineering spheres, NBSs improve resilience and address the impacts of climate change, thereby preventing and/or reducing environmental fragility. This study explores from a quali-quantitative perspective how public participation is crucial for the acceptance and success of nature-based solutions (NBS). It examines environmental fragilities in the Simeto Valley using participatory action-research methods. Focus groups and questionnaires disseminated to the population of the Simeto Valley inner area will inform the implementation of local development strategies. The data were analyzed using content analysis with ATLAS.TI software, uncovering four main macro-themes. Simultaneously, qualitative perception maps were created.

The results show what are the perceptions about environmental fragilities in the Simeto Valley in order to image, together with institutional actors, place-based and bottom-up solutions to improve wellbeing and make these marginal areas more attractive for residents.

Use of Optimized (Bio)Sensors for analyzing priority and emerging contaminants in surface waters: preliminary analysis

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The project aligns with NRRP M2C4 and focuses on selecting and characterizing emerging contaminants electrochemically. The goal is to develop an electrochemical (bio)sensor with synthetic (bio)receptors for water and environmental monitoring

In the first semester of the PhD program, the research focused on priority and emerging water contaminants, particularly artificial sweeteners. European Union regulations, such as Directive 2013/39/EU and Regulation (EU) 2020/741, define these contaminants and set limits for their presence in water. However, new needs arise, especially under the One Health perspective, considering the long-term impacts of artificial sweeteners, which are not fully evaluated.

The study targeted sweeteners (e.g., aspartame, saccharin, stevia) commonly used to impart sweetness to food and beverages without significant calories. Regulations on these sweeteners are based on the European Food Safety Authority (EFSA) guidelines, which establish acceptable daily intake (ADI) limits (European Food Safety Authority, 2013). Common detection methods include liquid chromatography coupled with mass spectrometry (LC-MS), enabling precise quantification in environmental matrices.

Preliminary analyses focused on aspartame, phenylalanine, and saccharin, employing both spectrophotometric and electrochemical techniques. Different pH levels and buffers were tested, including 0.1M acetate buffer pH 4.5, 0.1M PBS pH 7.5-8, 0.1M sulfuric acid, and synthetic seawater to simulate marine conditions. The goal was to identify reliable and reproducible conditions to assess the stability of these compounds until their apparent complete degradation. Additionally, their electrochemical behavior was investigated using three different working electrodes: glassy carbon, platinum, and gold.

These preliminary investigations have laid the groundwork for future research to develop highly selective and sensitive sensor surfaces for enhanced monitoring and detection of artificial sweeteners and other emerging contaminants in various environmental matrices.

Impact of climate change on small mammal zoonoses: the case of Friuli-Venezia Giulia

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Small mammals play a crucial role in the transmission of diseases due to their population dynamics, numbers and behavior. Among these, rodents and insectivores require attention for their importance to ecosystem dynamics as well as their roles as reservoir hosts and vectors of significant pathogens. This research, conducted in Friuli Venezia Giulia, aims to evaluate the current and future spread of pathogens transmitted by small mammals and the associated ecological variables.

The study employs live trapping and tissue analysis to identify the presence of multiple emerging zoonotic pathogens. The pathogens included are viral (Hantavirus & TBEv), nematoid (*Echinococcus multilocularis*) & bacterial (*Borrellia burgdoferii sensu lato*). The pathogens selected have all been previously confirmed in Friuli Venezia Giulia, however, their spread as well as potential human exposure are unknown.

12 sites have been selected in the Province of Udine, distributed along three separate mountainous areas. The sampling sites vary greatly in several ecological and climatic variables, namely NDVI, precipitation, temperature, growing season. Through sampling in a wide range of ecological variables and utilizing predictive models and variables, we hope to be able to predict future changes in pathogen.

The research is part of the larger PNRR project (National Biodiversity Future Centre) aimed at creating a publicly accessible visual model of species distribution and interaction. While acknowledging the uncertainties inherent to sampling these species and their associated pathogens, the study leverages successful models in predicting zoonotic trends, offering valuable insights into landscape level disease dynamics, particularly considering recent and future predicted increases.

Population genomic analyses of endangered and endemic plant species

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The diverse biodiversity of the globe is influenced by various species, with endemic and endangered plant species playing a crucial role in maintaining genetic diversity and ecological balance. However, habitat loss, climate change, and human activities pose threats to their survival, necessitating understanding of their genetic foundations for effective conservation efforts. Endangered and endemic species are valuable due to their ecological distinctiveness and vulnerability. Maintaining genetic diversity is crucial for their long-term survival and adaptability to changing environmental conditions. However, despite the recognition of the link between genetic diversity and adaptability, a significant information gap exists regarding the susceptibility of species characterized by endemism, rarity, and small population numbers, highlighting the need for protection. This research aims to understand the impact of decreased genetic diversity on endemic and endangered plant species, focusing on population genomics. It aims to understand the complex genetic relationships controlling their adaptation capacity. The research will analyze genetic diversity, population structure, and mechanisms facilitating adaptation to improve scientific knowledge and inform conservation measures. The goal is to improve conservation measures and inform targeted conservation measures.

Consumer trends in the herbal tea market: a systematic literature review

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This review synthesizes relevant literature to address main research areas within the herbal tea market. The research questions of this systematic review were formulated using a variant of Population, phenomenon of Interest, Contex (PICo) framework adapted for qualitative reviews. It was conducted in accordance with

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and utilizing VOSviewer for network analysis. Firstly, it analyses consumer behavior, highlighting how global integration impacts local cultures and health awareness, reflecting broader health, cultural, and environmental concerns. Then it addresses the significant health risks associated with herbal tea consumption, such as adverse reactions from contaminants, underscoring the importance of regulatory standards to ensure consumer safety. The analysis also faces the development of a safe value chain for medicinal and aromatic plants (MAPs), discussing the ecological benefits and the challenges of ensuring product traceability and safety. Lastly, it examines the global expansion of the herbal tea market, exploring economic dynamics and regional consumption trends to understand the implications for producers and consumers. The findings reveal a dynamic and evolving herbal tea market characterized by growing consumer demand for natural and organic products, necessitating enhanced industry practices and informed regulatory frameworks. This review sets a base for future economic studies and provides comprehensive insights into a rapidly expanding sector, advocating for sustainable production and accurate consumer information to support market growth and consumer trust.

The role of wooden tools in traditional cheese production: preserving quality, authenticity, and biodiversity

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This review provides an overview on the role of wooden tools in traditional cheesemaking production, with particular focus on their impact on the quality, authenticity, and biodiversity of typical and traditional cheeses. Wooden vats, shelves, and tables are essential in traditional cheese production, facilitating the growth of pro-technological microbial biofilms that contribute to the distinctive sensory traits of traditional cheeses, which cannot be replicated with alternative materials such as stainless steel or plastic. Despite the rigorous hygienic regulations, the use of wooden tools remains indispensable in numerous regions and is obligatory for specific Protected Designation of Origin (PDO) cheeses. Furthermore, these biofilms can enhance stability of the cheeses by providing a natural barrier against pathogenic microorganisms. Future research should concentrate on optimising the structure of biofilms, enhancing their robustness, and investigating the dynamics of microbial communities to further improve the traditional cheesemaking process while ensuring safety and quality.

Effects of water stress on fungal pathogens and use of proximal sensing for stress conditions monitoring

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Water stress represents one of the main limiting factors for crop production, especially in the Mediterranean agro–ecosystems. Moreover, water stressed crops can be more susceptible to pathogens attacks and thus, more exposed to diseases (e.g., *Botryosphaeriaceae* species in grapevines). For this reason, crop status monitoring is fundamental in a context of precision agriculture. In the last years, thermal and multispectral sensors have gained popularity because of the improvements in sensor technology and the reduction in costs. In this context, the general aim of this study is to propose innovative monitoring protocols based on the use of smart sensors, for detecting biotic and abiotic stress conditions. Additionally, the study aims were to evaluate whether different water regimes, associated with the presence of key pathogens, can: i) generate significant differences on the morphological parameters of potted plants; ii) generate significant differences in the quantity and quality of production in the field; and iii) favor or disfavor pathogens development. The study was carried out on vine cuttings grafted onto Ruggeri 140 rootstock, in climatic chamber. Initially, the cuttings were subjected to different water regimes (i.e., 20%, 50% and 100% of crop evapotranspiration) and one representative isolate of one fungal species (i.e., *Neofusiccocum parvum*) was inoculated. The crop status was assessed using low-cost thermal (Flir one Pro) and multispectral (Mapir) sensors, whereas the effect of the different water regimes on pathogen, was evaluated by measuring the length and width of any necrotic lesions on the wood that extend from the inoculation points. Therefore, the preliminary results indicate increased susceptibility to *N. parvum* infections in water-stressed plants. This research activity allowed to identify effective strategies to improve the sustainability of agriculture in the context of climate change.

Session IX

Analysis of emerging contaminants in wastewater from Foggia city by Wastewater-Based Epidemiology (WBE)

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The study of contaminants (personal care products, smoking, drinking coffee, alcohol consumption, pharmaceutical and illicit drugs) in wastewater is critical for understanding the lifestyle of society. Monitoring the scale of pharmaceuticals, licit and illicit drugs consumption is important to assess the needs of law enforcement and public health and provides more information about the trends within country. Community drug use patterns are usually described by national surveys, sales and seizure data. The quantitative determination of urinary biomarkers in raw wastewater, called wastewater-based epidemiology (WBE), has emerged in recent years as a promising tool for estimating the consumption of illicit drugs, tobacco, coffee and alcohol in a population and for comparing local and temporal trends. To study these lifestyle biomarkers, form the wastewater a detailed literature survey was done, and wastewater samples were analyzed. 24-h composite samples were collected from wastewater treatment plant in Foggia. A solid-phase extraction method was applied to influent wastewater and analyzed on liquid chromatography-tandem mass spectrometry (LC-MS/MS). Cocaine is the second most commonly used psychotropic substance after hashish in Italy, as shown by the published literature. The preliminary results about the consumption of different substances in Foggia will also be presented. To the best of our knowledge, this report is the first to present illicit drug consumption data from Foggia. This information could be useful for healthcare professionals and policymakers to monitor progress towards the reduction of prevalence of these substances and set up new health campaigns. Future research will focus on expanding the range of detectable contaminants and including other cities from the province of Foggia.

Enhancing sustainability in Mediterranean cotton production: variety choice, water management, and defoliant strategies

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Cotton production is often associated with the extensive use of water resources and chemicals. Additionally, farmers often adopt varieties that are unsuited to the pedoclimatic conditions of the cultivation area, leading to increased agronomic efforts and depletion of resources. Nowadays, agricultural contexts that take these sustainability factors into consideration are rare. Therefore, this study aims at evaluating the impact of variety choice, irrigation management and defoliant application on sustainable cotton production. Three field experimental trials were conducted to compare in terms of yield and physiology performances: (i) 13 varieties widely used in Mediterranean areas (trial 1); (ii) different levels of water stress (dry and 50% ET_M restoration) than a control (well-watered) (trial 2); and (iii) various organic defoliants (calcium hydrate combined with sulfur and pelargonic acid) (trial 3), to address the strong market demand to replace chemical defoliants, i.e. *Ethephon* and *Pyraflufen-ethyl*, which are still essential for mechanized harvesting. In trial 1, *Armonia* showed a significantly higher performance (P=0.05) compared to the other cultivar. The same variety, subjected to severe water stress conditions in trial 2, yielded 1.87 t ha^{-1}, which is a reasonable result than 2.08 t ha^{-1} obtained with full ET_M restoration. Additionally, the data of trial 3 allowed us to select a possible naturally synthesized defoliant with no residual action.

Investigating Rht GA3-sensitive genes to improve wheat drought tolerance through QTL-seq approach

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The discovery of gibberellic acid (GA3)-insensitive dwarfing genes, such as Rht-B1b and Rht-D1b, during the wheat Green Revolution transformed wheat breeding by reducing plant height and increasing grain yield through enhanced spike fertility. However, these GA3-insensitive genes also shorten coleoptile length and reduce early seedling vigor, traits that are beneficial for grain yield in water-limited environments. In contrast, GA3-sensitive dwarfing genes like Rht14, Rht16, Rht18, Rht24, and Rht25 reduce plant height without affecting coleoptile length, allowing for deeper sowing and better crop establishment, particularly in arid and semi-arid conditions. In this study, an F2 population of durum wheat (Triticum durum Desf.), derived from crossing Castelporziano (Rht14) and Atoudur (Rht1), was grown under controlled conditions to map QTLs and identify candidate genes for coleoptile and shoot length. Two contrasting bulks (short and long) were sequenced and genotyped using a high-density 600K SNP array. The QTL-seq approach identified seven regions on chromosomes 1B, 3A, 3B, 4B, 6A, 6B, and 7B associated with coleoptile and shoot length. Since previous studies mapped GA3-sensitive genes to chromosome 6A, an in-depth analysis of candidate genes in the QTL-6A region was performed. Out of 220 candidate genes on chromosome 6A, twenty-six exhibited deleterious variations, including stop gained, frameshift, and splice region variants. These included MYB family transcription factors, pathogenesis-related proteins (PR), cysteine proteases (CysProt), and a protein

phosphatase 2C (PP2C), all showing differential expression between the parental varieties, suggesting their potential role in regulating the GA pathway. Ongoing molecular validation analyses through Real-Time PCR and EMS mutant studies aim to confirm these findings.

Comprehensive genomic profiling via Oxford Nanopore Technologies: from genome assembly to structural and epigenetic analyses

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In this study, we provide a comprehensive view of some applications of Oxford Nanopore Technologies (ONT) reads for genomics analyses of plant species. The length of ONT reads, together with the ongoing rise in accuracy and affordability, have overcome the limits of previous short read sequencing techniques, leading to an increase in the capacity of detecting and annotating variants of various ranges (from SNPs to SVs) and to phase them. Furthermore, the presence of supplementary information, such as epigenetic modifications of DNA bases, enabled the detection of both genetic and epigenetic variation within the same experiment. ONT reads obtained from leaves samples of the heterozygous grapevine variety Rkatsiteli were used to produce *de-novo* genome assembly and to perform a resequencing experiment to detect and phase structural variants (SVs) and methylation levels. Most of the chromosomes were reconstructed from telomere to telomere (T2T), enabling the resolution and spanning of hard to assemble regions, such as centromeric regions. The completeness of the assembly was also evaluated by comparing it to the haplotype-specific assemblies obtained with PacBio HiFi reads (gold standard for *de-novo* assembly). Similar information of phased variants can also be achieved in an assembly-independent manner. Reads were aligned to the reference genome of a quasi-homozygous related line, PN40024, and phased and attributed to the two haplotypes. Subsequentially, detection of SVs and estimation of the methylation levels at the CG context were then performed independently on the two subsets of haplotype-specific reads.

Glad to know you better Ms. *Varroa destructor*.

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Varroa destructor is an ectoparasitic mite of the honey bee and is regarded as the most dangerous threat to the beekeeping industry of the Northern hemisphere. Despite its importance, many gaps in our knowledge on the

biology of the mite are still present. This is especially true for factors influencing reproduction and lifespan, which are key points in the parasite population dynamics. To rear the mite under lab conditions would help elucidating those factors but, to date, there are no available methods for this purpose.

My work has focused on the study of the lifespan and reproduction of the mite on its living host under lab conditions as well as the development of an artificial rearing method to identify the best diet and the most effective membrane for feeding the mite.

The mites showed the longest lifespans when infesting honey bee larvae, with a median survival of 53 days and a maximum survival of up to 100 days. A Polyethylene membrane 5µm thick can be used for the laboratory feeding of the mite.

The results obtained so far contributed to fill some gaps in our knowledge on this dangerous mite and will hopefully result in a more sustainable management of the problem.

Exploring the genetic and epigenetic regulation of budbreak in grapevine

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In grapevine, phenological development and especially bud development are strongly affected by changes in environmental stimuli such as temperature. Higher winter temperatures and warm spells caused by climate change lead to early deacclimation and dormancy release, anticipating budbreak and subsequent developmental stages, and prematurely exposing vulnerable tissues to late frost events which negatively impact bud development and survival. Dormancy and budbreak are complex traits under the control of multiple genes and exhibit variability among grapevine cultivars: however, the genetic adaptation for growth in specific geographical regions makes this diversity not sufficient to successfully respond to rapid and extreme environmental changes. Understanding the molecular determinants underpinning these physiological processes is therefore essential to select or produce genotypes better suited to the changing climate.

Previous transcriptome studies conducted on Cabernet Sauvignon buds highlighted the reactivation, during deacclimation and budbreak, of genes involved in cell cycle and DNA replication, supporting the expected developmental reactivation, as well as components of major epigenetic pathways such as DNA methylation and histone modifications. Genomic regions undergoing methylation changes in the progression from dormancy to budbreak were analysed and correlated to gene expression to identify budbreak-related genes potentially regulated through DNA methylation.

In addition, an experimental approach involving the use of single-bud cuttings was implemented in two early- and late-budbreaking cultivars (Chardonnay and Cabernet Sauvignon) to induce budbreak under controlled conditions and overcome field variability. Buds at different timepoints during dormancy and budbreak were collected and will be used to characterize changes in gene expression and in histone modifications such as H3K4me3 and H327me3, and to relate them to the phenotypic differences observed between the cultivars.

Session X

Development of molecular markers for sweet orange traceability

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Among Citrus species, sweet orange [Citrus sinensis (L.) Osbeck] is the most important in terms of production volumes and cultivated areas. Despite the hybrid origin of sweet orange, the entire cultivated germplasm is the result of somatic mutations accumulated over centuries from a single originary hybrid. Sweet oranges are widely employed for fresh consumption or for juice production; the rich varietal panorama is usually divided into four pomological groups: Common, Navel, Acidless and Blood (or Pigmented). The latter consists of varieties characterized by the synthesis and accumulation of anthocyanins in the fruit and for which Italy is the world-leading producer. Blood orange group includes hundreds of clonal selections belonging to three main varieties (Tarocco, Moro, and Sanguinello) that are appreciated for their high nutraceutical value. Such variability needs the set-up of innovative and reliable tools for genetic identification and product traceability along the entire production chain (from nursery to table). To this extent, a germplasm collection composed of 11 accessions was resequenced employing the Illumina platform at a genome coverage of 40X. The variant calling allowed the identification of unique SNPs (a locus characterized by a genotypic class that differentiates a specific accession, or a group of accessions, from all other samples). These set of SNPs were validated via HRM analysis, in a subset of 29 accessions encompassing the most widely cultivated varieties held at the ex-situ germplasm collections of the University of Catania (Italy) and IVIA (Spain). The development of group and accession-specific SNPs markers, together with specific DNA extraction protocols, enabled a precise traceability of plants, juices, and soft drinks together with the detection of juice blending.

Up-cycling of Plastic Waste into Valuable Products through Microwave Assisted Co-Pyrolysis with Biochar from Residual Biomass

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Plastic pollution has become a pressing global issue, with most of the plastic waste worldwide going unrecycled, amounting to less than 90%. Pyrolysis can efficiently convert plastics into solid carbonaceous materials, oils, and syngas, a gas mixture of H_2, CO and CH_4. Hydrogen (H_2) has been defined as a clean energy carrier for its zero-carbon nature, and plastics have been shown to be a valuable feedstock for H_2 generation. However, conventional pyrolysis faces limitations in achieving high yield of gas and hydrogen content. By providing rapid and efficient heating, microwave-assisted pyrolysis (MAP) enables better heat and mass transport, yielding different product compositions compared to conventional pyrolysis. The aim of this work is to investigate the MAP, associated with carbonaceous materials, as promising and challenging technology for plastic waste conversion into valuable products, including CH4, H2, CO, oils and char. Biochars achieved by conventional pyrolysis, operating at different temperatures and residence times, of local available raw biomass (agriculture residues and aquatic biowaste) are tested as both microwave absorber and "low cost" catalyst for increasing the H2 production. An in-depth chemical characterization of different type of plastics and biochars was performed to investigate the characteristics of samples. Microwave Assisted Pyrolysis tests were performed by using a PYROWAVE (Milestone) under different heating rates and retention times. The achieved products were quantified and analyzed for their composition. Preliminary results show that high yields of gas (70 % w) can be achieved at 600 °C and RT of 30 minutes, with an unprecedented concentration of H2 (34.4 % molar) and CH4 (26.9 % molar).

Exploring the interplay of European strategies and the farmer identity construction among the young generation: a qualitative case study from rural Sicily

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The shortage of young farmers is a global issue that captures the attention of politicians and scholars. In Europe, the percentage of farms managed by young farmers decreased from 11.5% to 9.3% between 2010 and 2020, with at least one-third of farmers now over 65 years old. This 'young farmer problem' highlights the need to find new ways to attract young people to agriculture. Indeed, according to recent literature and evaluation reports from the European Commission, the strategies adopted so far under the Common Agricultural Policy (CAP) have not achieved the intended results, revealing several limitations. Starting from a new theoretical perspective, this study aims to support policymakers in developing new strategies to incentivize younger generations to pursue agricultural careers.

Specifically, the research aims to explore how young people construct their 'farmer identity', focusing on the interaction between individual experiences, family and community dynamics, and political interventions. To this end, qualitative investigations were conducted with a purposefully selected sample from rural contexts in

Sicily. The sample, designed as a 'collective case study,' distinguishes between those who have inherited land (successors), those who could inherit but choose not to (potential successors), and those from non-farming families who start new agricultural enterprises (new entrants).

Results highlight how political tools intersect with the identity formation process and their impact on youth decision-making, identifying gaps where further interventions are necessary to ensure generational continuity in the sector. This contributes to the literature by enhancing the understanding of the contextual nuances on which policy strategies act and operate.

Integrating alternative ingredients and technological approaches for healthier and sustainable food products

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The development of healthier and more sustainable food products through the integration of innovative ingredients and technological approaches has been explored.

Okara, the by-product of soy manufacturing, rich in protein and fiber, was incorporated into a wheat flour dough (5% and 10%) to produce protein-enriched buns. Morphological and microstructural changes during leavening were described by 2D X-ray images. Results showed that okara hindered the volume increase and the total porosity during leavening and accelerated staling, making the buns harder than the control sample after 7 days of storage. Further analyses will follow to understand the mechanisms involved in these changes and to assess the buns nutritional value, focusing on protein content and digestibility. Salicornia, a plant from the Apulia region, known for its salty taste, was investigated as an innovative ingredient to reduce the salt content in cereal-based snacks. After optimizing the dehydration process, salicornia was ground into powder and added to wheat dough. A design of Experiment (DoE) consisting of 9 conditions was used to modulate the concentration of salt (0-1-2%) and salicornia (0-4-8%). Texture, color, microstructure properties and the perception of some sensory descriptors were analyzed. Results indicated that salicornia powder significantly affected the dough's color, hardness, and texture. In addition, the synergistic effect of salt and salicornia on the sensory perception offers the opportunity to reduce the salt content obtaining a healthier alternative for cereal-snacks. The most appreciated samples were formulated with 1% salt and 4% salicornia. Further analyses will investigate the impact of salicornia fiber on digestibility and glycemic index of the snacks.

Session XI

Plant growth-promoting bacteria in the rhizo- and endosphere of *Salicornia europea* plants

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Salinization of soils is one of the main biotic stresses impacting agricultural lands. The use of beneficial bacteria adapted to high salinity conditions is a viable option for improving crop production in salinity-affected areas, given that saline soil reclamation is a complex process. In particular, halotolerant Plant Growth Promoting Bacteria (PGPB) can enhance plant growth by increasing soil carbon, nitrogen, and mineral availability and uptake.

Over the years, coastal and saline regions have proven to be a natural source of beneficial microbes adapted to high salinity: the Margherita di Savoia saltworks area in north-eastern Apulia (Italy) is said to have a unique, diverse, and rich indigenous microbiota that is still largely unexplored.

Therefore, this study aimed to isolate, characterize, and select potential PGPB from endo- and rhizosphere of *Salicornia europea* plants collected in two sites located in Margherita di Savoia during the year 2023. A total of 110 bacteria (100 rhizobacteria and 10 endophytes) were isolated and morphologically and biochemically characterized through phenotypic (Gram staining, catalase, oxidase, urease test, microscopic observation, spore production, and motility) and qualitative tests (phosphate and silicon solubilization, indole acetic acid and siderophores production, ammonia generation, drought and salt resistance). The halotolerant isolates that possessed the best plant growth-promoting traits were identified through DNA barcoding based on 16S rRNA sequencing.

The obtained results suggest the possible implications of these PGPBs in improving the quality and productivity of halophytes in saline soil and in protecting other important plants against salt stress.

Evaluation of the potential anti-inflammatory effect of the ketogenic diet mediated by the synergistic action of β-hydroxybutyrate and MCT oil on Caco-2 cells

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Low-carbohydrate diets containing very high percentage of fat and adequate protein intake are called ketogenic diets (KD) due to their ability to stimulate the hepatic production of the ketone bodies acetoacetate (AcAc) and β-hydroxybutyrate (BHB). Ketone body production has various beneficial effects on bowel health, preferring energy sources for colonocytes, maintaining mucosal integrity, promoting satiety, suppressing inflammation and carcinogenesis. Medium-chain triglycerides (MCTs) are fats composed by fatty acids with carbon chain lengths ranging from C_6 to C_{12}. MCTs are naturally found in coconut oil, dairy products like butter and goat milk and in human milk. Exogenous MCTs are known to promote ketogenesis due to their rapid absorption through the portal vein and their oxidation to acetyl-CoA in the liver. This study aims to evaluate the anti-inflammatory synergic effects of MCT oil and BHB on CaCo-2 cells, which model intestinal epithelial cells, through cell viability assay, wound healing assay and ELISA test. The CaCo-2 cells were treated with 5 mM BHB and 0,5 mM MCT in the presence or absence of LPS (1µg/ml) for 24h and 48h. BHB and MCT oil increase cell viability, the migratory capacity and the production of anti-inflammatory cytokines, but the synergistic effect induces a notable improvement in the result, therefore a strengthening of the anti-inflammatory activity given by the combined action of the two substances is hypothesized.The future research proposal will consist of treating Caco-2 cells with sera from subjects who have undergone the ketogenic protocol.

Promising legumes integration on milk production and welfare

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This case study aims to evaluate the efficiency of integrating sheep grazing with legumes by assessing sheep welfare conditions, milk yield, and milk quality. The integration of legumes into sheep grazing systems has gained significant attention due to its potential benefits in improving forage quality, increasing animal productivity, and reducing reliance on external feed sources. The study was conducted over a specified period, involving a group of sheep raised in a grazing system that incorporates legumes into their diet. Most promising legumes known for their positive impact on milk production and animal welfare are: *Hedysarum coronarium* (Italian sainfoin), *Medicago sativa* (Alfalfa), *Trifolium pratense* (Red clover), *Trifolium repens* (White clover), *Lotus corniculatus* (Birds foot trefoil), *Vigna unguiculata* (Cowpea), *Glycine max* (Soybean). A control group consisted of sheep grazing on traditional forage without legume integration. Parameters related to sheep welfare conditions, milk yield, and milk quality were monitored and compared between the two groups. The

milk samples of sheep under different feeding treatments were collected to evaluate of physio-chemical characteristics. Fat, Total Solids, SNF, and Body Weight of sheep were evaluated to assess welfare conditions, parameters such as body condition score, growth rate, and health indicators. Milk yield, fat content, protein content, and somatic cell count were assessed. Additionally, feed costs and overall profitability will be considered. Data were collected and analyzed using appropriate statistical methods to determine any significant differences between the two groups. Findings will have practical implications for farmers and livestock producers interested in optimizing their grazing systems. Understanding the benefits and challenges associated with integrating legumes into sheep grazing can inform decision-making processes and promote sustainable and efficient livestock production systems with a reduction of ruminant emissions.

Microorganisms for the environment: technological robustness of plant growth promoting bacteria for Mediterranean crops

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Soil degradation caused by climate change could threaten economically important crops, such as durum wheat, particularly in Mediterranean regions where climatic and meteorological conditions play a major role. The aim of modern agriculture is therefore to find sustainable solutions to optimise the biological and economic productivity of the soil resources. Plant Growth Promoting Bacteria (PGPB) are the most promising approach to achieve these goals, as they offer a wide range of benefits in agriculture, including increasing crop productivity, improving soil nutrient levels and restoring soil fertility (Racioppo *et al.*, 2023). However, to use them properly, it is necessary to understand their limits, for example, whether they can be applied in different conditions from those in which they were isolated and developed. Therefore, this research aims to assess the technological robustness of some PGPB strains, focusing on the resistance to commercial fungicides, adhesion to seeds to design a protocol for bacterial use in the field, growth profiles as a function of pH and temperature, persistence in soil also under extreme conditions.

The strains were generally resistant to fungicides; in addition, the adhesion performance was >80% and for many microorganisms at 95-98%. Concerning the persistence in soil, they show a prolonged viability, although the increase of temperatures (at 45°C) could be a challenge. Generally, the results show a high technological robustness of the strains and their potentiality as active ingredients of bioformulates.

Combination of different vegetable matrices to produce fermented "one shot drinks" enriched in vitamin B2.

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Plant-based fermented beverages are gaining more interest among consumers. Their high fiber and antioxidant content and low cholesterol make them a healthy alternative to dairy products. In this study we obtained plant-based fermented beverages formulated as one-shot drinks from two different vegetable categories, such as AMARANTH (Amaranthus spp, pseudo-cereal) and LUPIN (Lupinus spp - legume). These matrices were chosen for their nutritional properties and for their cultivation methods with low environmental impact. Each individual matrix, alone or mixed at different percentages, was used as a substrate for the growth of probiotic *Lactiplantibacillus plantarum* strains with riboflavin overproducing phenotype, in order to select the best strain/matrix combinations to enhance probiotic growth and vitamin B2 content of the beverages. Therefore, the viability of the probiotic strains, pH and sensory characteristics were evaluated at the end of fermentation and during a shelf-life period of 21 days. In addition, fermented beverages were subjected to simulated in vitro digestion to evaluate the effect of the matrices and their combinations on the viability of probiotic under conditions mimicking the gastro-intestinal transit. The probiotic viability increased about 2 Log CFU/mL during fermentation from 7 to 9 Log CFU/mL and this viability remained stable during shelf-life. The high microbial concentration was also associated with a rapid increase in acidification. Beverages with the highest concentrations of lupin showed a protective effect on the survival of all probiotic strains subjected to simulated digestion, with a survival of 2 Log CFU/mL higher than amaranth-based beverages. The production of riboflavin during fermentation will be investigated to further discuss the ability of *Lactiplantibacillus plantarum* vitamin B2 overproducing strain to obtain functional foods.

Improving wheat storage: the impact of heat and CO_2 on insect mortality and grain quality

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Managing *Sitophilus granarius* in wheat grains is crucial for global food quality and security. Conventional chemical methods pose risks, prompting sustainable alternatives. This research investigates the impact of elevated carbon dioxide (100%) and higher temperatures (45, 50, and 60°C) on *S. granarius* mortality. Additionally, the study examines the effects of high temperatures (45, 55, 65, and 75°C) on durum wheat, including moisture, weight loss, color, texture, total phenolic content, antioxidant activity, and total tannins.

To test carbon dioxide and high temperatures on *S. granarius*, infested grains were exposed to 0 and 100% CO_2 combined with 45, 50, and 60°C for 1, 2, 3, 6, and 9 days. Results showed that temperatures of 50 and 60°C combined with 100% CO_2 induced 100% mortality in *S. granarius* for all treatment durations. However, 45°C alone and combined with CO_2 was ineffective in all durations. The subsequent study on the impact of high temperatures on quality of durum wheat revealed several findings. With increasing temperature, moisture decreased, weight loss increased, and water activity decreased in the grains. There was no remarkable change in color analyzed by colorimeter and image processing in control (25°C) and treated samples. Hardness of the grains increased with higher temperatures. Furthermore, total phenolic content and antioxidant activity increased, while total tannins decreased as the temperature increased to 75°C. Overall, the results demonstrated that using 50 and 60°C temperatures with 100% carbon dioxide is favorable in eliminating *S. granarius* in stored wheat grains. Moreover, high temperatures can positively influence certain quality attributes of durum wheat grains and flour.

Insecticide selectivity on the Spotted wing drosophila and its major parasitoids

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Arthropod pests are a major agricultural and ecological threat in the era of globalization. The spotted wing drosophila, *Drosophila suzukii*, represents a key example of invasive pest causing significant economic losses worldwide, particularly for the soft-skinned fruit production. Within the community of *D. suzukii* natural enemies, the pupal parasitoid *Trichopria drosophilae* is commercially available for augmentative releases, while the Asian larval parasitoid *Ganaspis kimorum* is being employed as a classical biological control agent in Europe and the US. However, insecticides remain a mainstay for controlling the invasive fly, despite their use comes with several drawbacks related to the impact on non-target organisms, at both lethal and sublethal concentrations. With the aim of integrating parasitoids into existing pest management practices against *D. suzukii,* this PhD project focused on (i) optimizing parasitoid mass rearing techniques, (ii) evaluating interspecific interactions between larval and pupal parasitoids, and (iii) assessing parasitoids compatibility with synthetic and bioinsecticides. Here, a focus on the assessment of the lethal and sublethal insecticide effects on *D. suzukii, G. kimorum* and *T. drosophilae* is presented. Results showed that organophosphates and spinosyns were the most toxic compounds towards immature and adult stages of the pest, and that sublethal concentrations (LC_{10}) can impair key life-history traits of juvenile *D. suzukii*. Spinosad was the most toxic insecticide to *G. kimorum* by affecting its survival and fertility at both field rates (FR) and sublethal concentrations (LC_{30} and LC_5), while *T. drosophilae* survival and fertility were strongly reduced by organophosphates, pyrethroids and spinosyns applied at FR and LC_{10}. Overall, these results offer practical

applications to promote the sustainable management of *D. suzukii* by supporting the use of biological control agents and minimizing the environmental harm caused by pesticides.