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Titoli sessioni

Mercoledì 08 Luglio 2026

Sessioni parallele (oral) | 15:40 - 16:40

S01 | Aula Darwin

Carlotta BRESCHI
Characterization of traditional sheep meat salami: valorizing a Tuscan agro-food heritage within the Mediterranean Diet

Francesca MONTICONE
Which future for cultured proteins in Europe? Analysis of value chain dynamics and business model resilience

Paolo Emilio BARTOLUCCI
Contractual terms for environmental sustainability in agri-food systems: dynamics and impacts. A systematic review

Antonina SPARACINO
Do demand and supply speak the same language? Evidence from apple markets

Andrea DOMINICI
To stay or to leave? Determinants of farm exit in marginal rural areas

S02 | Aula Leonardo

Luigi Giuseppe DURI
BioAltilis, an alternative sustainable approach for the bioactive compound production in Cardoon

Carmelo MOSCA
Phosphate-solubilising Bacillus consortium as a strategic tool for durum wheat production

Aurora GHIRARDELLI
Assessing seawater intrusion impacts on summer crops in the Po River Delta using long-term remote sensing data

Lucia CROSETTO
Understanding methane emission dynamics in temperate rice fields through systematic review and statistical modelling

Beatrice FIORE
Circular economy strategies for urban soil restoration: Reusing crushed asphalt in a de-sealing project in Prato, Italy

S03 | Aula Aristotele

Michele DENORA
On-farm experimentation of cereal-legume intercropping mixtures: weed suppression, system productivity and profitability

Noemi TORTORICI
Physiological indicators for drought resilience and irrigation management in cotton

Vera PAVESE
Biotechnological strategies to increase sweet chestnut tolerance to ink disease under climate change

Rita CRISCUOLO
Melatonin and serotonin differentially modulate growth, metabolism and antioxidant responses of lettuce under salinity stress

Federica FALCETTA
*Interaction between nanoplastics and water stress: effects on mobility, bioaccessibility and metabolic response of lettuce (*Lactuca sativa *L.) in the soil-plant system*

Mercoledì 08 Luglio 2026

Sessioni parallele (oral) | 17:30 - 18:30

S01 | Aula Darwin

Sara SANSONI
Actions to encourage climate and health friendly food choices among consumers: a systematic literature review

Federica CALDERONI
Economic evaluation of the use of by-products in leavened baked goods

Elisa GIAMPIETRI
No alcohol, many prices: a quantile regression analysis of the No- and Low-alcohol wine market

Lorenzo BAIMA
Income variability and cost structure in beekeeping: an economic analysis of Piedmontese beekeeping farms

Beatrice BEDIN
Mapping challenges in viticulture through an economic lens: insights from a systematic review

S02 | Aula Leonardo

Addolorata Maria NETTI
InVEST-SDR modeling of soil erosion mitigation strategies in Southern Italy

Alfredo LORENZO
Assessing the impact of soil and crop-based calibration strategies on OPTRAM-derived soil moisture estimates

Alice BOARINO
Phosphorus solubilization in livestock waste: enhancing nutrient recovery and reducing nutrient losses from soil

Claudia SARDELLA
Cover crops as a climate change mitigation strategy: Effects on wheat quality

Samuele DE PETRIS
When are spectral vegetation index changes significant? A framework for uncertainty-aware mapping

S03 | Aula Aristotele

Andrea CARLI
Yield stability under water deficit: the role of ear architecture in early and drought-tolerant maize hybrids

Cassandra DETTI
Phytochemical variability and antioxidant activity in Lavandula*: Insights for cultivar selection and horticultural valorization*

Edoardo VERGNANO
From genomes to defense: Key alleles driving pepper resistance to Leveillula taurica

Fulco FRASCATI
Impact of TsvlRNA1 infection on the Trichoderma*-tomato interaction under stress conditions*

Elia PAGLIARINI
Bacillus haynesii *WVC18 enhances vegetative growth and ornamental traits in Poinsettia and Cyclamen*

Giovedì 09 Luglio 2026

Sessioni parallele (short communication) | 09:00 - 09:45

SC01 | Aula Darwin	SC02 | Aula Leonardo	SC03 | Aula Aristotele
Elena RADICIONI *Resilient viticulture and consumer acceptance: evaluating wines produced from pest-resistant grapevines*	Giuseppe PARETE *Evaluating the economic sustainability of agritourism models: A multicriteria framework in the Alta Murgia area*	Francesco P. CARROZZINO *Digital sustainability readiness index (DSRI): Challenges and perspectives for the future*
Chiara COSTAMAGNA *Assessing the sustainability of dairy supply chains: alineation between consumer perceptions and production realities*	Fabio TUSCANO *Who seems local, who seems global? Exploring differences among consumer identity types in food neophobia, locavorism and food certification awareness*	Raffaele ZANCHINI *Economic valuation of tourist and recreational services in Gran Paradiso National Park: a choice experiment*
Christophe EL NAKHEL *Sustainable soil disinfestation strategies differentially modulate yield and nutritional quality of consecutive lettuce cropping*	Stefania STELLUTI *Wild edible plants in the western Italian Alps: Ethnobotanical heritage, phytochemical properties, safety, and postharvest quality*	Daniele VEZZOLLA *The use of wheat distiller to replace soybeans in rations for high-producing dairy cows*
Alessandro BIZZARRI *Two years of forest monitoring before and after prescribed fire: physiological responses from dendrometer measurements*	Teresa TOTARO *Water and carbon costs: A footprint-based evaluation of sustainability and competitive edge in organic cotton in Mediterranean environmental*	Alessandro BELTRAMO *Farm-scale water balance modelling to improve irrigation strategies*
Alice Carlotta TANI *Spatial planning and supply sizing of residual forest biomass for energy applications*	Lorenzo ROSSO *Peat substitution with chestnut wood fiber: species-specific responses in forest nursery seedlings under biostimulant application*	Massimiliano D'IMPERIO *From biofortification to personalized nutrition: Agronomic strategies for tailored vegetables*

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Agnese SPADI
Technological innovation in the management of dissolved gases in the winemaking process

Niccolò RIMBOTTI
Modular open-source platform for multi-gas soil emission monitoring: design and controlled validation

Simona CAVALLO
Mapping natural forest expansion following land abandonment in the Gran Paradiso national park

Lucrezia BORRIELLO
*Environmental biomonitoring using honeybees (*Apis Mellifera*) and honey to assess contamination from heavy metals, microplastics and plastic additives*

Massimo Vincenzo FERRO
Delineation of vineyard management zones through multi-sensor geostatistical data fusion

Edoardo RONCO
When a standard is uncertain. Implications of Penman-Monteith model uncertainty for agricultural water dynamics estimates

Natalia SGARAMELLA
Molecular traceability of pistachio products

Eleonora Vittoria FONTANA
Shaping the ambrosia beetle community: the role of environmental drivers in chestnut-dominant areas

Ferdinando CORTI
Application of EPR spectroscopy for quality and shelf-life assessments in extra virgin olive oil production

Laura ALBERICO
Epigenetic and genetic profiling of friariello napoletano ecotypes

Pietro NIGRO
Do pharmaceutical active compounds in reclaimed wastewater affect the in vitro growth of soilborne pathogens and biocontrol fungi?

Alisea SEREN ROSSO
Optimizing water management at fertilization enhances the mitigation efficiency of NBPT- treated urea on ammonia volatilization in temperate rice agrosystems

Marisa AMATO
Lactose-driven metabolic shift affects succinic acid production in Basfia succiniciproducens *4D*

Lorenzo CIRALDO
Optimization of biotechnological processes for the valorization of food by-products: oat okara and tomato peels

M. ANWAR-UL-HAQ
Genetic dissection of photosynthetic efficiency reveals its integration with vegetative architecture in a tomato recombinant inbred line population

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Mohammed SALMAN
The role of LuxR/LuxI-quorum sensing based system in P. gessardii in the regulation of proteolytic activity: Insights into QS inhibition as a strategy for control of spoilage activity

Federico RAMETTA
Combined bioprocesses for pesticide reduction in cereals: the pivotal role of germination and tailored lactic fermentation

Domenico NUZZOLESE
Culture-dependent and metagenomic characterization of sourdough from Senatore Cappelli, black chickpea, and a mixture thereof to select autochthonous starters for functional bread production

Federica Violetta CONTI
Exploring sourdoughs microbial communities to develop novel biotechnological strategies for the bakery industry

Giovedì 09 Luglio 2026

Sessioni parallele (oral) | 10:45 - 11:45

S04 | Aula Darwin

Roberto SENATORE
The environmental impact of different farming systems for Piemontese cattle

Gabriele ROLANDO
New genetics to increase resilience of maize production in a changing climate

Maria Chiara FABBRI
Stable or "Flexible"? Seasonal responses of sheep microbiota to environmental change

Marco RENZETTI
Evaluation of CoCas9 using a tomato hairy root screening platform as a rapid and scalable validation workflow for novel CRISPR nucleases in plants

Amelia LOCATELLI
Early metabolic markers of Flavescence dorée infection for sustainable grapevine management

S05 | Aula Leonardo

Azzurra ORLANDO
Stakeholder preferences for post-fire restoration practices in protective mountain forests

Irene VERCELLINO
Regional-scale mapping of direct protection forests through sediment connectivity analysis

Federico BERTONE
Comparative analysis of different carriage systems in cable yarding

Camilla MORITTU
Characterization of fungal communities in raw cork from standing trees and their potential role in 2,4,6-trichloroanisole formation

Andrea TORREGGIANI
Sustainable bioplastic production from agrifood waste using Cupriavidus necator

S06 | Aula Aristotele

Marco LAIOLO
Biocontrol agents strategies to minimize mycotoxin contamination in wheat under different tillage systems

Giovanna Marta FUSCO
Vermicompost as a sustainable strategy to enhance yield and functional quality of tomato

Paola CETERA
Valorizing residual powder from the cork stopper industry: chemical fingerprinting and sustainable valuation of cork extractives

Giulia MOZZO
The journey of mango: How the shipping systems affect fruit quality, consumer acceptance, and environmental impact

Alessia LISI
Carrot flour-enriched pasta with improved nutritional properties and in vitro *antioxidant activity counteracted inflammatory pathways in human colon cell line*

Giovedì 09 Luglio 2026

Sessioni parallele (oral) | 12:00 - 13:00

S06 | Aula Darwin

Rocco SABATO
Multi-environment analysis of yield and quality traits to boost the European common bean varietal portfolio

Giuseppina MAGARACI
Sustainable tomato production through PGPR-based microbial formulations: effects on yield, fruit quality, and plant-associated microbiomes under reduced nitrogen input

Simona CARBONE
Lactic acid bacteria fermentation as a strategy to reduce mycotoxin levels in contaminated wheat

Margherita CHIARINI
Harnessing non Saccharomyces diversity for low-ethanol wines: Framework validation under modern enological conditions

Lorenzo Antonio MARINO
Light matters: optimizing LED spectra to enhance in vitro propagation of European chestnut

S05 | Aula Leonardo

Stefano BRUZZESE
An empirical study on the motivations and impacts of adopting a forest certification scheme: The case of PEFC Italy

Antonio MULAS
Interaction between oak-infesting ambrosia beetles and plant pathogenic fungi in declining cork oak forests in Sardinia

Alessandro BENE
Systemic Brenneria goodwinii *in symptomatic and asymptomatic holm oaks in Salento: Insights into acute oak decline*

Ilaria INCOLLU
Preliminary metrological characterization of low-cost MEMS inclinometer for tree stability assessment: From laboratory to field

Hafiza Komal NAEEM
Acoustic priming as a sustainable strategy to enhance drought tolerance and physiological resilience in Olea europaea

S06 | Aula Aristotele

Giulia MASTROMONACO
From sustainability to tradition: Heterogeneous attitudes in wine consumption

Christophe EL NAKHEL
*Combined effects of soil disinfestants and foliar biostimulants on growth and quality of baby leaf lettuce (*Lactuca sativa *L.)*

Fabio CARNOVALE
Yield potential and mycotoxin contamination in wheat mutant lines with different amylose content

Valeria PALCHETTI
Preliminary screening of the herbicidal and fungicidal potential of essential oils from woody pruning biomass

Catarina CUHNA
Phenolic composition and colour stabilization of Nebbiolo wines through different fermentation strategies

Giovedì 09 Luglio 2026

Sessioni parallele (oral) | 15:15 - 16:35

S07 | Aula Darwin	S08 | Aula Leonardo	S09 | Aula Aristotele
Giovanni GAMBA *Optimizing chestnut rootstock production through LED-based light management: recent advances and implications for nursery performance*	Giovanbattista CALIFANO *Do algorithms share our taste? Comparing AI and human food choices*	Sebastien COMIN *Does early crown pruning stimulate root growth in young urban trees?*
Selene OLLANI *Upcycling Nergi® through fermentation and acetification for vinegar production and obtention of protein-rich biomass*	Chiara GELICI *Effects of social media influencers on willingness to pay for plant-based foods: Evidence from a BDM field experiment*	Letizia PORTACCIO Xylella fastidiosa *on* Leptospermum scoparium *in Salento (Apulia, Italy): First report*
Alice VARALDO *Application of physical light elicitors to improve color uniformity in sweet cherry*	Francesca ARDITO *Enhancing urban ecosystem service assessment through a vegetation structure index*	Enrico BUSCAROLI *Effects of microplastics, digestate, and antibiotics on the microbiome of two distinct soil types following six months of antibiotic incubation*
Federico BRUGNETI Diaporthe amygdali, *the causal agent of TCSB: a multidisciplinary approach for an eco-friendly control of the pathogen*	Celine RUSSO *Comparison of different combinations of remote and proximal sensors (LiDAR, RGB camera) and point cloud analysis for canopy volume in a steep-slope Mediterranean vineyard*	Marzia GUERRIERO *Whole-genome sequencing and phenotyping of neglected and underutilized vegetable melons from the Salento diversity centre (Southern Italy)*
Bruna DE SIMONE *Validation of an integrated method for PFAS plant-based and skimmed milk*	Ahmed MOUSTAFA *Automation and tele-management of precision irrigation systems*	Chiara DELVENTO *Wild and cultivated genomes provide insights into almond evolutionary dynamics and major phenotypic traits*

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Irene GIORDANO
From by-products to bioactives: Solid-state fermentation of tomato waste for GABA production by Levilactobacillus brevis *Y1*

Massimo Vincenzo FERRO
Smart grapevine disease assessment based on multi-source sensing systems

Ida ROMANO
Targeted culturomic approach to select new cellulolytic bacteria using Hermetia illucens *larvae as natural bioreactor*

Elige SALAMÉ
Evaluation of the spectral composition on the response to UV-B stress in Micro-Tom

Lorenzo BRUCHI
Development of new indices for tracking olive ripening stages

Diana ALFIERI
From theory to practice. A shiny R app for Climate-Smart Forestry Assessment

Knowledge gaps and risk perception toward insect-based ruminant feed: Evidence from Italian and Pakistani consumers

Jameel Ahmed [1], Lara Rastello [1], Laura Gasco [2], Manuela Renna [1,*]

[1] Department of Veterinary Sciences (DSV) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy
[2] Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy

* *Corresponding author: Manuela Renna (manuela.renna@unito.it)*

Abstract. This study investigates consumers' knowledge and risk perception regarding the use of insect-based feed for ruminants in two countries characterised by markedly different related legislative frameworks, namely Italy and Pakistan. Data were collected via questionnaires completed by 1040 Italian and 403 Pakistani consumers. The survey measured: (i) knowledge of the rules around using insect meal and insect oil in farm animal feed; (ii) risks associated with insect-based feed; and (iii) socio-demographic variables, focusing on the age of respondents. Descriptive statistics and Pearson correlation analyses were used to explore cross-country differences and relationships among variables. The results indicate generally low and fragmented levels of knowledge in both countries, albeit with distinct patterns. Pakistani consumers more frequently reported awareness of the absence of specific national legislation regulating the use of insects in farm animal feed. However, their understanding of concrete regulatory restrictions was inconsistent, with many incorrect answers and instances of uncertainty. In contrast, despite being embedded in a well-defined European regulatory framework, Italian consumers showed even higher levels of uncertainty, with 'I don't know' emerging as the dominant response to all regulatory knowledge questions. Risk perception was high in both countries, suggesting concerns about food safety, transparency and production practices are often grouped together. In Pakistan, risk perception was not linked to the age of respondents, indicating a relatively homogeneous perception. Overall, our findings suggest that differences in legislative context do not necessarily translate into higher consumer knowledge, while perceived risks remain substantial in both countries. Clear, transparent, and context-specific communication strategies are therefore essential to support informed consumer evaluations of insect-based feeding strategies for ruminants.

Keywords: Consumer; Acceptability; Ruminant feeding; Insect oil; Insect meal.

Epigenetic and genetic profiling of *friariello napoletano* ecotypes

Laura Alberico *, Pasqualina Woodrow

Department of Environmental, Biological and Pharmaceutical Sciences and Technologies (DiSTABiF), University of Campania 'Luigi Vanvitelli', Via Vivaldi 43, 81100-Caserta, Italy

* *Corresponding author: Laura Alberico (laura.alberico@unicampania.it)*

Abstract. *Friariello Napoletano* (*Brassica rapa* subsp. *sylvestris* L. Janc. var. *esculenta* Hort.) is a traditional leafy vegetable widely cultivated in Southern Italy, valued for its nutritional quality, adaptability, and suitability for low-input cultivation system. Despite its agronomic and cultural importance, *Friariello* has no officially registered cultivars and displays phenotypic variation among local ecotypes. This study aimed to characterize and valorise *Friariello Napoletano* through an integrated genetic and epigenetic approach to support its conservation and sustainable use as local agro-biodiversity resource. Six ecotypes (Cinquantino, Sessantino, Novantino, Centoventino, Marzatica, and Aprilatica) were analysed using Amplified Fragment Length Polymorphism (AFLP) markers to assess genetic diversity and distinctiveness. AFLP profiling revealed clear genetic differentiation among ecotypes, confirming their unique identities and highlighting the limitations of morphology-based classification. To evaluate whether part of this variability could be associated with epigenetic regulation, a Methylation-Sensitive AFLP (MS-AFLP) analysis was performed using the isoschizomeric enzymes *HpaII* and *MspI*, which differ in their sensitivity to cytosine methylation. MS-AFLP analysis revealed clear differences in global DNA methylation levels, band frequencies, and polymorphism rates among ecotypes and primer combinations. Methylation percentages ranged from approximately 23% to over 61%, with the ecotype Marzatica consistently showing the highest degree of methylation. The prevalence of methylated loci (Type II-III) suggests pronounced epigenetic differentiation, potentially linked to genome stabilization, transposable element silencing, and stress-responsive regulation. Conversely, lower methylation levels observed in Aprilatica and Cinquantino may reflect a more transcriptionally permissive chromatin state, supporting regulatory flexibility. Overall, the combined AFLP and MS-AFLP analyses indicate that both genetic divergence and DNA methylation contribute to functional differentiation among *Friariello* ecotypes. These results highlight DNA methylation as a key regulatory mechanism underlying environmental adaptability in *Brassica* landraces and provide a robust molecular framework for germplasm conservation, sustainable breeding strategies, and the valorization of *Friariello Napoletano* as a health-promoting traditional food.

Keywords: *Brassica rapa* subsp. *sylvestris*.; *Friariello Napoletano*; MS-AFLP; Epigenetic diversity; Agrobiodiversity conservation.

Lactose-driven metabolic shift affects succinic acid production in *Basfia succiniciproducens* 4D

Marisa Amato [1,*], Ida Romano [1], Valeria Ventorino [1,2], Olimpia Pepe [1,2], Paolo Dessì [1,2]

[1] Department of Agricultural Sciences, Division of Microbiology, University of Naples Federico II, Naples, Piazza Carlo di Borbone 1, Portici (NA), Italy
[2] Task Force on Microbiome Studies, University of Naples Federico II

* *Corresponding author: Marisa Amato (marisa.amato@unina.it)*

Abstract. The dairy industry is one of the most widespread agri-food sectors worldwide and, alongside the increasing demand for milk and dairy products, generates large volumes of wastewater and by-products. If not properly treated, dairy effluents represent a serious environmental concern due to their high organic load and elevated biological and chemical oxygen demand (BOD and COD). The high lactose content of whey makes it an attractive substrate for biotechnological valorization. The bio-based production of succinic acid from dairy waste streams represents a strategy to reduce environmental impact and promote sustainable processes. *Basfia (B.) succiniciproducens* 4D, a strain previously reported for succinic acid production from *Arundo donax* hydrolysate, was investigated for succinic acid production from lactose. Different lactose concentrations (2.5, 20, and 40 g/L) were used to simulate dairy effluents with variable composition. Cultivations were performed in a Minibioreactor, at pH 6.5, 150 rpm and CO_2 sparging (20 mL min^{-1}). Succinic acid production was dependent on the initial lactose concentration. The highest succinic acid yield was obtained at 2.5 g/L lactose (0.51 ± 0.01 g/g), with a selectivity of 45.5 ± 0.9%. At higher lactose concentrations (20 and 40 g/L), yield and selectivity decreased (0.36 ± 0.02 and 0.12 ± 0.05 g/g), while lactic acid production increased, becoming dominant at 40 g/L (0.45 ± 0.04 g/g). This indicates a metabolic shift from the succinate to the lactate pathway based on lactose concentration. This study confirms that *B. succiniproducens* is a promising organism for succinic acid production from lactose. The metabolic shift to lactic acid at high lactose concentration may hamper its applicability to concentrated dairy effluents such as cheese whey. Since the genetic basis of this metabolic shift in *B. succiniciproducens* 4D remains unclear, future transcriptomic analyses will be conducted to identify the genes involved, providing crucial information for process optimization.

Keywords: Dairy by-products; Waste valorization; Bio-based chemicals; Sustainable fermentation; Process optimization.

Acknowledgements: This study was carried out within the Agritech National Research Center and received funding from the European Union Next-GenerationEU (PIANO NAZIONALE DI RIPRESA E RESILIENZA (PNRR) – MISSIONE 4 COMPONENTE 2, INVESTIMENTO 1.4 – D.D. 1032 17/06/2022, CN00000022).

Genetic dissection of photosynthetic efficiency reveals its integration with vegetative architecture in a tomato recombinant inbred line population

Muhammad Anwar-Ul-Haq [1,2,*], Francesca Visconti [2,3], Gilda Aiello [2], Massimiliano Beretta [2]

[1] Department of Life Sciences, University of Modena and Reggio Emilia, Via Amendola 2, Pad. Besta, 42122 Reggio Emilia, Italy
[2] Panora Campus, Panora SpA, 43036 Fidenza (PR) Italy
[3] Department for the Promotion of Human Science and Quality of Life, San Raffaele Open University, Via di Val Cannuta, 247, 00166 Rome, Italy

* *Corresponding author: Muhammad Anwar-Ul-Haq (muhammad.anwarulhaq@unimore.it)*

Abstract: Photosynthetic efficiency is a complex, quantitatively inherited trait with major implications for biomass accumulation and plant architecture. The TRILLY population (Tomato RIL for Light Years) is a recombinant inbred line (RIL) population created by Panora SpA from a cross between two elite tomato lines. The population comprises 152 F13 sister-lines genotyped by single primer enrichment technology (SPET) and represents a suitable resource for dissecting physiological traits related to light-use efficiency. A comprehensive phenotyping activity was conducted at the pre-flowering stage, focusing on 1st internode length, chlorophyll content, and chlorophyll fluorescence parameters (OJIP test). Data were collected across three sampling dates, enabling temporal validation and correlation analyses. Significant and stable correlations were detected among photosynthetic traits across dates. Notably, photosynthetic efficiency parameters (Fv/Fm and PiAbs) showed consistent positive correlations with internode length and internode elongation dynamics ($r \approx 0.4–0.6$, $p < 0.05$), indicating a functional relationship between light-use efficiency and vegetative growth architecture. Quantitative trait locus (QTL) mapping identified genomic regions significantly associated with selected traits. Significant QTLs were detected for internode length and its variation, while a QTL for PiAbs was identified at the 5% significance threshold. No significant QTLs were detected for Fv/Fm or mean chlorophyll content, suggesting a more complex or polygenic genetic control for these physiological traits. Overall, the integration of phenotyping, correlation analysis, and QTL mapping highlights a functional association between photosynthetic efficiency and plant architecture in tomato, providing insights relevant for breeding strategies targeting improved light-use efficiency and growth performance.

Keywords: Photosynthetic efficiency; QTL mapping; RILs; Plant architecture.

Income variability and cost structure in beekeeping: an economic analysis of Piedmontese beekeeping farms

Lorenzo Baima *, Valentina Maria Merlino, Giulia Mastromonaco, Antonina Sparacino, Filippo Brun, Simone Blanc

Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy

* *Corresponding author: Lorenzo Baima (lorenzo.baima@unito.it)*

Abstract. The Italian beekeeping sector includes approximately 75,000 beekeepers and about 1.7 million colonies, distributed across the national territory. From an economic perspective, the sector plays a significant role, with honey production reaching nearly 22,000 tonnes in 2024 and being characterised by a high level of quality. Despite these strengths, Italian beekeeping is currently facing major challenges related to the decline of bee populations, climate change, and the reduced availability of floral resources. In addition, farm profitability is increasingly affected by irregular and often declining production yields, which amplify income uncertainty. In this context, the analysis of the economic performance of beekeeping farms has become increasingly important to better understand the sector's sustainability. The aim of this study was to assess the profitability of beekeeping through the analysis of selected economic and financial indicators and to estimate honey production costs for five beekeeping farms located in the Piedmont region over the period 2020–2024. Two complementary accounting tools were applied: (i) management accounting was used to determine net income and the remuneration of the main production factors, while (ii) cost accounting was employed to estimate the total cost incurred in producing one kilogram of honey. The results reveal a high degree of income variability and instability, both among different farms and within individual farms over time, with several cases of negative profitability. This outcome is particularly concerning, as the farms analysed are characterised by adequate structural conditions and professional managerial skills. Honey production costs also show substantial variability across case studies, both for retail and wholesale market channels. Overall, the findings suggest that external factors, particularly climatic conditions, exert a stronger influence on farm performance than managerial decisions, highlighting the complexity and vulnerability of the beekeeping sector.

Keywords: Beekeeping; Economic performance; Honey production costs; Retail market; Wholesale market.

Contractual terms for environmental sustainability in agri-food systems: dynamics and impacts. A systematic review

Paolo Emilio Bartolucci [1,2*], Angelo Frascarelli [1], Stefano Ciliberti [1]

[1] Department of Agricultural, Food and Environmental Sciences (DSA3), University of Perugia, Borgo XX Giugno 74, 06121 Perugia (PG), Italy
[2] Department of Economics, University of Perugia, Via Alessandro Pascoli 20, 06123 Perugia (PG), Italy

* *Corresponding author: Paolo Emilio Bartolucci (paoloemilio.bartolucci@dottorandi.unipg.it)*

Abstract. This study consists in a systematic review aiming to shed lights on the relationship between production contracts and environmental sustainability in agri-food value chains. While contracts have been extensively analysed with respect to income stabilisation, productivity, and risk sharing, empirical evidence on environmental impacts and dynamics and related conceptualisation remain scattered. To address this gap, the study applies the PRISMA methodology to identify, screen, and synthesise evidence on how contractual arrangements influence environmental outcomes or the adoption of environmentally sustainable practices. The review, based on 75 selected papers, covers a broad range of geographical contexts, with a strong concentration of studies in Southern-East Asia, Africa, and Continental Europe, and spans multiple agri-food sectors, including cereals, rice, maize, livestock, horticulture, and perennial crops. Theoretical frameworks range across multiple perspectives, mainly Neo-Institutional Economics, Transaction Cost Economics and contract governance, complemented also by relational and system-transition perspectives, like trust-knowledge dynamics, socio-technical and innovation systems, inclusion and welfare frameworks and contract-design/choice-theory approaches. Also, selected studies employ different methodological approaches, including econometric counterfactual analyses, discrete choice experiments, and qualitative case studies. Through a thematic analysis we highlight that production contracts can support environmental sustainability including explicit clauses or terms, related to technical assistance, monitoring mechanisms, or incentives aligned with sustainable practices. Conversely, evidence also points to risks of environmental degradation in contexts where contracts prioritise intensification, specialisation, or cost minimisation without ecological constraints. Overall, the review reveals substantial heterogeneity in conceptualisation and empirical outcomes, driven by contract design, governance structures, crop characteristics, and local institutional contexts. The paper concludes by identifying key evidence and gaps related to contract design and outlining implications for future research and tailored policy actions.

Keywords: Contracts; Environment; sustainability; agri-food; PRISMA.

Mapping challenges in viticulture through an economic lens: insights from a systematic review

Beatrice Bedin *, Leonardo Cei, Luca Rossetto

Department of Land Environment, Agriculture and Forestry, University of Padova, 35122 Padova, Italy

* *Corresponding author: Beatrice Bedin (beatrice.bedin@phd.unipd.it)*

Abstract. The global wine industry is undergoing profound transformations driven by environmental, economic, and social dynamics, requiring adaptation to preserve sustainability, resilience, and competitiveness. Despite growing attention to these issues, literature remains fragmented. This study aims to systematically identify and organize the key challenges facing future viticulture. The study is based on a systematic review following the PRISMA protocol. The search string was designed to capture studies addressing the economic and market-related dimensions of challenges affecting viticulture to give an economic perspective. The final dataset of 4.336 papers includes full-text, English-language articles addressing past, current, or future challenges in viticulture, with a global perspective and no restriction on publication year. Both qualitative, quantitative, and mixed-methods studies were included, as well as review articles. Article selection followed a screening process based on titles, abstracts, and keywords, in order to ensure consistency with the research question. The final 160 papers were then used to identify the main challenge areas through a qualitative content analysis on papers' objectives, methods, and key findings. The results identify five main challenge areas: i) climate change and environmental risks; ii) market pressures, economic crises, and competitiveness; iii) evolving consumer demand and preferences; iv) institutional and regulatory constraints; v) resilience strategies through innovation and production practices. A sixth area, sustainability, emerges as a transversal area that interacts with all other areas. The findings highlight three main gaps: the absence of integrated frameworks capturing interactions among multiple challenges, limited understanding of decision-making under uncertainty, and no consensus on key future challenges. From a research perspective, future studies should move beyond single-issue analyses and adopt integrated frameworks that better reflect real-world decision-making under multiple challenges. From a policy perspective, there is the need for policy instruments that support resilient strategies along the wine supply chain.

Keywords: Wine industry; Future challenges; Resilience; Economic competitiveness; Sustainability.

Wild edible plants as biocultural heritage: biodiversity and food traditions in Puglia (Italy)

Dalila Bellomo *, Adriano Didonna, Pietro Santamaria, Massimiliano Renna

Department of Soil, Plant and Food Sciences, University of Bari Aldo Moro, Via G. Amendola 165/A, 70126, Bari, Italy

* *Corresponding author: Dalila Bellomo (dalila.bellomo@uniba.it)*

Abstract. This study explores the relationship between agrobiodiversity and traditional cuisine in Puglia (Southern Italy), focusing on wild edible plants (WEPs), defined as edible spontaneous species growing without human cultivation. An analysis of 376 Traditional Agri-Food Products (TAPs) of Puglia reveals that about 25% include at least one WEP, either as a main ingredient or as a traditional component, with 39 species belonging to 18 botanical families. The most frequently represented species are *Foeniculum vulgare* Mill., *Capparis spinosa* L., *Origanum vulgare* L., and *Mentha* spp. TAPs containing WEPs mainly belonged to vegetable-based, gastronomic, and bakery product categories. A questionnaire administered to 303 respondents supported the cultural relevance of WEPs, highlighting *Cichorium intybus* L., *Diplotaxis erucoides* (L.) DC., *Asparagus acutifolius* L., *Sonchus* spp., and *Foeniculum vulgare* Mill. as the best-known species. Some WEPs appear to be deeply embedded in local food traditions, whereas their gathering and direct use were more prevalent among rural residents. Overall, this study highlights the strong link between biodiversity, cultural heritage, and food traditions, and shows how foods once considered subsistence foods are now being rediscovered, underscoring the importance of integrating folk knowledge with institutional catalogues to better represent the agri-food heritage specific to a given territory.

Keywords: WEP; Traditional agri-food products; Ethnobotany; Agrobiodiversity.

Farm-scale water balance modelling to improve irrigation strategies

Alessandro Beltramo [1,*], Carlo Grignani [1], Mattia Racco[1], Alessio Fariello[1], Ornela Yoana Cavalieri[1], Laura Zavattaro [2], Francesco Ferrero [1]

[1] Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco, Italy
[2] Department of Veterinary Sciences (DSV) - University of Turin, Largo P. Braccini 2, 10095 Grugliasco, Italy
* *Corresponding author: Alessandro Beltramo (alessandro.beltramo@unito.it)*

Abstract. In recent years, increasing water scarcity has created challenging conditions for the agricultural sector, affecting both water availability and quality. Since agriculture is the largest water consumer and is highly vulnerable during droughts, efficient irrigation strategies are essential. In Italy, traditional surface irrigation remains widely used in plain areas for cereals, forage and fodder crops, due to its low cost, established territorial structures and ability to deliver large water volumes quickly. Aiming to increase the resilience of the agricultural sector to the effects of climate change, the European Project MountResilience focuses on developing an irrigation DSS for farmers that could analyse diverse scenarios of water availability and irrigation systems and propose better irrigation strategies. For the project purpose, a study area was identified in the southern Piedmont Region plain (Cuneo province), and 16 maize and grassland fields were selected. These fields were irrigated using a variety of practices including the classic surface irrigation and the pivot system. Information on the cultivation technique and irrigation strategies of the last 5 years were collected. Data were used to validate a newly-developed DSS based on an improved water balance calculation that allows comparison among the selected farms in terms of irrigation type, soil characteristics, location, and crop management, as well as comparisons across different years within the same farm. The model simulates the trend of the soil water content (SWC) all year round, providing as a result an estimate of the percolated water that contributes to the groundwater recharge. Overall, the integration of water balance modeling within a decision support system represents a promising tool to enhance adaptive irrigation management and strengthen the resilience of agricultural systems facing increasing water scarcity.

Keywords: Water; Model; DSS; Aquifer; Irrigation.

Systemic *Brenneria goodwinii* in symptomatic and asymptomatic holm oaks in Salento: Insights into acute oak decline

Alessandro Bene *, Guido Piraino, Letizia Portaccio, Marzia Vergine, Luigi De Bellis, Andrea Luvisi

Department of Biological and Environmental Sciences and Technologies, University of Salento, 73100 Lecce, Italy

* *Corresponding author: Alessandro Bene (alessandro.bene@unisalento.it)*

Abstract. Acute Oak Decline (AOD) is a complex disease typically associated with a bacterial consortium, often linked to insect activity and cortical tissue damage. Recent studies in Mediterranean oak forests of the Salento Peninsula (southern Italy) have confirmed the presence of these bacteria in declining stands. However, the structure of the bacterial consortium associated with AOD symptoms in this region remains poorly defined, particularly in relation to asymptomatic trees. In this study, we report the recurrent detection of *Brenneria goodwinii*, *Gibbsiella quercinecans*, and *Rhanella victoriana* in association with AOD-like contexts across four oak forests dominated by Quercus ilex (L.). Bacterial detection was performed on cortical tissues, exudates, insect galleries, and canopy twigs in both older (>20 years) and younger (<20 years) trees, including symptomatic and asymptomatic individuals. *B. goodwinii* was more frequently detected in canopy twigs (about 38%) than in cortical tissues (about 16%), whereas *G. quercinecans* and *R. victoriana* occurred at lower frequencies across tissues (around 10%). The higher prevalence of *B. goodwinii* in the canopy suggests possible systemic bacterial colonization, indicating its presence even in tissues distant from putative initial inoculation sites or visible symptoms. Moreover, both asymptomatic younger and older trees frequently harbored one, two, or all three bacterial species, highlighting critical challenges for disease monitoring and management. These findings underscore the importance of considering bacterial systematicity within the trees and asymptomatic hosts in early AOD diagnosis, as symptom-based surveys alone may fail to identify potentially at-risk trees. This study provides novel insights into bacterial colonization dynamics in *Q. ilex* and informs strategies for monitoring and managing forest health in Mediterranean oak ecosystems.

Keywords: Acute Oak Decline; *Brenneria goodwinii*; bacterial consortium; *Quercus ilex*.

Comparative analysis of different carriage systems in cable yarding

Federico Bertone *, Marco Manzone

Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy

* *Corresponding author: Federico Bertone (federico.bertone@unito.it)*

Abstract. Timber extraction in mountainous areas characterized by steep terrain represents one of the most critical phases of forest operations, both in terms of operator safety and operational efficiency. In such conditions, cable yarder systems are widely adopted as an effective technical solution. Although several studies have examined the productivity of cable yarders, direct comparisons among different carriage types under standardized operating conditions remain limited. This study analyzes the performance and fuel consumption of three different types of carriages used in forest cable yarder operations: automatic, motorized, and self-propelled. The automatic carriage was evaluated under two different operational configurations: trailer-mounted and truck-mounted. The motorized carriage was employed in combination with a cable winch, while the self-propelled carriage was employed with a truck mounted yarder. The study was carried out for 300 work cycles for each configuration. The average delay-free work cycle ranged between 239.4 s and 370.7 s, while the productivity ranged between 10.2 t PMH^{-1} and 15.7 t PMH^{-1}. The best overall performance was achieved by the motorized carriage, which consistently showed shorter cycle times and higher productivity. On average, productivity decreased by approximately 0.075 t PMH^{-1} per additional meter of extraction distance. The self-propelled carriage showed the best performance at short extraction distances, with the shortest cycle times and highest productivity up to approximately 130 m, whereas its efficiency declined markedly at longer distances. Fuel consumption varied substantially among carriage types and work configurations. Despite the operation of two internal combustion engines (one powering the winch and one mounted on the carriage), the motorized system showed competitive specific fuel consumption values (0.94 l t^{-1}), reflecting its higher productivity. Overall, fuel consumption ranged between 6.5 and 17.8 l h^{-1}, corresponding to specific fuel consumption values between 0.65 and 1.41 l t^{-1}.

Keywords: Cable yarder; Logging; Timber extraction; Carriage.

Safeguarding and valorising agricultural biodiversity through the registration of amateur varieties: A critical analysis

Silvia Bitritto *, Adriano Didonna, Angelo Signore, Massimiliano Renna, Pietro Santamaria

Department of Soil, Plant and Food Sciences, University of Bari Aldo Moro, Via Giovanni Amendola, 165/a, 70126, Bari.

* *Corresponding author: Silvia Bitritto (silvia.bitritto@uniba.it)*

Abstract. The growing global market demand for standardised, high-yielding plant varieties has led to a progressive impoverishment of agricultural biodiversity in recent decades. This trend towards genetic homogenisation has been exacerbated by strict regulatory frameworks governing seed circulation. In particular, the implementation of DUS (Distinctness, Uniformity, and Stability) criteria for registration in the European Common Catalogue (CC) of varieties of vegetable species has acted as a catalyst for genetic erosion, marginalising traditional landraces that do not meet uniformity standards. In response to this phenomenon, European Union introduced two derogation regimes with Directive 98/95/EC – the conservation variety (CVs) and the variety of no commercial interest (AVs) – to facilitate *in situ* conservation and allow the marketing of traditional varieties or varieties adapted to local conditions. In Europe, 1,284 AVs are recognised, accounting for approximately 5.50% of the varieties of vegetable species registered in the CC. The country with the most AVs is France, with 23.1% of European AVs, followed by Germany (20.2%) and the Netherlands (13.6%). Italy, which alongside Spain is a leading European producer of vegetables, ranks seventh in this list with 72 AVs – the majority of these (approximately 40%) are tomato varieties (*Solanum lycopersicum* L.) – registered by 16 maintainers. The analysis reported that approximately 80% of the AVs registered in Italy are F1 hybrids, with only one in five varieties attributable to traditional landraces. Furthermore, approximately 40% of Italian AVs are registered by maintainers with registered offices abroad (Israel, Spain, Japan). Although the AVs regime has achieved greater success than the CVs regime in terms of the number of registered varieties and represents a valuable tool for protecting and disseminating traditional landraces, it is still used only to a limited extent by a few international competitors and should be more widely exploited in Italy to safeguard local horticultural biodiversity.

Keywords: Genetic erosion; Agrobiodiversity; Landraces; Seed legislation; Agroecology.

Two years of forest monitoring before and after prescribed fire: physiological responses from dendrometer measurements

Alessandro Bizzarri [1,*], Valerio Giorgio Muzzini [2], Lorenzo Procino [1], Alessio Giovannelli [2], Claudia Cocozza [1]

[1] Department of Agriculture, Food, Environment and Forestry (DAGRI), University of Florence, via San Bonaventura 13, 50145 Florence, Italy
[2] Research Institute on Terrestrial Ecosystems (IRET), National Research Council (CNR), Via Madonna del Piano 10, 50019 Sesto Fiorentino, Italy

* *Corresponding author: Alessandro Bizzarri (alessandro.bizzarri@unifi.it)*

Abstract. The vulnerability of Mediterranean ecosystems is increasing due to climate change. In this context, the rising intensity and frequency of forest fires pose a significant risk to biodiversity and ecosystem health. Additionally, evaluating tree behaviour and survival following a wildfire is often hindered by the challenge of quickly detect irreversible physiological damage. To bridge this gap, this project focused on evaluating the effects of prescribed fire on tree growth and health in *Pinus pinaster* with the goal of underlying fire-related stress mechanisms responses. The study was conducted in Tuscany (Italy) over two growing seasons (2024-2025). We employed fifteen custom-built Arduino-based point dendrometers to continuously track stem diameter variations, a key proxy for water use and growth in trees. The experiment entailed using prescribed fire at different intensities to simulate a realistic stressor. Our monitoring effectively detected subtle changes in tree physiology, stem water relation and growth, that traditional visual assessment overlook, either totally or partially. These data offer a detailed perspective on how fire-related stress changes stem growth dynamics, enabling the exploration of early warning signals for tree decline (latent mortality), especially when combined with other analysis and tools. The approach is crucial for improving understanding of post-fire physiological responses through Nature-Based Solution (NBS), moreover setting the possibility of predicting tree physiological damages, and, consequently, the latent mortality.

Keywords: *Pinus pinaster*; Prescribed fire; Point dendrometer; Fire-related stress; Ecophysiology.

Acknowledgements: This project was funded by National Recovery and Resilience Plan (NRRP), Mission 4, Component C2, Investment 1.1 - Call for tender No. 1409 of 14 September 2022- 'Progetti di Ricerca di Rilevante interesse Nazionale – PRIN' of Italian Ministry of University and Research funded by the European Union – NextGenerationEU; Grant N° P2022Z5742, CUP B53D23023780001.

Phosphorus solubilization in livestock waste: enhancing nutrient recovery and reducing nutrient losses from soil

Alice Boarino *, Martina Friuli, Giovanni Barbera, Andrea Palermi, Elio Dinuccio, Maria Martin, Michela Schiavon, Daniel Said Pullicino, Luisella Celi

Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy

* *Corresponding author: Alice Boarino (alice.boarino@unito.it)*

Abstract. Livestock-derived amendments can enhance soil organic carbon stocks and reduce reliance on synthetic mineral fertilizers, but their nutrient ratios often poorly match crop demand. This can cause nitrogen (N) and phosphorus (P) surpluses and increase the risk of nutrient losses to water and the atmosphere via nitrate leaching, ammonia volatilization, nitrous oxide emissions, and phosphorus runoff. This study addresses these challenges by improving the nutrient balance of livestock-based fertilizers and enhancing synchronization between nutrient supply and crop uptake. In regions with intensive livestock production, cattle slurry is commonly anaerobically digested for biogas generation, yielding a digestate that is mechanically separated into an N-rich liquid fraction and a P-rich solid fraction, further intensifying nutrient imbalances relative to crop requirements. Herein, to overcome this limitation, cattle slurry was pre-treated using combined physical and enzymatic hydrolysis prior to anaerobic digestion. This pre-treatment enhanced phosphorus solubilization and transfer from the solid to the liquid fraction, enabling efficient recovery of ammonium and phosphate as struvite, a slow-release fertilizer, while optimizing the N:P ratio of the remaining solid fraction for crop nutrition. The achieved products were evaluated in a greenhouse experiment for the growth of *Lolium multiflorum* Lam. in two soils differing in texture and pH. The trial compared conventional mineral fertilization with partial or full substitution using untreated or pre-treated digestate solid fractions and recovered struvite. Results showed that nutrient-balanced solid digestate could fully replace mineral N and P fertilizers, while struvite reduced mineral N inputs and completely substituted mineral P. This strategy showed significant mitigation of nutrient losses via leaching, runoff and gaseous emissions from agricultural soils, with performance dependent on soil properties.

Keywords: Anaerobic digestion; Enzymatic pre-treatments; Struvite; *Lolium multiflorum* Lam.; Gas emission.

Acknowledgements: This work was financed by the European Union´s Horizon Europe research and innovation programme for the ECONUTRI project (Grant Agreement 101081858).

Sensory evolution of white wines cv. Favorita produced with sustainable alternatives to sulphur dioxide

Micaela Boido [1,*], Anastasiia Kasianova [1], Giorgia Botta [1], Negin Seif Zadeh [1], Beatrice Cordero [1], Gaetano Pio Liscio [1], Simone Giacosa [1,2], Luca Rolle [1,2], Maria Alessandra Paissoni [1,2], Susana Río Segade [1,2]

[1] Department of Agricultural, Forest, and Food Sciences, University of Torino, Corso Enotria 2/C, 12051 Alba, Italy
[2] Interdepartmental Centre for Grapevines and Wine Sciences, University of Torino, Corso Enotria 2/C, 12051 Alba, Italy

* *Corresponding author: Micaela Boido (micaela.boido@unito.it)*

Abstract. The use of innovative and eco-friendly products as alternatives to sulphur dioxide (SO_2) in wine production is of growing interest in oenological sustainability. The impact of these products on the sensory characteristics of wines over time represents one of the main research topics of the WiSSaTech project. Five oenological products were compared with a control without additions (NAG) and one added with SO_2 during the vinification of *Vitis vinifera* cv. 'Favorita' (syn. 'Vermentino'): acacia (AC) and grape seed (VIN) tannins, bio-protection (*Metschnikowia pulcherrima* and *Torulaspora delbrueckii*, BIO), gall tannin (GAL) and yeast derivatives rich in glutathione (GLU). Sensory analysis was conducted by a trained panel using Just About Right (JAR) scale to assess the perception of absence of faults (0), oxidative (+5) or reductive (-5) aromas at bottling, after six months of bottle storage, and after an accelerated aging treatment. Additionally, wines were evaluated using descriptive analysis (DA) with unstructured scales to assess colour hue (*green–yellow–gold*), in-mouth sensations (*bitterness*, *astringency*, *acidity*), and aroma attributes (*citrus*, *yellow-pulp fruit*, *pineapple*, *green apple*, *pear*, and *rose*). Instrumental colour, total polyphenols, and antioxidant capacity were determined. At bottling, SO_2-treated wines were perceived as more reductive (with higher *pineapple* intensity), while wines with procyanidin tannins (AC and VIN) showed a tendency toward oxidation, a trend confirmed with the accelerated aging. After six months in bottle, AC, NAG, and SO_2 samples exhibited higher oxidative scores, whereas BIO and GLU wines were characterized by negative scores (reductive profile), maintaining *pineapple* intensity similar to SO_2. Procyanidin tannins consistently showed the highest colour hue, shifting toward *gold* regardless of aging time. These results highlight that certain oenological products can sustainably replace SO_2 in preserving wine sensory quality.

Keywords: Sensory analysis; Antioxidant capacity; Oenological tannins; Bio-protection; Glutathione.

Acknowledgements: The study was funded by MUR and European Union Next-GenerationEU under PRIN PNRR 2022 M4C2-I 1.1 (Project P2022LXY3A).

Are farmers' markets really competitive? Participation, certification and market evolution

Riccardo Bregolin [2,3,*], Andrea Fantini [4], Francesca Monticone [4], Cristiana Peano [1,3]

[1] Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy
[2] Department of Earth Sciences (DST) – University of Turin, Via Valperga Caluso 35, 10124 Torino, Italy
[3] Interdepartmental Center for Research and Technical Scientific Cooperation with Africa (CISAO) – University of Turin, Via Valperga Caluso 35, 10124 Torino, Italy
[4] Department of Agricultural and Food Sciences – University of Bologna, viale Fanin 50, 40127 Bologna, Italy
* *Corresponding author: Riccardo Bregolin (riccardo.bregolin@unito.it)*

Abstract. The evolution of markets under globalisation has reshaped notions of competitiveness, innovation and market legitimacy within agri-food systems. While conventional markets tend to emphasise scale, standardisation and price competition, farmers' markets have emerged as alternative spaces that propose different competitive logics. However, their position in relation to global markets and their capacity to compete with conventional agri-food channels remains an open question. This contribution explores how farmers' markets engage with evolving market dynamics by comparing two participatory initiatives operating in distinct institutional and socio-political contexts. The first case is a certified farmers' market in the city of Cochabamba, Bolivia, operating through a Participatory Guarantee System (PGS) called ECO-FERIA. The second case is *Campi Aperti*, a network of farmers and co-producers in Bologna (Italy) that is organising six farmers' market in the city. By choice, they do not adhere to formal organic certification schemes while they adopt participatory forms of governance, such as PGS, co-design processes and direct producer-consumer relationships. The comparison focuses on how these initiatives construct competitiveness in relation to conventional markets, examining elements such as governance structures, validation mechanisms, innovation in organisational practices and forms of value creation beyond price-based competition. In the Bolivian case, attention is given to how the PGS supports market recognition and interaction with broader institutional and commercial circuits. In the Italian case, the emphasis is on the rejection of certification as part of an alternative approach to competitiveness, grounded in trust, participation and social embeddedness. By situating these experiences within broader processes of market evolution, the contribution reflects on how farmers' markets experiment with innovative competitive strategies that coexist with, adapt to, or diverge from dominant global market models, raising broader questions about plural forms of competitiveness in contemporary agri-food systems.

Keywords: Farmers' markets; Competitiveness; Participatory guarantee system; governance.

Characterization of traditional sheep meat salami: valorizing a Tuscan agro-food heritage within the Mediterranean Diet

Carlotta Breschi [1], Silvia Parrini [1,*], Chiara Aquilani [1], Francesco Sirtori [1], Lina Fernanda Pulido Rodriguez [1], Martina Cirlini [2], Leandra Leto [2], Gianni Galaverna [2], Carolina Pugliese [1]

[1] Department of Agriculture, Food, Environment and Forestry (DAGRI) – University of Florence, Piazzale delle Cascine 18, 50144 Florence (FI), Italy
[2] Dipartimento di Scienze degli Alimenti e del Farmaco – Università di Parma, Parco Area delle Scienze 49/A, 43124 Parma, Italy

* *Corresponding author: Silvia Parrini (silvia.parrini@unifi.it)*

Abstract. Within the framework of the PRIMA project 'MoreMedDiet - More on the adoption of a healthy Mediterranean diet', this study focuses on the valorization of sheep meat, a resource deeply rooted in Mediterranean tradition but currently underutilized in the modern food chain. The research aims to address the current knowledge gaps by providing a comprehensive physico-chemical characterization of a traditional sheep meat salami, officially recognized as a Traditional Agri-food Product (PAT) by the Tuscany Region. Three independent batches were produced using a sheep meet base with 30% pork fat. Weight loss was monitored weekly, while sampling and analyses were performed at three time points: after production, and after 21 and 28 days of a controlled curing period. The study evaluated key quality parameters, including microbiological safety, weight loss, and water activity (aw). Furthermore, the nutritional and technological profile was defined through the salinity, the analysis of dry matter, lipid and protein content, the characterization of the fatty acid profile, and the determination of volatile organic compounds. Additionally, color (CIELab) and textural properties were assessed via Texture Profile Analysis (TPA). Results provide a detailed overview of the traditional salami's ripening dynamics and its final quality attributes. The samples proved to be microbiologically stable, meeting safety standards. After the ripening period of 28 days, the salami exhibited a weight loss of ~50%, consistent with the high dry matter content recorded. The TPA revealed a significant increase in hardness during ripening, which is likely a consequence of the substantial water loss. Furthermore, colorimetric analysis showed consistent and reproducible internal and external color profiles across the different batches at the specific ripening time, indicating high process stability. Finally, by defining the quality of traditional sheep salami, this study represents a first step toward the valorization of Mediterranean by-products as sheep cured products.

Keywords: Mediterranean diet; Sheep meat salami; Traditional agri-food product; Quality profile.

MoreMedDiet project: Increasing awareness and adherence to the Mediterranean diet

Elena Buonafede [1,*], Carlotta Breschi [2], Cristiana Giordano [1], Carla Benelli [1], Raffaella Petruccelli [1], Chiara Aquilani [2], Francesco Sirtori [2], Silvia Parrini [2]

[1] Institute of BioEconomy (IBE) – National Research Council (CNR), via Madonna del Piano 10, 50019 Sesto Fiorentino, Firenze (FI), Italy
[2] Department of Agriculture, Food, Environmental, and Forestry Sciences and Technologies (DAGRI) – University of Florence, Piazzale delle Casine 18, 50144 Firenze (FI), Italy

* *Corresponding author: Elena Buonafede (elenabuonafede@cnr.it)*

Abstract. The Mediterranean Diet (MD) is a true lifestyle rooted in the Mediterranean area, rather than just a series of notions. The MoreMedDiet project addresses the increasing divergence between Mediterranean populations and the Mediterranean Diet: contemporary dietary trends show a preference for exotic foods and quicker solutions for their daily meals. However, the MD is a successful choice: it is proved to help in preventing many non-communicable diseases, and prioritize local and seasonal product, also promoting environmental sustainability. Funded under the European PRIMA program, MoreMedDiet – *More on the Adoption of a Healthy Mediterranean Diet* - part of the European program PRIMA, involves twelve partners across the Mediterranean (Spain, Portugal, Italy, France, Egypt, Tunisia, and Turkey). The project aims to enhance MD adherence through an integrated approach combining social sciences, food technology, and digitalization. The project adopts a Living Lab method to analyse the determinants of consumer behavior (socio-economic, educational, and cultural barriers/motivations) across consortium countries. Co-creation is the core of the project: people have been engaged in all the phases necessary to create the recipes. Through multi-stakeholder co-design involving different generational cohorts (youth, adults, and seniors), 10 preliminary formulations will be developed, leading to the final selection of 5 authentic MD recipes. In addition, these recipes will be valorised with local and traditional varieties and enriched with bioactive compounds from by-products of the agri-food industry, seaweed, medicinal plants, and microbial source. Extracts will be obtained through environmentally friendly techniques (e.g., HDD). A dissemination campaign is also ongoing in the countries participating in the project, with workshops, congresses, and even consultations with policymakers. To date, MoreMedDiet has enabled the collection of critical data to inform future evidence-based policies, market-ready functional recipes, and innovative business models tailored to the Mediterranean context.

Keywords: Mediterranean Diet; Co-creation; Food choice; Local varieties; Bioactive compounds.

Development of new indices for tracking olive ripening stages

Lorenzo Bruchi *, G. Angeloni, A. Spadi, M. Pignatone, F. Corti, C. Vizzo, A. Parenti, P. Masella

Department of Agricultural, Food, Environmental and Forestry Sciences and Technologies (DAGRI) – University of Florence, Piazzale delle Cascine, 18 — 50144 Florence (FI), Italy

* *Corresponding author: Lorenzo Bruchi (lorenzo.bruchi@unifi.it)*

Abstract. Monitoring olive ripening is a fundamental factor for defining the harvesting window and, consequently, for maximizing extraction yield and oil quality. The procedure most commonly adopted relies on visual indices (e.g., the Jaén index) combined with a limited set of physicochemical parameters; however, standard approaches already explored in the literature may be insufficient to capture the multidimensional nature of olive ripening and to screen candidate indicators that remain informative under variable operational and experimental settings (e.g., season, cultivar, acquisition conditions). In this study, we evaluated the ripening of Moraiolo olives across four stages (M1-M4), with three replicates per stage (n=12), integrating traditional quality markers such as (e.g., polyphenols, sugars, paste pH) and potentially innovative descriptors, including CO_2 and ethanol released by the drupes, paste potential difference and vegetation-water pH. Data were screened using dual-threshold ANOVA ($\alpha = 0.05$, $\alpha = 0.10$). This exploratory, hypothesis-generating screening framework, was adopted to ensure that potentially informative variables were not prematurely discarded. Subsequently, PCA was applied to 14 parameters selected to reduce redundancy: the analysis showed consistent separation among sampling times, and some candidate innovative variables exhibited moderate-to-high component loadings ($\approx$ 0.5–0.8), indicating a non-marginal contribution to time discrimination. The first principal component (PC1) explained approximately 50% of the total variance and was interpreted as the main direction of ripening-associated variation within the explored dataset. Overall, PC1 serves as a robust multivariate ripening index, providing a more comprehensive assessment of maturity than the Jaén score alone. While these results highlight the potential of innovative physiological markers for precision harvesting, further validation on independent seasons/cultivars and under broader acquisition conditions is required before general adoption.

Keywords: Harvest timing; Oil quality; Maturity index; Innovative parameters; Multivariate ripening index.

Diaporthe amygdali, the causal agent of TCSB: a multidisciplinary approach for an eco-friendly control of the pathogen

Federico Brugneti [1,*], Antonella Cardacino [1], Marco Cirilli [2], Angelo Mazzaglia [1], Silvia Turco [1]

[1] Dipartimento di Scienze Agrarie e Forestali, Università degli Studi della Tuscia, 01100 Viterbo, Italy
[2] Dipartimento di Scienze Agrarie ed Ambientali, Università degli Studi di Milano, 20133 Milano, Italy

* *Corresponding author: Federico Brugneti (federico.brugneti@unitus.it)*

Abstract. The progressive reduction of active substances and the transition toward more sustainable agricultural practices are posing new challenges for the phytosanitary management of peach. Among emerging threats, twig canker and shoot blight (TCSB), caused by *Diaporthe amygdali*, has recently re-emerged with significant production losses, particularly in the Emilia-Romagna region. This study adopted a different approach combining plant pathology, molecular biology, and biocontrol. Following morphological and molecular analyses of *D. amygadali* from symptomatic peach twigs, the entire genome of the pathogen was sequenced using a hybrid approach and assembled to identify virulence-associated genes and putative effectors involved in pathogenicity, including the fusicoccin biosynthetic gene cluster. These data provide a basis for molecularly precise control strategies based on the production of double-stranded RNA (dsRNA) molecules capable of silencing target genes and reducing pathogen virulence. Susceptibility tests were conducted on 95 commercial and experimental peach genotypes artificially inoculated with *D. amygdali*. The identification of tolerant and less susceptible genotypes provides a valuable resource for breeding programs aimed at developing resistant varieties. To investigate the role of the plant-associated microbiome in modulating disease tolerance and susceptibility, metagenomic analyses were performed on three peach cultivars exhibiting contrasting responses to TCSB (Catherina, Pavoro 1605, and LAMI.COM). Tolerance-associated microbial communities were detected in Catherina, whereas *D. amygdali* was prevalent in Pavoro 1605, consistent with its higher susceptibility. Several *Trichoderma* species showed promising antagonistic activity against *D. amygdali* in vitro compared with commercial fungicides. The integration of resistance breeding, RNAi-based approaches, and biological control represents a promising pathway toward sustainable and durable TCSB management, enhancing the resilience of peach production systems.

Keywords: Diaporthe amygdali; Molecular characterization; Plant pathogens; Plant pathology.

Beyond the plate: environmental hotspots and sustainability pathways in a pasta supply chain

Lorenzo Brunetti [1,*], Alice Varaldo [1], Giovanna Giacalone [1], Cristiana Peano [1], Francesco Sottile [2]

[1] Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy
[2] Department of Architecture – University of Palermo, Viale delle Scienze, Ed. 14, 90128, Palermo (PA), Italy

* *Corresponding author: Lorenzo Brunetti (l.brunetti@unito.it)*

Abstract. Food systems are complex systems whose capacity to influence multiple dimensions has increased over time. Although they have the potential to promote human health and support environmental sustainability, they currently risk acting negatively on both. Within this context, the pasta supply chain is widely recognized as playing a relevant role. This centrality is further amplified when contextualized within the Mediterranean region, where wheat represents a staple crop in the diet. Consequently, there is currently considerable attention toward the environmental impacts of the pasta supply chain. Building on this awareness, this study aimed to assess the environmental performance associated with the different stages of pasta production in the Italian Mediterranean context, to identify the main impact hotspots and outline potential improvement solutions. To this end, a Life Cycle Assessment (LCA) was conducted on a pasta producer located in Southern Italy, using a "cradle-to-gate" approach and covering the stages from cultivation to the finished product. The results suggest that the cultivation phase is the main contributor across all the impact categories analysed. Furthermore, it was observed that the management of crop residues through incorporation into the soil may contribute positively to the environmental performance of the entire wheat production cycle. In conclusion, the study highlights that improvement interventions implemented at the field level could significantly affect both the environmental sustainability and the productive efficiency of the entire pasta supply chain.

Keywords: Environmental sustainability; Life cycle assessment; Food system; Pasta supply chain.

An empirical study on the motivations and impacts of adopting a forest certification scheme: The case of PEFC Italy

Stefano Bruzzese [1,*], Simone Blanc [2], Antonio Galati [3], Valeria Borsellino [3], Claudio Mirabella [3], Antonio Brunori [4], Filippo Brun [2]

[1] Department of Veterinary Sciences (DSV) - University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy
[2] Department of Agricultural, Forest and Food Sciences (DISAFA) - University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy
[3] Department of Agricultural, Food and Forest Sciences - Università degli Studi di Palermo, Viale delle Scienze Building 4, 90128 Palermo (PA), Italy
[4] Programme for the Endorsement of Forest Certification (PEFC) Schemes, Via Pietro Cestellini, 17, 06135 Perugia (PG), Italy

* *Corresponding author: Stefano Bruzzese (stefano.bruzzese@unito.it)*

Abstract. Forest certification is a market-based instrument that helps protect forest resources from threats such as deforestation while simultaneously differentiating products derived from sustainably managed forests from other competitive goods. The Programme for the Endorsement of Forest Certification (PEFC) is one of the most widely recognised international forest certification schemes. In this context, this study investigates the motivations driving the Italian forest industry to adopt the PEFC scheme and the impacts resulting from its adoption. To this end, a questionnaire was administered to PEFC-certified companies between November 2022 and March 2023, collecting 236 valid responses. The results show that intrinsic beliefs and values represent the main motivational drivers in the pre-adoption phase, whereas in the post-adoption phase the most significant impacts concern staff environmental awareness and corporate image. Moreover, there was a strong alignment between pre-adoption expectations and the outcomes achieved after adoption, demonstrating how PEFC acts as a signalling tool to the market for those who adopt it. This study provides useful guidelines for companies seeking to adopt a sustainable business approach through forest certification.

Keywords: Forestry Certification; Market-based Mechanism; Motivational Levers; Principal Component Analysis; Importance-Performance Analysis.

Lessons learned on consumer awareness and willingness to pay a premium for blockchain-traced forest products

Stefano Bruzzese [1,*], Simone Blanc [2], Corrado Costa [3], Simona Violino [3], Andrea Rosario Proto [4], Filippo Brun [2]

[1] Department of Veterinary Sciences (DSV) - University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy
[2] Department of Agricultural, Forest and Food Sciences (DISAFA) - University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy
[3] Consiglio per la Ricerca in Agricoltura e l'Analisi dell'Economia Agraria (CREA) - Research Centre for Engineering and Agro-Food Processing, Via della Pascolare 16, 00015 Monterotondo (RM), Italy
[4] Department of Agraria - Mediterranean University of Reggio Calabria, Feo di Vito, 89122 Reggio Calabria (RC), Italy
* *Corresponding author: Stefano Bruzzese (stefano.bruzzese@unito.it)*

Abstract. Supply chain traceability often faces challenges related to transparency, quality control, and product sustainability due to the complexity of production processes. Blockchain technologies, owing to their features such as data immutability, transparency, distributed networks, and programmability, have the potential to address these challenges. In this context, consumer awareness of blockchain technologies and their willingness to pay (WTP) a price premium for a forest product traced through a blockchain-based traceability system were investigated. To this end, a questionnaire was administered to a sample of forest nurseries nationwide between August 2021 and May 2023, collecting 259 valid responses. Subsequently, three ordered logit models were developed for the attributes under investigation, namely "origin", "quality", and "sustainability". The results show that 62.6% of respondents are not familiar with blockchain technologies; however, 71.4% of those who have heard of them recognise their usefulness as a traceability system. Regarding WTP, respondents prefer to pay a higher price premium for the "quality" attribute, although "origin" is the attribute that most strongly influences WTP. Education emerged as the most influential sociodemographic factor, followed by gender, age, and household size. In conclusion, the study highlights the key elements on which nurseries should focus when developing marketing and communication strategies to promote the adoption of blockchain-based traceability systems.

Keywords: Forestry Nurseries; Infotracing; Distributed Systems; Consumer Demand; Econometric Models.

Seasonal saltwater intrusion and implications for soil and irrigation water quality along the Lazio Coast

Roxana Burbulea *, Chiara Marchina, Paolo Tarolli

Department of Land, Environment, Agriculture and Forestry, University of Padua, Viale dell'Università 16 - 35020 Legnaro, Italy

* *Corresponding author: Roxana Burbulea (roxana.burbulea@unipd.it)*

Abstract. The stress from saltwater intrusion is emerging as a critical factor for agricultural systems in coastal plains, where the availability of freshwater is most compromised by marine influence. Along the Lazio coast, the Tiber River represents a strategic but vulnerable water source for irrigation, particularly during periods of high agricultural demand. This study investigates the temporal evolution and spatial extent of salinization affecting both agricultural soils and surface waters in the area surrounding the Tiber River mouth. An initial monitoring phase was conducted during the 2024 agricultural season through monthly sampling of soils and surface waters. Measurements focused on electrical conductivity (EC), used as a key indicator of salinity. The 2024 results revealed a clear seasonal pattern, with salinity levels increasing during the summer. EC values frequently exceeded 2 dS/m, which represents the threshold defined by the FAO beyond which negative impacts on crop growth and yields are expected. Building on these results, monitoring activities were expanded in 2025 to better identify salinity propagation. Water analyses were extended along the Tiber River, from the mouth to the confluence with the irrigation canal. This expanded monitoring strategy proved effective, enabling the collection of continuous datasets and revealing prolonged periods characterized by EC values far exceeding the FAO threshold. The new soil and water samples collected in 2025 were specifically analysed to quantify electrical conductivity and assess the interaction between the use of saline water and soil salinization processes. Field observations were integrated with laboratory leaching tests and chemical analyses of major ions to evaluate salt mobilization from soils into water. The results underscore the urgency of mitigation and adaptation strategies, including better water management and the adoption of more salt-tolerant crop species, to reduce salinity-related risks and enhance the resilience of coastal agriculture along the Lazio coast.

Keywords: SeawaterIntrusion; TiberRiver; Electrical conductivity; Soil salinization; Coastal agriculture.

Effects of microplastics, digestate, and antibiotics on the microbiome of two distinct soil types following six months of antibiotic incubation

Enrico Buscaroli [1,*], Andrea Ciurli [1], Federico Correa [1], Luciano Cavani [1], Ilaria Braschi [1], Daniela Pezzolla [2], Diana Luise [1]

[1] Department of Agricultural and Food Sciences, University of Bologna, Italy
[2] Department of Civil and Environmental Engineering, University of Perugia, Italy

* *Corresponding author: Enrico Buscaroli (enrico.buscaroli2@unibo.it)*

Abstract. Anthropogenic pressures such as organic amendments, antibiotic inputs, and emerging contaminants like microplastics may alter soil microbial community structure and functioning. Microplastics have been shown to interact with soil microorganisms through several mechanisms, while biowastes byproducts are increasingly applied to agricultural soils despite uncertainties regarding their ecological impacts. This study aimed to disentangle the combined effects of microplastics, digestate, and antibiotics on soil microbial communities. In an incomplete factorial experiment, two contrasting soil types were added with microplastics (PE, PP, PS, PLA) alone or in presence of digestate. In parallel, an identicalset of treatments received a mixture of veterinary antibiotics, yielding a total of 12 treatments. After six-month incubation period, soil microbiomes were characterized by using shotgun metagenomics, and Community Level Physiological Profiling (CLPP). Alpha-diversity analyses revealed that the Shannon index was marginally influenced by digestate ($p < 0.1$). Beta-diversity patterns confirmed that soil type and antibiotic addition were the dominant drivers of community composition, whereas microplastics played minor roles ($p<0.1$). CLPP results demonstrated a strong inhibitory effect of antibiotics, causing a pronounced and non-selective reduction in microbial functional activity. Notably, in one soil type, microplastic addition partially mitigated the antibiotic-induced inhibition, suggesting a potential protective or buffering effect. Moreover, PerMANOVA underlined a significant ($p<0.05$) effect of microplastics addition in altering microbiota abundance and metabolism. These findings indicate that intrinsic soil properties largely govern microbial community responses to external stressors. Nevertheless, microplastics may have a role as microbial protector/reservoir, and exogenous “alien” carbon source can nudge microbiota composition or metabolism. This study provides novel insights into the combined impacts of antibiotics, biowaste amendments, and microplastics on soil microbiomes, with implications for soil microbiome eubiosis, environmental safety, and sustainable soil management practices.

Keywords: Soil microbiome; Microplastics; Veterinary antibiotics; Digestate (organic amendments).

Economic evaluation of the use of by-products in leavened baked goods

Federica Calderoni [1,*], Alessandro Petrontino [1,2], Francesco Di Cosola [1], Simona Carbone [1], Francesco Bozzo[1]

[1] Department of Soil, Plant, and Food Sciences, (Di.S.S.P.A) – University of Bari, via Giovanni Amendola 165/A, 70126 Bari (BA), Italy
[2] SINAGRI s.r.l., Spin off of the University of Bari Aldo Moro, Via Amendola 165/A, 70126 Bari, Italy
* *Corresponding author: Federica Calderoni (f.calderoni1@phd.uniba.it)*

Abstract. The valorization of agri-food by-products is a central challenge for the transition towards more sustainable and circular food systems. An increasing number of food companies are adopting circular economy solutions to innovate their production, differentiate their products through sustainability attributes, and enhance their nutritional and nutraceutical profiles. Within this framework, the study aims to integrate economic, microbiological, and food-technology expertise to enhance the valorisation of by-products generated during plant-based beverage production. In particular, almond okara, naturally rich in fibres, proteins, and bioactive compounds, is investigated as a promising ingredient to meet the growing consumer demand for healthier bakery products. The evaluation of the market potential of this bakery innovation follows a multi-stage approach. First, a market analysis is conducted through a hedonic price model (HPM) to identify how specific product attributes are evaluated in the current market. This is complemented by a Discrete Choice Experiment (DCE) aimed at eliciting consumers' willingness to pay (WTP) for innovative bakery products incorporating agri-food by-products. For the HPM stage, an extensive dataset of more than 1,000 products was collected from the Italian large-scale retail sector, covering eight bakery categories, including sliced bread, crackers, crostini, grissini, rusks, pucce, and flatbreads. The results of the HPM provide the empirical basis for selecting the attributes and levels to be included in the subsequent consumer preference study. Preliminary findings reveal heterogeneous price premiums across categories for attributes related to sustainability (e.g. organic, vegan claims), quality (e.g. origin of wheat, sourdough), and perceived innovation or nutritional enhancement (e.g. "rich in fiber", "high in protein", use of alternative flours, etc.). Overall, the integrated evidence is expected to inform both policy design, by supporting strategies for by-product valorization, and business decisions on pricing, positioning, and attribute selection for sustainable bakery innovations.

Keywords: Recycled food ingredients; Hedonic pricing model (HPM); Willingness to pay (WTP); Agricultural by-products; Leavened baked goods.

Do algorithms share our taste? Comparing AI and human food choices

Giovanbattista Califano *, Francesco Caracciolo

Department of Agricultural Sciences – University of Naples Federico II, Via Università 96, 80055 Portici (NA), Italy

* *Corresponding author: Giovanbattista Califano (giovanbattista.califano@unina.it)*

Abstract. Large language models (LLMs) are increasingly integrated into digital environments where consumers search for, compare, and evaluate food products. As these AI systems become embedded in recommendation platforms and shopping assistants, understanding whether they replicate human preference structures becomes critical for both consumer applications and research design. This study evaluates how GPT-based agents respond to structured food choice tasks compared with actual consumers. We replicated three discrete choice experiments originally conducted with human participants, exposing *GPT-4.1-nano* agents to the same choice scenarios. Both uninformed GPT agents and profile-informed agents (i.e., prompted to impersonate individual respondents) generated choices that were analysed using the same random utility framework applied to human data. Across studies, GPT consistently reproduced the qualitative direction of major effects, particularly for universal attributes such as price, organic certification, and sustainability claims. Correlations between predicted utilities were high (up to 0.84), indicating strong ordinal alignment. However, GPT utilities were systematically inflated and more deterministic, requiring substantial downscaling (≈0.3–0.4) to match human choice variability. Misalignments emerged for culturally embedded and experiential attributes, such as 3D-printing technology and the Italian SQNPI certification, where GPT underestimated or reversed human valuations. Profile-informed agents did not systematically improve alignment and occasionally increased distortions. Nonetheless, when GPT-derived parameters were used as priors in D-efficient design simulations, efficiency improved by 10–15% relative to uninformed priors after appropriate calibration. A comparison across eight commercial LLMs revealed high inter-model agreement and above-chance correspondence with human modal choices, suggesting that these patterns are not architecture-specific. Overall, LLMs can serve as useful synthetic agents for early-stage experimental design in agri-food research. However, their current limitations in sensory grounding and cultural contextualization hinder their ability to function as reliable decision support systems for consumer welfare and policy-relevant applications.

Keywords: Generative AI; Silicon samples; Consumer behaviour; Food marketing; Econometrics.

Beyond the field and towards the landscape. A multiscale approach to investigate the diversity of an agroecosystem

Fabrizio Cannizzaro [1,3,*], Riccardo Bregolin [2,3], Paolo Longo [1], Cristiana Peano [1,3]

[1] Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy
[2] Department of Earth Sciences (DST) – University of Turin, Via Valperga Caluso 35, 10124 Torino, Italy
[3] Interdepartmental Center for Research and Technical Scientific Cooperation with Africa (CISAO) – University of Turin, Via Valperga Caluso 35, 10124 Torino, Italy

* *Corresponding author: Fabrizio Cannizzaro (fabrizio.cannizzaro@unito.it)*

Abstract. Agroecosystems constitute an integral and structural component of many urban and rural landscapes. They are embedded within and contribute to the heterogeneity of territorial mosaics, which are characterised by the combination of natural, semi-natural, and artificial elements. Their management and composition therefore have direct implications for biodiversity, ecosystem services, and spatial organisation. Consequently, a detailed analysis of agroecosystems and their contextualisation within the reference territory enables a better understanding of the reciprocal interdependence between agroecosystems and territory. Despite this, a significant portion of the literature continues to privilege the analysis of agroecosystems at the field or farm scale. This contribution proposes an integrated reading of agroecosystems and their reference territories by analysing the diversity of their structure, components, and management practices. It presents a conceptual and methodological research effort that introduces an indicator-based framework for analysing agroecosystem diversity across a multilevel scale, from the field to the landscape. In particular, the landscape scale is assumed as a key level for the integrated study of (bio-)diversity, agricultural practices, ecosystem services, and territorial dynamics. This perspective is conceptualised through the degree of heterogeneity of both the landscape and the agroecosystem, determined by the combination of composition (diversity of habitats, ecosystems, and agroecosystems) and configuration (field density and size, as well as the type and distribution of natural and semi-natural elements). Overall, this research aims to contribute to a deeper understanding of agroecosystems by analysing them not merely as systems of food production, but as dynamic, complex, and diversified (eco-)systems whose primary distinguishing factor is the territory in which they are embedded.

Keywords: (bio-)diversity; (agro-)ecosystem; Landscape analysis; Multilevel scale approach; Indicator-based framework.

Lactic acid bacteria fermentation as a strategy to reduce mycotoxin levels in contaminated wheat

Simona Carbone [1,*], Giuseppe Perri [1], Federico Rametta [1], Lorenzo Ciraldo [1], Valentina Guarino [2], Claudia Sardella [2], Massimo Blandino [2], Carlo Giuseppe Rizzello [3], Erica Pontonio [1]

[1] Department of Soil, Plant and Food Sciences, University of Bari Aldo Moro, Via Amendola 165/A, 70126 Bari, Italy
[2] Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy
[3] Department of Environmental Biology, Sapienza University of Rome, 00185 Rome, Italy
* *Corresponding author: Simona Carbone (s.carbone12@phd.uniba.it)*

Abstract. Mycotoxins represent a major challenge in the cereal supply chain, as they frequently contaminate staple raw materials such as wheat and may enter the food chain at levels exceeding regulatory limits. Among them, deoxynivalenol (DON), a trichothecene mycotoxin produced by *Fusarium* spp., is widely distributed in cereals intended for human consumption. Conventional strategies to prevent or reduce mycotoxin contamination are often insufficient or incompatible with sustainable food processing, highlighting the need for alternative biotechnological approaches.
This study evaluated the effectiveness of lactic acid bacteria (LAB) fermentation in reducing DON levels in naturally contaminated wheat flour. Selected LAB strains with putative detoxifying properties were used to ferment flour samples under controlled conditions (dough yield 200, 30 °C, 48 h). DON concentrations were quantified by ELISA and confirmed by HPLC–MS/MS, which was also employed to assess the formation of potential degradation metabolites. In addition, the underlying detoxification mechanisms, enzymatic transformation and/or adsorption to microbial cell walls, were investigated. Fermentation resulted in a significant reduction of DON content (approximately 50%) compared to uninoculated controls ($p < 0.05$), with strain-dependent effects. *Lactiplantibacillus plantarum* 1A7 showed the highest detoxification efficiency, suggesting a major role of metabolic activity in DON reduction. Conversely, *Pediococcus pentosaceus* I76 significantly reduced DON even under non-fermentative conditions, indicating a mechanism mainly based on cellular adsorption. Overall, these findings demonstrate that both LAB metabolic activity and cell wall-mediated adsorption contribute to DON reduction, supporting the use of LAB as a sustainable strategy to mitigate mycotoxin contamination in wheat, with potential applications both as a biotechnological process and as a bio-based functional ingredient to enhance cereal safety.

Keywords: Mycotoxins; Deoxynivalenol; Lactic acid bacteria; Wheat fermentation; Food safety.

Public school catering as a driver for sustainable food systems: stakeholder engagement in the city of Rome

Martina Carbonetti *, Maria Teresa Cappella, Emanuele Blasi

Department for Innovation in Biological, Agri-Food and Forestry Systems (DIBAF) - University of Tuscia, Via S. Camillo de Lellis, snc, 01100 Viterbo (VT), Italy

* *Corresponding author: Martina Carbonetti (martina.carbonetti@unitus.it)*

Abstract. Public school catering and public procurement represent a strategic domain to promote more sustainable diets and healthier lifestyles. School canteens serve large volumes of food daily, which gives public authorities the possibility to influence food production patterns and encourage sustainable agricultural practices. Meanwhile, school meals play a crucial role in education: by familiarizing children with healthier food choices, they can develop more responsible eating behaviours in the future. This study explores how new environmentally sustainable food products, such as minor crops, can be introduced into public school catering systems. Achieving this objective requires structured collaboration among the various stakeholders involved in the school catering supply chain, to understand decision-making processes, the feasibility of menu adaptations and the potential involvement of local producers. In this context, Living Labs are adopted as a methodological framework to support co-creation and bridge the gap between research and real-life application. The case study focuses on the city of Rome, within the framework of the Euopean project "*CropCat – Upscaling minor crops with institutional catering*", which aims to develop cultivation of minor crops and the consumption in school canteens. In Rome, school catering service is organized through a centralized public procurement which poses specific challenges for integrating local and sustainable supply chains. The expected outcomes include the promotion of more sustainable food supply chains and the stimulation of environmentally sustainable agricultural production through a demand-driven approach. By involving local producers and integrating rewarding criteria for minor crops within public procurement tenders, public canteens can create stable demand and incentivize farmers to introduce these crops into their production systems. Key deliverables include stakeholder mapping, the organization of Living Labs, and the co-definition of a replicable Business Model Canvas, as well as engagement with families and children to assess the acceptance of minor crops in the new school menus.

Keywords: Sustainable food system; Living labs; Public school canteens; Stakeholder engagement Minor crops.

Yield stability under water deficit: the role of ear architecture in early and drought-tolerant maize hybrids

Andrea Carli *, Graziano Ghinassi, Leonardo Verdi, Anna Dalla Marta

Department of Agricultural, Food, Environmental and Forestry Sciences and Technologies, University of Florence, Piazzale delle Cascine, 18, 50144 Firenze (FI), Italy

* *Corresponding author: Andrea Carli (andrea.carli@unifi.it)*

Abstract. Among cereal crops, maize, which has high water requirements, is expected to be the most affected by climate change in Europe, making it necessary to develop appropriate strategies to improve water productivity (WP). In the 2025 season, a field experiment was conducted in Scarperia (FI) to evaluate four maize hybrids differing in drought tolerance (drought-tolerant, DT, and conventional) and maturity class (FAO 300 and 400) under three drip irrigation regimes (100%, 50%, and 0% ET_c). Grain yield, aboveground biomass, harvest index (HI), WP, detailed morphological characteristics of the ear and grain quality were evaluated. Grain yield was maintained with deficit irrigation (I_{50}), while under rainfed conditions it was reduced by an average of 22% in DT hybrids and 29% in conventional hybrids. Under severe water deficit conditions, the number of grains decreased by about 8% in DT hybrids compared to 27% in conventional hybrids, while ear volume was reduced by 6% and 29%, respectively. The weight of a thousand grains was relatively less sensitive to reduced irrigation, indicating that yield losses were mainly determined by the reduction in the number of grains rather than their mass. In all hybrids, WP increased with reduced irrigation compared to the control (I_{100}). Early maturing hybrids (FAO 300) were less affected by water stress than FAO 400 hybrids, maintaining a more stable grain yield and ear characteristics under non-irrigated growing conditions. These results indicate that drought tolerance and early phenology mitigate yield losses mainly through the preservation of ear architecture, highlighting the importance of integrating morphological characteristics of ears with conventional efficiency parameters in assessing maize adaptation to drought.

Keywords: Deficit drip irrigation; Drought tolerance; Phenotyping; Water use efficiency; Ear architecture.

Yield potential and mycotoxin contamination in wheat mutant lines with different amylose content

Fabio Carnovale [1,*], Claudia Sardella [1], Francesca Vanara [1], Valentina Scarpino [1], Arianna Frittelli [2], Francesco Sestili [2], Massimo Blandino [1]

[1] Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy
[2] Department of Agriculture and Forest Sciences, University of Tuscia, Viterbo, Italy

* *Corresponding author: Fabio Carnovale (fabio.carnovale@unito.it)*

Abstract. In recent years high-amylose wheats have gained significant interest due to their potential for developing healthier foods. Unlike conventional varieties, where amylose constitutes 20-30% of starch, high-amylose genotypes can contain up to 70-80% of this polymer. The primary benefit lies in the compact structure of amylose, which reduces its susceptibility to enzymatic digestion, increasing the content in derived baked food of resistant starch (RS), a type of dietary fibre, which contributes to reduce the postprandial glycaemic peak. While the health-promoting properties of high-amylose wheats are well documented, their agronomic behaviors and associated risks of contaminant accumulation remain largely unexplored. This limitation currently represents a key bottleneck for the sustainable integration of high-amylose wheat into cereal-based agri-food value chains. An open field experiment was carried out in 3 growing seasons and 2 sites in Northwest Italy, to verify the grain yield, disease susceptibility and the grain contamination of deoxynivalenol (DON) in a conventional genotype (cv. Cadenza) and its mutant lines with medium (MA) and high (HA) amylose content. The percentage of amylose relative to total starch was determined in wholegrain flours using Megazyme K-AMYL assay kit. On average, the HA genotypes had a content of amylose of 47% compared to 19% for the conventional one, without a clear effect of the environmental conditions (sites, year). DON quantification was achieved by means of a multi-mycotoxin LC-MS/MS analysis. HA mutant line showed higher DON values than its conventional counterpart (+22%). Overall, HA and MA genotypes exhibit a yield gap (-17%) driven by lower grain filling and test weight (-6%) and are more prone to mycotoxin contamination. Reducing this sanitary risk will depend on the identification of agronomic strategies and the implementation of targeted breeding efforts aimed at improving productivity and safety.

Keywords: High-amylose; wheat; mycotoxins; deoxynivalenol; Fusarium graminearum.

Acknowledgements: Research carried out within the Amylocer project (CUPD23C25000670001) founded by MASAF, Italy.

Agronomic and qualitative traits of high amylose maize hybrids for the dry-milling supply chain

Fabio Carnovale *, Claudia Sardella, Marco Laiolo, Raffaele Meloni, Mattia Scapino, Francesca Vanara, Massimo Blandino

Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy

* *Corresponding author: Fabio Carnovale (fabio.carnovale@unito.it)*

Abstract. Amylose is the linear component of starch, consisting of glucose chains, and accounts for approximately 20–30% of the total starch content in conventional maize; the remaining fraction is amylopectin, with a branched structure. Beyond the starch industry, food supply chains have shown increasing interest in ingredients obtained from milling high-amylose (HA) maize genotypes, characterized by amylose contents ranging from 40 to 70%. The incorporation of maize ingredients with elevated amylose levels can enhance the resistant starch content of derived products, which is associated with a reduced postprandial glycemic response and others benefits. Literature reports that increasing amylose content in HA maize breeding is associated with greater susceptibility to biotic and abiotic stresses, a higher yield gap, and lower milling yield. Therefore, breeding programs are currently developing novel HA hybrids tailored for the food supply chain to mitigate these limitations. Field experiments were established during the 2025 growing season at three locations in North-West Italy to compare five HA hybrids with conventional genotypes used in dry-milling industry. Three pre-commercial hybrids showed higher amylose contents (50–60% of total starch) than currently commercial HA genotypes (40–48%). Grain yield didn't differ significantly among HA hybrids; however, they exhibited an average yield gap of 36% compared with a conventional hybrid and over 55% relative to a high-yielding genotype (i.e., short stature genotype). HA hybrids showed lower early vigour, with higher post-emergence damping-off and barren plants at maturity. Regarding quality traits, HA genotypes displayed higher total antioxidant capacity, but lower test weight and dry-milling extraction yield, while showing a lower incidence of ear rot and mycotoxin contamination than conventional hybrids. Future research should focus on targeted breeding and optimized cropping systems to reduce agronomic and quality constraints and improve HA maize profitability.

Keywords: High-amylose; Corn; Yield; Crop strategies.

Acknowledgements: Research carried out within the Healthychain project (Regione Piemonte, CUP D79I25000140006).

Digital sustainability readiness index (DSRI): Challenges and perspectives for the future

Francesco Pio Carrozzino *, Carmine Santoro

Department of Economics, Management and Quantitative Methods (DEMM) – University of Sannio, Via delle Puglie 82, 82100 Benevento, Italy.

* *Corresponding author: Francesco Pio Carrozzino (f.carrozzino@studenti.unisannio.it)*

Abstract. The digital transformation of agricultural and rural systems is widely recognised as a strategic lever for competitiveness and sustainability. Yet rural areas continue to face structural asymmetries in infrastructure, skills, and institutional capacity that limit the effective integration of digital technologies and weaken their ability to respond to green transition challenges. Agricultural economics literature highlights that digitalisation in rural contexts is embedded in socio-institutional ecosystems rather than being purely technological. However, while digital divide frameworks measure access and usage gaps, and sustainability indicators assess outcomes, limited attention has been paid to the structural readiness required to align digitalisation with sustainable agricultural transition. This paper develops a conceptual framework for a Digital Sustainability Readiness Index (DSRI) aimed at assessing the preparedness of rural and agricultural systems to integrate digital technologies in ways that support environmental sustainability, socio-economic resilience, and generational renewal. The approach shifts from deficit-based measurement toward a capacity-oriented perspective. The DSRI follows established principles of composite indicator construction: conceptual coherence, transparent normalisation, and robustness analysis. It is structured around four interrelated dimensions:

- Technological readiness, capturing broadband coverage, connectivity quality, and access to digital infrastructures;
- Digital human capital, reflecting farmers' digital skills, training, and generational turnover;
- Sustainability-oriented digital adoption, measuring the diffusion of precision agriculture, resource-efficiency tools, and data-driven environmental practices;
- Institutional and governance readiness, assessing local policy capacity, coordination mechanisms, and support for digital–green innovation.

Grounded in sustainability transition theory and institutional economics, readiness is conceptualised as a structural precondition for transformative rural trajectories. The DSRI is expected to identify structural bottlenecks in the digital–green transition and to inform policy design within the Common Agricultural Policy and cohesion strategies. By measuring readiness rather than performance alone, the index offers forward-looking perspectives for sustainable innovation and the future of agricultural sciences.

Keywords: Digital sustainability readiness; Rural digital transformation; Sustainable agricultural transition; Composite indicators.

Mapping natural forest expansion following land abandonment in the Gran Paradiso national park

Simona Cavallo [1,*], Nicolò Anselmetto [1], Simone Ferrero [1], Fabio Meloni [1], Andrea Mainetti [2], Matteo Garbarino [1]

[1] Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy
[2] Biodiversity Service and Scientific Research, Gran Paradiso National Park, Frazione Valnontey 44, 11012 Cogne (AO), Italy

* *Corresponding author: Simona Cavallo (s.cavallo@unito.it)*

Abstract. Land abandonment is reshaping Alpine ecosystems by triggering natural forest expansion in former open areas traditionally managed as pastures, meadows, or croplands through agro-pastoral activities. These newly established secondary forests are complex ecosystems that modify the provision of ecosystem services and pose new management challenges. Our study aims to map and characterise post-abandonment natural forest expansion in the Gran Paradiso National Park by integrating remote sensing and field data. Land cover change was analysed using aerial and satellite imagery for five time steps (1954, 1975, 1991, 2005, and 2022), allowing the identification and dating of newly established secondary forests and their land-use legacies. Within these areas, field surveys were conducted to assess species composition and forest structure, soil cover, and evidence of past traditional activities. This integrated approach allowed us to test two hypotheses: (i) natural reforestation driven by gap filling responds more rapidly to depopulation than treeline shift, and (ii) land-use legacies (year of abandonment, former land use, past traditional activities, marginality) exert a stronger influence on forest structure and composition than environmental filters (climate, topography, soil characteristics). Between 1954 and 2022, forest expansion led to almost a doubling of total forest area, with dense forest cover increasing by 11%. Forest dynamics were significantly associated with depopulation trends, highlighting the close link between demographic change and landscape transformation in mountain ecosystems. Mapping and characterising post-abandonment secondary forests provides a spatial and ecological basis for interpreting ongoing forest dynamics and supporting adaptive management strategies in protected mountain areas.

Keywords: Forest expansion; Land abandonment; Land-use change; Protected areas; Remote sensing.

Valorizing residual powder from the cork stopper industry: chemical fingerprinting and sustainable valuation of cork extractives

Paola Cetera [1,*], Maria Giovanna Canu [2], Marco Biagioli [2]

[1] Department of Land, Environment, Agriculture and Forestry (TeSAF) – University of Padua, Viale dell'Università 16, 35020 Legnaro (PD), Italy
[2] Department of Agricultural Sciences – University of Sassari – UniNuoro, Via Colombo 1 Loc. Sa Terra Mala, 08100 Nuoro (NU), Italy

* *Corresponding author: Paola Cetera (paola.cetera@unipd.it)*

Abstract. The cork stopper industry generates substantial amounts of residual powder during cutting, drilling, and finishing operations. Although commonly treated as low-value waste, this by-product represents a potentially rich source of bioactive compounds. In the framework of circular bioeconomy strategies, its chemical characterization and valorization are of increasing industrial and environmental interest. This study investigates the chemical fingerprint of extractives obtained from residual cork powder derived from industrial processing of cork stoppers produced from *Quercus suber* L. The powdered material was subjected to solvent extraction under controlled conditions in order to recover the extractive fraction. Extraction yield was determined gravimetrically, while the chemical profile was assessed through spectrophotometric determination of total phenolic content, total flavonoids, and condensed tannins. The compositional variability of the extractives was evaluated to identify compounds of potential nutraceutical relevance. Results indicate that residual cork powder retains a significant fraction of bioactive secondary metabolites, particularly phenolic compounds known for antioxidant properties. The chemical fingerprint demonstrates that industrial processing does not substantially deplete the extractive pool, highlighting the suitability of this by-product as a source of high-value phytochemicals. Variability in composition suggests that extraction parameters and raw material quality play a critical role in optimizing recovery efficiency. These findings support the sustainable valorization of cork stopper industry residues through the recovery of bioactive extractives for potential nutraceutical applications. The proposed approach contributes to waste minimization, resource efficiency, and added value generation within the cork production chain, aligning with circular economy principles and promoting the integrated exploitation of Mediterranean forest resources.

Keywords: *Quercus suber* L.; Cork, Extractives, Mediterranean wood species.

Harnessing non-*Saccharomyces* diversity for low-ethanol wines: Framework validation under modern enological conditions

Margherita Chiarini [1], Francesco Maria Calabrese [1,*], Annalisa De Boni [1], Audrey Bloem [2], Carole Camarasa [2], Irene De Guidi [2], Maria De Angelis [1]

[1] Department of Soil, Plant and Food Science (DiSSPA), University of Bari "Aldo Moro", Bari, Italy
[2] SPO, Univ Montpellier, INRAE, Institut Agro, Montpellier, France

* *Corresponding author: Francesco Maria Calabrese (francesco.calabrese@uniba.it)*

Abstract. The growing demand for wines with reduced ethanol content and improved sensory complexity has renewed interest in mixed fermentations involving non-*Saccharomyces* (NS) and *Saccharomyces cerevisiae* (Sc) yeasts. The objective of this work is to evaluate the contributions of NS yeasts to enological fermentation within the context of climate change. Evaluating physiological, molecular, and metabolic events in these processes requires precise and sensitive measurements of growth dynamics, inoculation timing, and sampling methods. Our structured experimental framework aims to characterize sequential fermentations, emphasizing the validation of single exponential NS growth before scale-up. Eleven NS strains and one Sc control are evaluated in a synthetic low-malic must, an artificial grape juice formulated to meet modern winemaking requirements under evolving climatic conditions. The design comprises two preliminary phases. First, growth kinetics are assessed at the microplate scale using optical density of 600 nanometers (OD_{600}) to identify reproducible exponential growth. Concurrently, flow cytometry is used to assess population changes and standardize inoculum concentrations. These parameters are then validated in 300 mL fermenters to optimize sampling and sequential inoculation timing. The primary experiment is conducted in automated robotic fermenters, comparing single NS fermentations with sequential NS-Sc fermentations in triplicate. Downstream analyses monitor changes in microbial populations and assess gene expression using droplet digital polymerase chain reaction (ddPCR). Carbon metabolites are quantified by high-performance liquid chromatography (HPLC), and volatile compounds are identified by gas chromatography-mass spectrometry (GC-MS). Integrated data analysis correlates microbial dynamics, gene expression, and metabolic and aroma profiles. Finally, selected NS–Sc strain combinations undergo transcriptomic analysis to elucidate strain-specific interactions and metabolic responses. Overall, this scalable and reproducible framework improves the interpretation of sequential fermentations, supporting microbiological strategies to reduce ethanol content while preserving wine quality and providing a basis for future life cycle assessment (LCA) of their environmental sustainability.

Keywords: non-*Saccharomyces* yeasts; Sequential fermentation; Low malic synthetic must; Climate change; Fermentation kinetics.

Optimization of biotechnological processes for the valorization of food by-products: oat okara and tomato peels

Lorenzo Ciraldo [1,*], Elisabetta Zupa [2], Marco Montemurro [2], Anna Rita Bavaro [2], Federico Rametta [1], Simona Carbone [1], Giuseppe Perri [1], Erica Pontonio [1]

[1] Department of the Soil, Plant and Food Sciences (DiSSPA), University of Bari Aldo Moro, Via Amendola, 165/a, Bari, I-70126, Italy
[2] Institute of Sciences of Food Production (ISPA), National Research Council (CNR), Via G. Amendola 122/O, 70126, Bari, Italy

* *Corresponding author: Lorenzo Ciraldo (lorenzo.ciraldo@uniba.it)*

Abstract. The implementation of biotechnological processes for the valorization of by-products derived from agri-food processing enables the conversion of these residues into value-added products. This study aimed to investigate the biotechnological potential of two by-products: oat and tomato okara powders (OBP and TBP). These matrices, processed through upcycling approaches, were selected for their high content of dietary fiber (22.7 and 62.7 g/100 g in OBP and TBP, respectively), proteins (43.3 and 12.1 g/100 g in OBP and TBP, respectively), and bioactive compounds (such as β-glucans and lycopene). The adopted approach, based on spontaneous fermentation followed by isolation and characterization of dominant microbial strains, enabled the identification of populations naturally adapted to these matrices and capable of playing an active role in fermentation processes. Microbiological analysis showed that both matrices represent favorable environments for the development of lactic acid bacteria and yeasts. The isolated strains were identified by MALDI-TOF SIRIUS analysis. The results highlighted a predominance of bacterial populations in both matrices (>8 log CFU/g). In particular, strains of *Weissella confusa* and *Weissella cibaria* were able to ferment both OBP (PMR1, Pm8, P24MR4, and P24m8) and TBP (A24MR2, A24m3, and A24m7). In addition, *Pediococcus pentosaceus* (A24MR3) was able to ferment OBP. Controlled fermentations confirmed good growth and substrate acidification capacity, suggesting the pro-technological traits of the isolated strains and their potential application as starter cultures in sustainable fermentation processes. In parallel, β-glucan quantification confirmed the richness of OBP in bioactive soluble fibers, supporting its possible use as a high-value functional ingredient. Overall, this study provides an initial insight into the biotechnological potential of oat and tomato okara powders, representing a starting point for further studies focused on process optimization and the evaluation of their application in food systems.

Keywords: Upcycling; Oat okara; Tomato okara; Lactic acid bacteria; Fermentation.

Exploring sourdoughs microbial communities to develop novel biotechnological strategies for the bakery industry

Federica Violetta Conti *

Department of Environmental Biology – University of Rome "La Sapienza", P.zz Aldo Moro 5, 00185 Roma (RM), Italy

* *Corresponding author: Federica Violetta Conti (violetta.conti@uniroma1.it)*

Abstract. The establishment and maintenance of a mature and stable sourdough community are primarily driven by, among others, propagation time and temperature, ingredient used and bakery environment, which all together create ecological conditions that support starter persistence. In this study, the microbial communities of five different type-I sourdoughs, each originating from the same dough but propagated in different facilities of the same company, were investigated. The main biochemical and microbial parameters were evaluated to highlight potential differences among samples. All five sourdoughs showed a similar pH, while total titratable acidity ranged from 13 to 16 mL. Indeed, while lactic acid concentration was on average 12 mmol/kg, acetic acid concentrations ranged from 1.9 to 3.2 mmol/kg. The contribution of fermentation to proteolysis was also assessed by quantifying free amino acids which ranged from 502 to 837 mg/kg. Both culture-dependent and -independent analyses were performed. Viable yeasts:lactic acid bacteria ratio varied from 1:1 to 1:100. Isolation of dominant and subdominant species yielded a total of 658 isolates (399 bacteria and 259 yeasts), with *Fructilactobacillus sanfranciscensis* and *Maudiozyma humilis* identified as the main representatives, respectively. A more in-depth evaluation of the microbial communities, assessed through Illumina MiSeq platform, revealed 230 species across the five sourdoughs, of which 82 were identified as core taxa present in all samples. Moreover, the KEGG database was used to reconstruct which species possess the enzymes necessary for the main sourdough metabolic pathways. Based on meta-omics data collected so far, a synthetic microbial community will be assembled to recreate the features shared by all five sourdoughs, thereby ensuring stability and technological performances in an industrial bakery context. While industrial sourdoughs are often highly simplified to ensure process standardization; approach that may compromise microbial diversity and functionality. However, this study lays the groundwork to preserve microbial complexity without sacrificing process reliability.

Keywords: Sourdough; Microbiota; Fermentation; Synthetic communities.

Application of EPR spectroscopy for quality and shelf-life assessments in extra virgin olive oil production

Ferdinando Corti [1,*], Agnese Spadi [1], Giulia Angeloni [1], Piernicola Masella [1], Lorenzo Bruchi [1], Cristiano Vizzo [1], Matteo Pignatone [1], Alessandro Parenti [1], Michele Segantini [2]

[1] Dipartimento di Scienze e Tecnologie Agrarie, Alimentari, Ambientali e Forestali (DAGRI) - Università degli Studi di Firenze Piazzale delle Cascine 18, 50144, Firenze, Italy
[2] Helmholtz-Zentrum Berlin für Materialien und Energie, Hahn-Meitner-Platz 1, 14109 Berlin, Germany

* *Corresponding author: Ferdinando Corti (ferdinando.corti@unifi.it)*

Abstract. In edible oils and lipid-based products, oxidative stability is a key parameter for assessing both the quality of the fresh product and its shelf-life. During the virgin olive oil processing and storage, many oxidative parameters or indexes are commonly monitored and controlled for processing optimization and predictive analysis of stability, since they are strongly affected by several factors, e.g. temperature, light, exposure to oxygen and metal ions. Electron paramagnetic resonance (EPR) spectroscopy coupled with spin trapping techniques, is an emerging methodology for the reliable determination of the oxidative stability of oils and other foods, by measuring the rate of formation of free radical species on few mg of sample under high-temperature conditions, or other oxidative stresses. The EPR signal is inversely related to the capability of the sample to resist to oxidative stress and, in general, its increase can be slowed by the presence of antioxidants. Unlike the most common analytical methods that rely on the detection of secondary oxidation products, EPR quantifies primary oxidation compounds in the propagation phase, trapping them by specific added reagents (spin traps), which stabilize highly reactive species and make them detectable by the instrument. In order to accelerate the development of new miniaturized EPR-tools and promote the introduction of cheaper and easy-to-use devices for the rapid analysis of olive oil batches in the production, it is necessary to demonstrate the benefits of this technology in predicting resistance to oxidative degradation, with reference to conventional analytical procedures, including official methods. A series of analysis using conventional EPR were performed on different olive oil batches, before monitoring their physico-chemical and sensory evolution during the storage. The tests served as a preliminary step for investigate the application of comparative EPR spectra as a tool for estimating relative differences in the shelf-life evolution of different oils.

Keywords: Extra virgin olive oil; Shelf-life; Oxidative stability; Free radicals; Analytical technique.

Assessing the sustainability of dairy supply chains: alineation between consumer perceptions and production realities

Chiara Costamagna [1,*], Giulia Mastromonaco [1], Emanuela Vassallo [2], Valentina Maria Merlino [1], Paolo Cornale [1], Davide Biagini [1], Danielle Borra [1]

[1] Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy
[2] Independent Researchers, Via Vivaro 21/B, 12051 Alba, Italy

* *Corresponding author: Chiara Costamagna (c.costamagna@unito.it)*

Abstract. Issues concerning sustainability across its three dimensions – social, environmental and economic – have become key factors in consumer decisions within agri-food supply chains, including those for dairy products. Consequently, farms face growing pressure to adopt practices that comply with increasingly stringent sustainability standards. Understanding consumer expectations and assessing the sustainability of farm performance are therefore essential for developing effective strategies to promote supply chains. To this end, a survey was conducted among consumers and farmers involved in three small, PDO-certified dairy producers in Piedmont, north-west Italy: Murazzano PDO, Roccaverano PDO and Ossolano PDO. The questionnaire, completed by 170 consumers, was structured into two sections: 1) the socio-demographic characteristics of the respondent, and 2) the perceived importance of selected sustainability issues, measured on a 7-point Likert scale and grouped into the three sustainability dimensions. In parallel, indicators based on the same issues included in the consumer questionnaire were developed to assess the sustainability performance of nine farms across the three supply chains. Firstly, consumer survey data were analysed using the Combination of Uniform and Shifted Binomial (CUB) model. This generated two factors relating to the perceived importance of each sustainability issue: feeling and uncertainty. These dimensions were then compared with farm performance data using importance–performance analysis (IPA). The results indicate that, for the vast majority of social sustainability issues, farms practices are aligned with consumer preferences. However, farms are lacking in terms of the environmental sustainability of certain production practices, that consumers consider highly important. Finally, with regards to economic sustainability, farm performance varies widely across sustainability levels, and consumers generally perceive this dimension as less important, with a certain degree of uncertainty. The results therefore highlight the need to define issues-specific marketing strategies for each selected sustainability topic.

Keywords: Consumer preferences; Marketing strategies; Sustainability indicators; Integrated evaluation.

Lamb meat consumption in Piedmont: Comparative analysis of market supply and consumer demand

Chiara Costamagna [1,*], Valentina Maria Merlino [1], Danielle Borra [1], Stefano Massaglia [1], Carmine Giuseppe Gullì [2], Roberto Senatore [1], Antonio Mimosi [1], Paolo Cornale [1]

[1] Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy
[2] Independent researcher

* *Corresponding author: Chiara Costamagna (c.costamagna@unito.it)*

Abstract. Understanding the potential impact of consumer demand on products available on the market is crucial to describing the evolution of lamb consumption. In particular, sheep meat sector is currently experiencing a constant decline in both production and sales volume. Given this, in order to describe the state of the sector in the limited area of Piedmont, the aim of our study is to identify the preferences of lamb consumers and whether these are reflected in the range of products available in large-scale retail chains. Piedmontese consumers were interviewed using a questionnaire structured in two sections relating to: a) socio-demographic characteristics of the interviewee and b) preferences regarding the defining attributes of lamb meat, analysing them using the Best-Worst Scaling methodology. Based on the attributes investigated in the consumer research, a survey was conducted in various large retail stores. The label of lamb-based products was analysed to verify the information provided. Specifically, for individual attributes, the presence or absence was indicated and the differences were reported. The results show a partial mismatch between consumer preferences and product supply. In fact, the availability of products in the LSR tends to increase during the holidays, but, on the contrary, consumer demand has no seasonal link. However, the wide variety of products in terms of origin and variety of cuts is in accordance with consumer preferences. The comparative approach has therefore highlighted critical issues in the supply of lamb meat and allows for the planning of appropriate marketing strategies to compensate for the decline in consumption.

Keywords: Consumer behaviour; Sheep supply chain; Large-scale retail; Choice analysis.

The "pet-effect" in meat consumption: how emotional bonds with companion animals mediate perceptions of rabbit farming

Chiara Costamagna [1,*], Valentina Maria Merlino [1], Giulia Mastromonaco [1], Antonina Sparacino [1], Marco Cullere [2], Antonella Dalle Zotte [2], Jatziri Mota Gutierrez [3], Cecilia Mugnai [3], Claudio Forte [3], Simone Blanc [1]

[1] Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy
[2] Department of Animal Medicine, Production and Health - MAPS, University of Padova, Viale dell'Università 16, 35020 Legnaro, Padova, Italy

[3] Department of Veterinary Sciences (DSV) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy

* *Corresponding author: Chiara Costamagna (c.costamagna@unito.it)*

Abstract. In the current European context, particularly in Italy, the role of rabbit is progressively shifting from farm animal to pet. The ambivalence of this role, together with growing awareness of animal welfare and sustainability and other market-related constraints, is strongly influencing rabbit consumption, limiting it mainly to areas with a long culinary tradition of this product. Consequently, this study seeks to investigate this phenomenon further, specifically examining the extent to which consumers' perceptions of rabbit meat are mediated by their attitudes toward companion animals. The survey was therefore structured through a questionnaire divided into three sections concerning: a) the socio-demographic characteristics of the respondent and information relating to pet ownership (specifically, the degree of emotional attachment to their pet); b) opinions on housing systems, respect for animal welfare and sustainability in rabbit farming system; and c) acceptance of different approaches to rabbit production (pet, laboratory, fur production, meat production). The variables relating to emotional response and information in the second and third sections, measured using a 7-point Likert scale, were processed using correlation analysis. The results showed that high emotional involvement with their pet significantly influences individuals' perceptions of the housing system, the sustainability of the farm and the acceptability of the role of rabbit. In general, respondents with close emotional attachment to their pets disagree with rabbit farming systems that use cages, and do not accept the role of rabbit as fur and laboratory animal. However, as consumers of rabbit meat, they accept that these animals are used for meat production, thus accepting this role under certain conditions. The need to design appropriate and effective marketing strategies to align the rabbit farming supply chain with consumer sensibilities is therefore highlighted.

Keywords: Consumer behaviour; Emotional perception; Rabbit farming systems; Pets.

Melatonin and serotonin differentially modulate growth, metabolism and antioxidant responses of lettuce under salinity stress

Rita Criscuolo [1,2,*], Leilei Zhang [1], Luigi Lucini [1]

[1] Department for Sustainable Food Process, Università Cattolica del Sacro Cuore, Piacenza, Italy
[2] Department of Science, Technology and Society, Scuola Universitaria Superiore IUSS Pavia, Palazzo del Broletto, Piazza della Vittoria, 15, Pavia, Italy

* *Corresponding author: Rita Criscuolo (rita.criscuolo@unicatt.it)*

Abstract. Soil salinization reduces global agricultural productivity each year by impairing plant growth and metabolic function. While melatonin (N-acetyl-5-methoxytryptamine; MLT) is known to be an effective regulator of plant growth and development in response to abiotic stress, the role of serotonin (5-hydroxytryptamine; SER) in mitigating abiotic stress remains comparatively underexplored. The present study investigates, under both non-stress and salt-stress conditions (NaCl, 150 mM), the effect of MLT (100 µM), SER (100 µM), and their combinations (MLT+SER) on lettuce (*Lactuca sativa* L.) under hydroponic conditions. Exogenous treatments were applied four times over nine days, beginning at the onset of salinity stress. Specifically, we assessed plant morphological traits (shoot and root fresh weight) and key physiological parameters, including photosynthetic performance, chlorophyll content, and relative water content. In addition, ionomic profiling was performed to determine how the treatments influenced plant nutrient accumulation and homeostasis. Finally, untargeted metabolomics was employed to characterize plant metabolic responses and to explore potential hormone cross-talk underlying the observed physiological effects. Results revealed a positive role of SER in plant growth in both shoots and roots, as well as in photosynthetic performance, particularly under stress conditions. In contrast, MLT exerted a markedly stronger antioxidant effect, significantly reducing ROS accumulation, as indicated by oxidative marker quantification (e.g., H_2O_2 and MDA) when applied alone or in combination. The metabolite profile revealed that the three treatments (MLT, SER, MLT+SER) under both control and salinity conditions modulated secondary metabolite accumulation in leaves and roots, primarily affecting isoprenoids, phenylpropanoids, and polyketides. Moreover, AMOPLS-DA revealed that the interaction between stressor and treatment is found to have a more significant effect in the individual treatment as mitigator. These results laid the groundwork for future studies on the use of serotonin to enhance plant tolerance to salinity stress.

Keywords: Salt stress; Melatonin; Serotonin; Hormone cross-talk; Hydroponic.

Effects of alternate wetting and drying (AWD) on driving factors controlling CH_4 emissions from rice paddy soils

Lucia Crosetto [1]*, Steven Sleutel [2], Daniel Said-Pullicino [1]

[1] Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy
[2] Faculty of Bioscience Engineering, Ghent University - Belgium

* *Corresponding author: Lucia Crosetto (lucia.crosetto@unito.it)*

Abstract. Alternate Wetting and Drying (AWD) is a water-saving irrigation technique adopted in rice systems to reduce methane (CH_4) emissions. However, mitigation outcomes remain variable, suggesting that the effectiveness of AWD depends on how soil characteristics and residue management influence microbial activity and redox conditions. We hypothesize that AWD-induced microbial and redox dynamics generate hysteresis in CH_4 emissions, modulated by soil texture and residue incorporation depth. A mesocosm experiment was conducted using two soils of contrasting textures (coarse and fine) and two crop residue incorporation depths (shallow: 0–10 cm; deep: 20–30 cm). Following an initial continuous flooding period, two AWD cycles were implemented, lowering and raising the water table. During these cycles, CH_4 fluxes and $\delta^{13}C$-CH_4, soil redox potential at multiple depths, and porewater chemistry were monitored. Results suggest an asymmetric CH_4 response to drainage and reflooding phases, consistent with a hysteresis effect. Redox potential increased during drainage, suppressing methanogenesis and partially enhancing CH_4 oxidation. However, emission reductions varied across treatments. Deeper straw incorporation (20–30 cm) resulted in higher CH_4 emissions during drainage phases when the water table dropped below –10 cm, compared to shallower incorporation. This suggests that under dry conditions, anoxic microsites at depth, enriched in labile organic carbon, can maintain active methanogenesis, while reduced water-filled pore connectivity may hinder oxygen penetration and CH_4 oxidation. Moreover, isotopic analyses ($\delta^{13}C$-CH_4) aim to distinguish the contributions of microbial and physical processes and transport mechanisms to the fluxes. The results highlight the importance of vertical interactions between redox conditions and carbon availability in determining CH_4 responses to AWD. While AWD can mitigate, its effectiveness may be sensitive to residue management and soil physical properties. This study contributes to a process-level understanding of CH_4 dynamics under AWD and informs strategies to optimize its implementation for climate mitigation in rice systems.

Keywords: Alternate wetting and drying; Methane emissions; Redox dynamics; Soil texture; Residue incorporation depth.

Understanding methane emission dynamics in temperate rice fields through systematic review and statistical modelling

Lucia Crosetto [1,*], Marco Pittarello [2], Laura Zavattaro [2], Barbara Moretti [1], Simone Pelissetti [3], Luisella Roberta Celi [1], Daniel Said-Pullicino [1]

[1] Department of Agricultural, Forest and Food Sciences (DiSaFa)– University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy
[2] Department of Veterinary Sciences – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy
[3] UpToFarm S.R.L.

* *Corresponding author: Lucia Crosetto (lucia.crosetto@unito.it)*

Abstract. Rice cultivation is a major anthropogenic source of atmospheric methane (CH_4), accounting for about 10% of total agricultural greenhouse gas (GHG) emissions. While Asia dominates global rice production, temperate rice systems also contribute significantly to regional and national GHG budgets. In Europe and the United States, rice cultivation is highly mechanized, relies on artificial irrigation, and follows relatively homogeneous agronomic practices. However, most existing CH_4 emission models were developed for tropical conditions and remain poorly validated for temperate regions, leading to substantial uncertainty in emission estimates. This study addresses this gap by focusing on methane emissions from temperate rice systems in Europe and the United States. A systematic literature review identified field-based studies measuring CH_4 emissions using non-steady-state closed chamber techniques. In total, 40 publications met the selection criteria, yielding 223 independent statistical units. For each unit, methane emission factors were calculated as average daily emission rates (kg CH_4 ha^{-1} d^{-1}) over the cropping season. A comprehensive set of explanatory variables was compiled, including water and residue management practices, soil properties, climatic conditions, and agronomic inputs. Several statistical models and variable combinations were tested to identify the main drivers of methane emissions. Generalized Additive Mixed Models (GAMMs) showed the best performance based on the Akaike Information Criterion (AIC). The most robust model identified soil pH, water management during the cropping season and at seeding, nitrogen and carbon inputs, and soil sand content as significant predictors of CH_4 emissions. Non-linear responses were observed for soil pH, nitrogen inputs, and sand fraction, while country and year were included as significant random effects. Overall, the results highlight the strong influence of local environmental and management conditions on methane emissions from temperate rice systems and underline the need for region-specific modeling approaches to improve emission inventories and support effective mitigation policies.

Keywords: Methane emissions; Temperate rice systems; Modelling; Water management; Soil properties.

Phenolic composition and colour stabilization of Nebbiolo wines through different fermentation strategies

Catarina Cunha [1,*], Vasileios Englezos [1,2], Paola Di Gianvito [1], Francesca Cristetti [1], Maria Alessandra Paissoni [1,2], Susana Río Segade [1,2], Luca Cocolin [1,2], Luca Rolle [1,2], Kalliopi Rantsiou [1,2], Simone Giacosa [1,2]

[1] Department of Agricultural, Forest, and Food Sciences, University of Torino, Corso Enotria 2/C, 12051 Alba, Italy
[2] Interdepartmental Centre for Grapevines and Wine Sciences, University of Torino, Corso Enotria 2/C, 12051 Alba, Italy

* *Corresponding author: Catarina Cunha (anacatarina.cabralvaledacunha@unito.it)*

Abstract. Nebbiolo wines present a distinctive matrix characterized by high levels of flavanols but intrinsically low anthocyanin content, due to a high percentage of di-substituted anthocyanins highly prone to oxidation. While wine production relies on alcoholic fermentation, the choice of yeasts can impact the final phenolic profile, by the production of metabolites involved in the development of stable polymeric pigments. This study aimed to characterize the phenolic parameters of Nebbiolo wines, assessing how different fermentation strategies (spontaneous opposed to *Saccharomyces cerevisiae* inoculum) can influence their composition. A multizone experimental design was applied, sampling grapes from 32 distinct vineyards (vintage 2024). Micro-scale winemaking was conducted performing the two fermentation strategies to compare the resulting phenolic and colour traits, utilizing LC-MS/MS to determine detailed phenolic composition. Partial Least Squares Discriminant Analysis (PLS-DA) identified the metabolic drivers defining varietal expression. The "spontaneous" modality was associated with higher contents in monomeric anthocyanins, specifically delphinidin (Variable Importance in Projection-VIP 1.87) and cyanidin (VIP 1.76). Furthermore, the formation of derived pigments was significantly higher in spontaneous fermentation wines. Key markers included malvidin catechin (VIP 1.69) and peonidin vinylcatechol (VIP 1.59), as well as stable vitisins (malvidin vitisin A, VIP 1.19). These findings suggest that fermentation decisions play an important role in the general phenolic profile of Nebbiolo wines and consequently on their colour stabilization.

Keywords: Nebbiolo; Fermentation; Anthocyanins; Pigments; Colour stabilization.

Acknowledgements: This study was carried out within the Agritech National Research Center and was funded by the European Union Next-GenerationEU under the PNRR - Missione 4 Componente 2, Investimento 1.4 - D.D. 1032 17/06/2022, CN00000022.

From biofortification to personalized nutrition: Agronomic strategies for tailored vegetables

Massimiliano D'Imperio *, Francesco Serio

Institute of Sciences of Food Production, National Research Council of Italy, Bari, Italy

* *Corresponding author: Massimiliano D'Imperio (massimiliano.dimperio@cnr.it)*

Abstract. Biofortification represents an innovative agronomic strategy to enhance the nutritional value of plant-based foods, particularly vegetables, addressing the growing demands of public health and personalized nutrition. In recent years, the use of soilless cultivation systems has significantly simplified and improved the efficiency of biofortification practices, thanks to the possibility of precise and dynamic control of the nutrient solution. This enables the targeted modulation of mineral uptake and nutritional profiles in crops, including elements not commonly found in nutrient solutions, such as silicon and iodine. In parallel, the concept of biofortification has undergone a substantial evolution: from an approach primarily aimed at increasing essential nutrients, it has progressively shifted toward the production of foods tailored to specific nutritional needs. Within this framework, the development of low-potassium vegetables for individuals affected by chronic kidney disease has emerged as a relevant application, as the management of potassium intake represents a critical clinical aspect for these patients. Looking ahead, increasing interest is being directed toward the biofortification of fast-growing aquatic species, such as *Lemna minor*, which has recently been included as a functional food in the list of novel foods authorized for human consumption (Commission Implementing Regulation (EU) 2025/153). The assessment of the actual nutritional impact of these foods relies heavily on the adoption of nutritional validation models, including *in vitro* digestion systems, which enable the estimation of nutrient bioavailability and provide a more comprehensive and realistic evaluation of their potential benefits for consumers. Overall, the integration of agronomic innovation with advanced nutritional assessment models represents a key step toward the development of health-oriented food systems.

Keywords: Novel food; Soilless; In vitro digestion; *Lemna minor* L.

When are spectral vegetation index changes significant? A framework for uncertainty-aware mapping

Samuele De Petris *, Filippo Sarvia, Enrico Borgogno-Mondino

Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy

* *Corresponding author: Samuele De Petris (samuele.depetris@unito.it)*

Abstract. Vegetation spectral indices (VIs) derived from multispectral remote sensing imagery, like NDVI, are widely used for monitoring natural and agricultural vegetation, supporting applications such as crop assessment, forest dynamics analysis, and land-cover change detection. However, the scientific interpretation of VI variations critically depends on the ability of distinguishing significant changes from variations induced by sensor noise, atmospheric effects, and acquisition geometry. Despite this, uncertainty is often neglected in VI-based analyses, potentially leading to misleading conclusions about vegetation dynamics. This study presents a methodological framework for estimating and mapping the theoretical uncertainty of the mostly used vegetation index, namely NDVI, highlighting its specific relevance to vegetation monitoring. The approach is based on the variance propagation law, which enables the propagation of spectral band uncertainties through the VI formulation, providing pixel-level uncertainty estimates in both space and time domains. The methodology is applied with reference to time series of Sentinel-2 L2A images and it is intended (i) to support the interpretation of seasonal patterns of NDVI uncertainty and (ii) to recognize significant NDVI differences when approaching a change detection analysis. This makes possible to detect those situations where apparent changes may not be statistically robust. To generalize the approach beyond regional analyses, uncertainty patterns are explored at the global scale using Google Earth Engine platform across major vegetated ecosystem types, including forests, grasslands, and croplands, using global ecosystem maps. The comparison between summer and winter conditions reveals systematic differences in NDVI uncertainty related to vegetation phenological cycles that reveal important implications for both natural and agricultural monitoring. Overall, this work emphasizes that vegetation monitoring by EO data, to be reliable, need to couple NDVI difference map with the correspondent one defining its uncertainty. Explicit uncertainty quantification is therefore essential to support scientifically sound conclusions in vegetation cover monitoring and change detection studies.

Keywords: NDVI; Uncertainty; Google Earth Engine; Change detection.

Validation of an integrated method for PFAS analysis in plant-based and skimmed milk

Bruna De Simone [1,*], Elvira De Rosa [2], Francesco Esposito [1], Teresa Cirillo [1]

[1] University of Naples Federico II, Department of Agricultural Science, Italy
[2] San Raffaele University, Department of Human Sciences and Quality of Life Promotion, 00166 Rome, Italy

* *Corresponding author: Bruna De Simone (bruna.desimone@unina.it)*

Abstract. Per- and polyfluoroalkyl substances (PFAS) are persistent contaminants that bioaccumulate along the food chain, thereby representing a significant risk to food safety. Although validated procedures have been developed to quantify these substances in drinking water and selected foodstuffs, no standardized analytical method is currently available for PFAS determination in matrices such as skimmed milk and plant-based beverages which are increasingly consumed by individuals adopting vegetarian and vegan diets. Indeed, current analytical approaches rely on adapted procedures. Unlike whole milk, skimmed milk and plant-based beverages are characterized by a low-fat content; moreover, plant-based beverages have a variable composition and are predominantly composed of water. Therefore, the validation of an analytical method previously validated for drinking water was considered a rational approach for these low-fat liquid food matrices. An integrated method was optimized for the simultaneous quantification of 12 PFAS in drinking water, skimmed milk and plant-based beverages (soy, oat and coconut) using UHPLC–MS/MS. The procedure combined acetonitrile-based QuEChERS extraction for food samples with Strata-PFAS SPE clean-up, adapting U.S. EPA Method 537.1 to allow multi-matrix analysis within a single analytical batch using a single solvent-based calibration curve. Quantification was performed by isotope dilution with ^{13}C-labelled internal standards (ISs), without matrix-matched calibration. Preliminary validation showed satisfactory linearity ($R^2 \geq 0.990$) over the 0.0005–0.0100 µg L^{-1} range for all compounds. Limits of quantification were 0.5 ng L^{-1} for water and 4 ng kg^{-1} for food matrices, below the 1 µg kg^{-1} recommended level for PFOA and PFOS. Repeatability was acceptable with relative standard deviation ≤ 20%. Although matrix effects were observed, particularly in skimmed milk, isotopically labelled ISs effectively compensated for ion suppression or enhancement (80–120%). These results demonstrate the feasibility of extending a water-validated method to low-fat liquid food matrices, ensuring reliable and sensitive multi-matrix PFAS determination.

Keywords: PFAS; Validation; Analytical method; Plant-based milk; skimmed milk.

Wild and cultivated genomes provide insights into almond evolutionary dynamics and major phenotypic traits

Chiara Delvento [1,*], Gaetano Giudice [1], Marzia Guerriero [1], Marco Di Marsico [2], Gaetano Pazienza [1,3], Fabio Palumbo [4], Pasquale Luca Curci [5], Angelica Giancaspro [6], Giulia Castorina [7], Francesco Arcieri [1], Pasquale Losciale [1], Valeria Tomaselli [3], Luigi Forte [3], Gianni Barcaccia [4], Riccardo Aiese Cigliano [2], Luigi Ricciardi [1], Concetta Lotti [6], Stefano Pavan [1]

[1] Department of Soil, Plant and Food Sciences, University of Bari Aldo Moro, Bari, Italy
[2] Sequentia Biotech, Barcelona, Spain
[3] Department of Biosciences, Biotechnologies and Environment, University of Bari Aldo Moro, Bari, Italy
[4] Department of Agronomy, Food, Natural resources, Animals and Environment, University of Padova, Padova, Italy
[5] Institute of Biosciences and Bioresources, National Research Council (CNR), Bari, Italy
[6] Department of Agricultural, Food and Environmental Sciences, University of Foggia, Foggia, Italy
[7] Research Centre for Genomics and Bioinformatics, Council for Agricultural Research and Economics (CREA), Fiorenzuola d'Arda, Italy

* *Corresponding author: Chiara Delvento (chiara.delvento@uniba.it)*

Abstract. Domesticated almond (*Prunus dulcis*, *Pd*) is the leading tree nut species worldwide, yet genetic research on *Pd* and its wild relatives remains limited. Here, we present haplotype-resolved genome assemblies for the *Pd* cultivar 'Tuono', the primary source of self-compatibility in global almond breeding, and the xerophytic wild almond species *Prunus webbii* (*Pw*), together with whole-genome resequencing data from 72 *Pd*, *Pw,* and *Pd* × *Pw* hybrid individuals. Phylogenomic inference indicated that the *Pd* and *Pw* lineages diverged in the early Pleistocene and followed distinct evolutionary trajectories emphasizing energy production in Pd and stress adaptation in Pw. Selection scans revealed candidate genes for domestication-related changes in *Pd*, including seed size, tree architecture, and shell hardness, and drought tolerance in *Pw*. Population genomic analyses indicated that *Pw* did not contribute self-compatibility to *Pd*, challenging a long-standing hypothesis. Instead, allele-specific expression profiling highlighted convergent evolution of self-compatibility via transcriptional inactivation of the S-RNase and F-box determinants of *Prunus* self-incompatibility. Remarkably, *Pd* × *Pw* hybrids carrying the *Sweet kernel* allele displayed reduced accumulation of toxic amygdalin, highlighting a path toward neo-domestication of additional edible almond species from wild relatives. Overall, this study advances almond biology and provides actionable guidance to leverage wild almond diversity.

Keywords: Almond; Evolution; Genomics; Self-compatibility; Wild genetic diversity.

Sprouting and fermenting food safety: Natural strategies against fungal contamination

Chiara Demarinis [1,*], Giuseppe Perri [1], Simona Carbone [1], Lorenzo Ciraldo [1], Federico Rametta [1], Michela Verni [2], Carlo Giuseppe Rizzello [2], Erica Pontonio [1]

[1] Department of Soil, Plant and Food Sciences, University of Bari Aldo Moro, 70126 Bari, Italy
[2] Department of Environmental Biology, "Sapienza" University of Rome, Rome, Italy

* *Corresponding author: Chiara Demarinis (chiara.demarinis@uniba.it)*

Abstract. Germination and fermentation of cereals, legumes, and their bran enhance antifungal activity through the production and/or release of bioactive compounds. Germination activates endogenous enzymes, increases phenolic acids, flavonoids, and peptides, and reduces antinutritional factors, contributing to improved nutrient availability and antifungal potential. Fermentation by lactic acid bacteria provides additional antimicrobial metabolites, including organic acids and other antifungal compounds, lowering pH and inhibiting fungal growth. These processes represent sustainable strategies to improve food safety and shelf life of plant-based products. This study evaluated the individual and combined effects of germination and fermentation on the antifungal activity of cereals (barley, wheat) and legumes (chickpeas, lentils), including their bran fractions. Aqueous extracts from non-germinated flours fermented with twelve lactic acid bacteria strains were autoclaved and screened against *Penicillium roqueforti*. Antifungal activity depended on strain and fermentation time (16 vs 24 h). After 24 h, *Levilactobacillus brevis* P7m1 showed the highest and most consistent inhibition (>60%) in barley and wheat, and markedly increased activity in chickpea; it was therefore selected for further trials. Germinated, fermented, and germinated–fermented barley and barley bran extracts were tested against several spoilage fungi. Germinated barley showed inhibition levels exceeding 60% against *Aspergillus niger* DSM 737, *Penicillium lanosocoeruleum* old 8, and *Penicillium paneum* old 15. Fermentation alone enhanced inhibition against *A. niger* old 4 and *Penicillium carneum* old 2, while the combined treatment yielded the strongest effects in barley bran (up to 77.14%). Based on the in vitro results, germinated–fermented barley bran was used to produce bread (DY 160) with 30% flour substitution. Slices were inoculated with the same fungal species, sealed in sterile zip bags, and monitored after 5 and 10 days. Bread containing treated bran showed inhibition patterns consistent with the in vitro findings. Further analyses are ongoing to assess bread quality and technological feasibility.

Keywords: Germination; Lactic acid fermentation; Barley bran; Antifungal activity; Food biopreservation.

On-farm experimentation of cereal-legume intercropping mixtures: weed suppression, system productivity and profitability

Michele Denora *, Donato Casiello, Pierluigi Casiero, Domenico Mario Melone, Michele Perniola

Department of Agriculture, Forest, Food and Environmental Sciences, University of Basilicata, Viale dell'Ateneo Lucano 10, 85100 Potenza, Italy

* *Corresponding author: Michele Denora (michele.denora@unibas.it)*

Abstract. Cereal-legume intercropping is an agroecological practice aimed at increasing crop diversification and reducing dependence on external inputs in Mediterranean cereal-based systems (MESSÉAN et al., 2021). The present work reports the results of the 2024-2025 cropping season for the intercropping plot (2.5 ha) within a long-term on-farm experimentation (OFE) pilot field established in 2020 at the agricultural cooperative "La Generale" (Genzano di Lucania, Basilicata, Southern Italy). The trial follows a strip-plot OFE design, in which cereal-legume intercropping and the corresponding sole-crop systems are arranged in operational strips aligned with machinery width and embedded within homogeneous soil zones identified by proximal sensing and clustering analysis (Denora et al., 2025; Giannini and Marraccini, 2023). The objectives were to evaluate under on-farm conditions: (i) weed control, (ii) agronomic performance and land-use efficiency through the Land Equivalent Ratio (LER), and (iii) economic performance through the contribution margin. Intercropping was compared with unfertilized durum wheat monoculture (weed control reference) and a conventional cereal system (baseline for efficiency and economics). Under no-input management (no mineral fertilization or chemical weed control), three additive mixtures of durum wheat (Triticum durum Desf., cv. Farah, 150 kg ha^{-1}) with grain legumes were evaluated: faba bean (Vicia faba L., 120 kg ha^{-1}), lentil (Lens culinaris Medik., 100 kg ha^{-1}), and common vetch (Vicia sativa L., 80 kg ha^{-1}). Mixtures were sown and harvested jointly; grain components were subsequently separated to determine individual yields. The intercrops showed high weed control efficiency (WCE) compared with pure legume stands (62-86%) and achieved weed suppression comparable to or exceeding unfertilized durum wheat (WCE 10-44%). Land-use efficiency exceeded 1 for all evaluated mixtures. Economic performance was consistent with the previous season and competitive with the conventional reference; post-harvest grain separation remains a management constraint but did not compromise overall profitability.

Keywords: Intercropping; Weed control efficiency; Land equivalent ratio; Gross margin; On-farm.

Phytochemical variability and antioxidant activity in *Lavandula*: Insights for cultivar selection and horticultural valorization

Cassandra Detti [1,*], Andrea Baptista [1,2], Cecilia Brunetti [1,2], Dalila Pasquini [2,3], Luana Beatriz dos Santos Nascimento [1], Francesco Ferrini [1,2], Sara Beltrami [1], Antonella Gori [1]

[1] Department of Agriculture, Food, Environment and Forestry, University of Florence, Viale delle Idee 30, Sesto Fiorentino, I-50019 Florence, Italy
[2] Institute for Sustainable Plant Protection, National Research Council of Italy (CNR), Via Madonna del Piano 10, Sesto Fiorentino, I-50019 Florence, Italy
[3] Bioeconomy Science Institute, Titokorangi Drive, Private Bag 3020, Rotorua 3046, New Zealand

* *Corresponding author: Cassandra Detti (cassandra.detti@unifi.it)*

Abstract. The genus *Lavandula* (Lamiaceae) includes numerous species, cultivars, and hybrids widely cultivated for ornamental purposes, and for applications in food, pharmaceutical, and cosmetic sectors. In this work, the phytochemical profiles and antioxidant activity of three species (*Lavandula stoechas* L., *Lavandula latifolia* Medik., and *Lavandula angustifolia* Mill.), two cultivars (*L. stoechas* 'Alba' L. and *L. angustifolia* 'Krajova' Mill.), and the interspecific hybrid *Lavandula* × *intermedia* 'Alba' Emeric ex Loisel were comparatively evaluated. All selected taxa are widely appreciated and cultivated for ornamental purposes due to their decorative flowering, aromatic blend and adaptability to different environmental conditions. All plants were cultivated under uniform environmental conditions and harvested simultaneously to ensure reliable comparison. Polyphenolic compounds were characterized by HPLC-DAD/QTOF-MS, terpene composition was determined using GC-MS, and antioxidant activity was assessed through DPPH and FRAP assays. Qualitative and quantitative differences in phenolic composition were observed among species and cultivars. The major compounds identified included glycosylated derivatives of coumaric, caffeic, and ferulic acids, together with derivatives of luteolin and apigenin. *L. latifolia* exhibited the highest hydroxycinnamic acids content (5.306 ± 1.265 mg/g FW), whereas *L. stoechas* 'Alba' showed the highest flavonoid concentration (2.537 ± 0.192 mg/g FW). Regarding terpene profiling, hydrocarbon and oxygenated monoterpenes were the predominant classes, with the highest levels detected in *L. stoechas*. Antioxidant activity varied significantly among samples and showed a strong positive correlation with flavonoid content. The results highlight a marked intra- and interspecific variability within the *Lavandula* genus in terms of phenolic and terpene composition, which affects antioxidant activity and reveals distinct phenolic and terpene signatures. This diversity represents a valuable resource for the selection of genotypes for functional and industrial applications.

Keywords: *Lavandula*; Secondary metabolites; Phenolic profile; Terpene composition; Phytochemical diversity.

Predicting the frequency of Tree-related Microhabitats (TreMs) using TLS data: a comparison between stepwise linear regression and Random Forest models

Antonio di Biase [1,*], Giovanni Santopuoli [2], Pierdomenico Spina [3], Tiziana Panichella [1]

[1] Dipartimento di Bioscienze e Territorio (DiBT) - Università degli Studi del Molise, C/da Fonte Lappone s.n.c., 86090 Pesche (IS), Italy
[2] Dipartimento di Agricoltura, Ambiente e Alimenti (DiAAA) - Università degli Studi del Molise, Via De Sanctis snc, 86100 Campobasso, Italy
[3] Dipartimento di Scienze Agrarie, Forestali e Alimentari (DISAFA) - Università di Torino, Largo Paolo Braccini, 2, 10095 Grugliasco (TO), Italy;

* *Corresponding author: Antonio di Biase (a.dibiase5@studenti.unimol.it)*

Abstract. Forests play a fundamental role in biodiversity conservation at the global level. In recent years, increasing attention has been given to Tree-related Microhabitats (TreMs), which are structures that occur on trees (such as cavities, injuries, deadwood, nests, etc.) and are able to host numerous species of living organisms. The presence and frequency of plants that host microhabitats (habitat trees) within forests represent a reliable indicator for biodiversity monitoring, particularly within an Integrative Forest Management (IFM) approach. In this context, the introduction of LiDAR technologies, such as the Terrestrial Laser Scanner (TLS), has opened new opportunities for the analysis of forest ecosystems, allowing the acquisition of highly detailed information on their structure. These technologies enable the characterization of forest attributes with high accuracy, at the individual tree scale. The aim of this study is to evaluate the effectiveness of the Terrestrial Laser Scanner (TLS) in the characterization of habitat trees and in the prediction of TreMs using structural metrics extracted from point clouds. The forest area was surveyed using a Terrestrial Laser Scanner, resulting in point clouds that were subsequently processed. Each tree was segmented, and 25 metrics, including dendrometric and morphometric parameters, were extracted for each individual tree. The metrics were correlated with the frequency of microhabitats present on each tree, and two predictive models were subsequently implemented: Stepwise Multiple Linear Regression and Random Forest. The results showed that both models achieved similar performance in predicting TreMs, with a coefficient of determination (R^2) of 0.28. Therefore, these results confirm that metrics derived from LiDAR point clouds can represent effective predictors of TreMs frequency, providing an innovative tool for monitoring forest biodiversity and the sustainable forest management.

Keywords: Tree-related Microhabitat; LiDAR; Forest Biodiversity; Integrative Forest Management; Predictive Model.

From challenges to best practices: a structured assessment of animal welfare in European beef cattle systems

Elena Diaz Vicuna [1], Stefano Bruzzese [1,*], Sean Ashe [2], Geneviève Aubin-Houzelstein [3], Eléa Caumette [4], Tiziano Bernardo [5], Xavier Boivin [4], Alain Boissy [4], Francesca Fusi [5], Emma Fàbrega [6], Emma Hvidtfeldt Jensen [7], Leene Juul Pedersen [7], Luisa Magrin [8], Eva Mainau [9], Sonia Marti [6], Sara Rota Nodari [5], Claudio Forte [1]

[1] Department of Veterinary Sciences – University of Turin, Italy
[2] European Food Safety Authority, Parma, Italy
[3] Institut national de recherche pour l'agriculture, l'alimentation et l'environnement (INRAE), Paris, France
[4] Department of Biology, Ecole Normale Supérieure de Lyon, France
[5] Istituto Zooprofilattico Sperimentale della Lombardia e dell'Emilia-Romagna, Brescia, Italy
[6] Institute of Agrifood Research and Technology (IRTA), Spain
[7] Department of Animal and Veterinary Sciences – Aarhus University, Denmark
[8] Department of Animal Medicine, Production and Health – University of Padua, Italy
[9] Department of Animal and Food Sciences – Universitat Autònoma de Barcelona, Spain

* *Corresponding author: Stefano Bruzzese (stefano.bruzzese@unito.it)*

Abstract. The revision of the European Union legislative framework on animal welfare highlights the need for an integrated understanding of how on-farm welfare-improving practices interact with the environmental, economic, and social dimensions of sustainability. In beef cattle production, evidence linking animal welfare to sustainability outcomes remains fragmented. Within this framework, this study aimed to identify animal welfare topics (AWTs) and welfare-promoting best practices (BPs) in beef cattle systems and to analyse their relationships with the three sustainability dimensions. Through expert elicitation and literature review, 42 AWTs and 162 BPs were identified across multiple animal categories and beef production systems, then classified according to the 5 animal welfare domains (behaviour, environment, health, mental state, and nutrition) and analysed in terms of frequency of attribution. Behaviour and environment emerged as the most represented domains, while nutrition and mental state were less addressed. Dairy-beef calves and indoor farming systems production systems accounted for the highest number of identified AWTs and BPs, reflecting both the complexity and research intensity of these systems. Through a subsequent scoping review, direct links between welfare-promoting BPs and sustainability outcomes were analysed. Economic impacts resulted to be the most frequently documented, followed by the social, while environmental effects were consistently less assessed. Practices related to flooring conditions, space allowance, veterinary interventions, shelter provision, and outdoor access showed context-dependent trade-offs and synergies across sustainability dimensions. Economic benefits were often associated with improved health management and heat stress mitigation, whereas social sustainability was mainly linked to labour requirements, farmer satisfaction, and consumer perception. Environmental outcomes were highly dependent on system characteristics, management intensity, and resource use efficiency. The findings highlight the complexity and variability of research in beef production systems regarding animal welfare, as well as a substantial lack of scientific research explicitly linking animal welfare to sustainability outcomes.

Keywords: Animal welfare; Beef cattle production; Best practices; Sustainability dimensions; One Health / One Welfare.

To stay or to leave? Determinants of farm exit in marginal rural areas

Andrea Dominici [1,*], Daniel Vecchiato [1], Leonardo Casini [2]

[1] Department of Land, Environment, Agriculture and Forestry (TESAF) – University of Padova, Viale dell'Università 16, 35020 Legnaro (PD), Italy
[2] Department of Agriculture, Food, Environment and Forestry (DAGRI) – University of Florence, Piazzale delle Cascine 18, 50144 Florence, Italy

* *Corresponding author: Andrea Dominici (andrea.dominici@unipd.it)*

Abstract. Farm exit and land abandonment represent a territorial challenge in Southern Europe, particularly in Italy, where marginal rural areas are increasingly affected by declining agricultural activity. This study investigates the determinants of farmers' intentions to exit agriculture, focusing on six marginal areas of the Tuscany region (Italy). In Tuscany, agricultural activities strongly shape territorial identity in terms of landscape and product quality, yet the region is identified as being at high risk of farmland abandonment. Based on face-to-face survey data collected from 203 farm owners, the analysis integrates socio-demographic characteristics, farm structural and economic features, territorial context, and farmers' perceptions of quality of life and community well-being. A logistic regression model is employed to identify factors associated with the probability of farm exit. Results indicate that approximately one-third of the interviewed farmers intend to abandon agricultural activity, with substantial heterogeneity across territories. Age emerges as a strong predictor of exit, while the presence of potential successors reduces the risk of abandonment. Economic viability plays a protective role: higher farm revenues are associated with a lower probability of exit, whereas income diversification alone does not guarantee farm continuity. Farm size exhibits a non-linear relationship with exit probability, with very large farms showing a higher risk of exiting. Production specialisation also matters, as livestock, olive groves, and other productions display higher exit probabilities compared to arable farming, while viticulture appears more resilient. Beyond economic and structural factors, community well-being and perceived access to services reduce the likelihood of exit, highlighting the importance of quality of life and social integration in sustaining agricultural activity. Overall, the findings confirm that farm exit results from a complex interaction of economic, demographic, structural, and social factors, suggesting that effective policy responses should combine income support with measures that improve rural services, social capital, and territorial cohesion.

Keywords: Land abandonment; Well-being; Rural population; Agricultural policy; Tuscany.

BioAltilis, an alternative sustainable approach for the bioactive compound production in Cardoon

Giulia Conversa [1], Luigi Giuseppe Duri [1,*], Claudia Formenti [2], Gaetano Pandino [2], Francesco di Nunzio [1], Francesco Pio Bruno [1], Corrado Lazzizera [1], Cristina Abbate 2, Salvatore Alfio Salicola [2], Mirko La Iacona [2], Sara Lombardo [2], Giovanni Mauromicale [2], Antonio Elia [1]

[1] Department of Agriculture, Food, Natural Resources and Engineering (DAFNE) - University of Foggia, Via Napoli 25, 71100 Foggia, Italy
[2] Department of Agriculture, Food and Environment (Di3A) - University of Catania, Via S. Sofia 100, 95123 Catania, Italy

* *Corresponding author: Luigi Giuseppe Duri (luigi.duri@unifg.it)*

Abstract. Cardoon (*Cynara cardunculus* L. var. *altilis*) is well adapted to the Mediterranean climate and rich in bioactive compound (BaC). The study aimed to define a low-input protocol for cardoon biomass production for BaC extraction. The experiments were conducted (September 2023 - June 2025) in two southern Italy areas (Sicily and Apulia), comparing two planting densities (2 vs. 4 plants m-², D1 and D2, respectively) and applying an arbuscular mycorrhizal fungus (*Glomus* spp.) biostimulant (Myco+ and Myco-, inoculated and non-inoculated, respectively). The biostimulant was applied to seedlings before transplanting and at the start of the second crop cycle (September 2024). Treatments followed a split-plot design with three replicates, with density as the main factor and AMF as the secondary factor. From January 2024 to June 2025, seven aboveground biomass harvests were carried out, and the following were determined: fresh and dry aboveground biomass, and total polyphenol (TP) content of the plant aboveground. The genera *Glomus* and *Gigaspora* were quantified in the soils and roots using qRT-PCR. This analysis revealed that although both genera were present in the soil and root systems, *Glomus* exhibited significantly higher colonization in the Myco+ root samples. The cumulative production of fresh biomass was higher in Sicily than in Apulia (283 vs. 225 t ha-1), while the dry biomass was similar (28 t ha-1). In both locations, D2 provided higher yields per unit area. The application of the biostimulant improved the cumulative fresh biomass for the crop grown in Apulia (254 and 196.5 t ha-1, in Myco+ and Myco-, respectively). The TP content was higher in the leaf lamina than in the midrib. More abundant TP were observed in leaf of the Apulian cardoon (780 vs. 550 kg ha-1). TP content was sporadically influenced by planting density and frequently increased in the midrib of Myco+ plants.

Keywords: Arbuscular mycorrhizal fungi; Bioactive compounds; Plant density; Polyphenols.

DSS-driven fully automated irrigation and nitrogen fertigation for processing tomato: a case study in the Capitanata area (FG, Puglia)

Giulia Conversa [1], Luigi Giuseppe Duri [1,*], Ventucci Nicola Pio [1], Michele Elia [2], Antonio Elia [1]

[1] Department of Agriculture, Food, Natural Resources and Engineering (DAFNE) - University of Foggia, Via Napoli 25, 71100 Foggia, Italy
[2] Department of Soil, Plant and Food Sciences, University of Bari Aldo Moro, Via Amendola 165/A, 70126 Bari, Italy

* *Corresponding author: Luigi Giuseppe Duri (luigi.duri@unifg.it)*

Abstract. To evaluate the EcoFert Decision Support System (DSS), a field trial was conducted at a commercial farm in Foggia province (southern Italy) on drip-fertigated processing tomato. Two adjacent main plots (0.5 ha each) were established: (i) Traditional Management (TM), based on the farmer's usual irrigation and N fertilization practice; and (ii) Automated Irrigation + Nitrogen application guidance (AIN), in which irrigation was managed by the EcoFert DSS, that also provided recommendations on N rate and fertilizer type. Each main plot was subdivided into four blocks serving as replicates. Irrigation was automated using LoRaWAN as the communication protocol connecting the field-control unit to the DSS. Tomato seedlings were transplanted in May 2025 in twin rows (2.8 plants m^{-2}). Weed control and pest/pathogen management were kept identical across treatments throughout the cycle. At harvest (100 days after transplanting), yield components were measured on 10 plants per replicate, separating fruits into marketable and unmarketable classes and recording both fruit number and fresh weight. Total yield was markedly higher under DSS management, reaching 164 t ha^{-1} in AIN versus 130 t ha^{-1} in TM; the same trend was observed for marketable yield, indicating a clear production advantage when irrigation and fertilisation were guided by EcoFert. TM also produced a greater proportion of immature product, with 10 t ha^{-1} of unripe fruit compared with 4.3 t ha^{-1} in AIN. EcoFert's irrigation scheduling substantially reduced seasonal water application relative to the farmer's practice (6918 vs 10,122 m^3 ha^{-1}). Excluding pre-crop N–P–K inputs, the DSS led to input reductions of 12% (N), 42% (P), and 100% (K). Overall, the combined savings in irrigation water and fertilizers translate into meaningful cost reductions, highlighting EcoFert's effectiveness in improving water-use efficiency and in selecting the most appropriate, cost-effective fertilizers for each crop growth stage.

Keywords: Decision support system; LoRaWAN; WUE; NUE.

Changing soil redox conditions affects organic C and electron acceptors availabilities leading to shifts in microbial CUE

Alexine Ehlinger [1,2,*], Alberto Canarini [3], Andreas Richter [4], Daniel Said-Pullicino [1]

[1] Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Grugliasco, Italy
[2] Department of Science, Technology and Society – University School for Advanced Studies (IUSS), Pavia, Italy
[3] Department of Biological, Geological and Environmental Sciences – University of Bologna, Bologna, Italy
[4] Center for Microbial Environmental System Sciences (CeMESS) – University of Vienna, Vienna, Austria

* *Corresponding author: Alexine Ehlinger (alexine.ehlinger@unito.it)*

Abstract. Soil microbial carbon use efficiency (CUE) drives the fate of below-ground C between C source and sink. CUE is largely affected by environmental factors, but also by the quality and availability of organic C (OC) and electron acceptors, particularly in soils experiencing shifts in redox conditions. Indeed, in water-saturated soils, like rice paddies, microorganisms shift from using O_2 to alternative electron acceptors, including NO_3^- and Fe^{III}. These metabolic changes may also be accompanied by shifts in microbial community, affecting the overall CUE. This work investigates the short-term (i.e. 17 days) effects of redox changes (i.e. aerobic-to-anaerobic) on microbial physiology in paddy soils, focusing on microbial growth, respiration and CUE, in response to labile OC (electron donors) and electron acceptors availabilities, and their dependence on changes in microbial community structure. A typical paddy soil was incubated under aerobic or anaerobic conditions, with or without rice straw (RS) and NO_3^- addition, in a complete factorial design. Soils were sampled on days 4 and 17, and microbial respiration and growth were evaluated by measuring CO_2 production and ^2H incorporation into PLFAs after a D_2O incubation. Our results show that, under anoxia, NO_3^- was rapidly consumed within the first 4 d, while Fe^{III} reduction was most evident by 17 d, especially with RS addition. Reductive dissolution of Fe oxyhydroxides led to an increase in DOC in soil solution, further enhanced by RS addition. Microbial respiration was higher and sustained under anoxia, while microbial growth was slower, although stimulated by RS under both redox conditions. CUE was significantly lower under anoxic conditions, and did not increase with RS addition, mainly due to the higher respiration rates. This may reflect energy demands to maintain growth but also support microbial community shifts, as suggested by the increased gram-positive and gram-negative bacterial growth over the incubation period.

Keywords: Microbial CUE; Redox changes; Electron acceptors and donors.

Sustainable soil disinfestation strategies differentially modulate yield and nutritional quality of consecutive lettuce cropping

Christophe El Nakhel [1,*], Antonietta Mirabella [1], Michele Ciriello [1], Luana Izzo [2], Youssef Rouphael [1]

[1] Department of Agricultural Sciences – University of Naples Federico II, Via Università 100, 80055 Portici (NA), Italy
[2] Department of Pharmacy – University of Naples Federico II, Via Domenico Montesano 49, 80131 Naples, Italy

* *Corresponding author: Christophe El-Nakhel (christophe.elnakhel@unina.it)*

Abstract. In intensive leafy vegetable production, increasing restrictions on synthetic soil fumigants highlight the need for sustainable alternatives. This study assessed four non-chemical strategies—solarization (SOL), anaerobic soil disinfestation (ASD), bio-fumigation (BF), and biological control with *Trichoderma* spp. (T. spp.) on yield and quality of two consecutive lettuce cultivars cropping under greenhouse conditions. Across both cycles, BF consistently produced the highest fresh yield, with an increase of up to 53% in blond and 44% in red lettuce, while T. spp. showed residual yield-promoting effects in the second cycle. By contrast, SOL and ASD provided limited or inconsistent benefits. BF also enhanced flavonoid accumulation in blond lettuce, suggesting stimulation of secondary metabolism with potential nutritional implications. Mineral composition was strongly influenced by treatment and cultivar, where ASD significantly increased nitrate in blond lettuce to levels above EU safety thresholds, whereas T. spp. markedly reduced them. Red lettuce accumulated nearly twice the phenolic acids of blond lettuce regardless of treatment, confirming a genotype-driven effect. Overall, BF and T. spp. emerge as promising, environmentally sustainable soil management strategies capable of improving both yield and nutritional quality of leafy vegetables, although treatment efficacy is influenced by crop cycle and cultivar.

Keywords: Organic amendment; Glucosinolate; Phenols; Nitrate metabolism; Beneficial microorganisms.

Stable or "Flexible"? Seasonal responses of sheep microbiota to environmental change

Maria Chiara Fabbri *, Silvia Graziani, Riccardo Bozzi, Alessandro Crovetti, Simone Callegaro, Francesco Tiezzi

Department of Agriculture, Food, Environment, and Forestry (DAGRI), University of Florence, Florence, 50144, Italy

* *Corresponding author: Maria Chiara Fabbri (mariachiara.fabbri@unifi.it)*

Abstract. The animal microbiota is central to host health and productivity; however, the characterization of the microbiota in grazing sheep remains largely unexplored. This study investigated the fecal and buccal microbiome of two lactating sheep breeds—one under selection and one local—reared under the same environmental conditions on a pilot farm located in Tuscany. Samples were collected across seasons, from winter to autumn, over 2 years (2024-2025) to assess temporal variability. A subset of animals was randomly selected, ensuring that each individual was sampled at least three times per season for both fecal and buccal microbiota. 156 samples were included in the analyses: 13 individuals per breed and three samplings for each microbiome type. The aims of the study were: to compare the microbiome of two genetically distinct breeds sharing the same environment, and to identify which microbiome exhibited greater stability across seasons characterized by differences in diet and thermal stress. Such insights may contribute to improved animal welfare, more effective management strategies, and microbiome-based research. Microbial community composition was assessed by sequencing the 16S rRNA gene. Alpha and beta diversity indices were calculated, and non-parametric statistical tests were applied to evaluate differences between microbiome types and seasons. Breed did not significantly affect α diversity, whereas fecal samples showed significantly higher diversity than buccal samples. Summer was associated with the lowest α diversity and showed a slight but significant difference between fecal and buccal microbiomes, which were clearly distinct in other seasons. PERMANOVA on β diversity further supported distinct seasonal patterns for fecal and buccal microbiota, with fecal communities differing across all seasonal comparisons except between autumn and winter, a trend also observed for buccal samples. Overall, these results highlight the differential stability and seasonal responsiveness of sheep microbiomes, underscoring their potential role as indicators of environmental and physiological adaptation.

Keywords: Microbiome; Grazing sheep; Local breed.

Interaction between nanoplastics and water stress: effects on mobility, bioaccessibility and metabolic response of lettuce (*Lactuca sativa* L.) in the soil-plant system

Federica Falcetta [1,2,*], Leilei Zhang [2], Luigi Lucini [2], Andrea Fiorini [1]

[1] Department of Sustainable Crop Production (DI.PRO.VE.S) – Università Cattolica del Sacro Cuore, Via Emilia Parmense 84, 29122 Piacenza (PC), Italy
[2] Department of Sustainable Food Process (DiSTAS) – Università Cattolica del Sacro Cuore, Via Emilia Parmense 84, 29122 Piacenza (PC), Italy

* *Corresponding author: Federica Falcetta (federica.falcetta@unicatt.it)*

Abstract. Nanoplastics (NPs) are an emerging contaminant widely found in agricultural soils. Due to their extremely small size and high surface area, NPs can alter soil properties and enter root tissues, translocating within the plants. Most studies on terrestrial plants use optimal conditions, leaving a knowledge gap on how climate-related stress factors, worsened by climate change, may affect NPs in the soil-plant system. Accordingly, the aim of this study was to evaluate the impact of water stress on the mobility, bioaccessibility, and translocation of NPs from soil to plants. Lettuce (*Lactuca sativa* L. var. capitata) was used as a model plant and grown under two different water regimes, well-watered (70% FC) and drought (40% FC) conditions, in the presence or absence of NPs. Plants' responses were evaluated through an integrated approach, combining morphophysiological parameters with biochemical and metabolomic analyses. This included the determination of stress-related metabolites (glutathione, GABA, proline, MDA, and H_2O_2) and related antioxidant enzyme activities (SOD, CAT, APX). Metabolomics analyses were performed, with particular focus on secondary metabolisms and targeted analysis of hormone cross-talk. In parallel, the accumulation and distribution of NPs in root and shoot tissues were quantified using micro-Raman spectroscopy. The morphophysiological results revealed a correlation between biomass and photosynthetic parameters: a decrease in photosynthetic efficiency (Phi2) led to a significant reduction in fresh biomass relative to the control. Conversely, plants exposed to NPs under drought stress maintained higher Phi2 levels than the drought control, which was associated with reduced biomass loss. This holistic framework aims to improve understanding of the interactions between NPs and environmental stressors, thereby contributing to environmental sustainability and food safety under climate change.

Keywords: Nanoplastics; Water stress; Soil-plant system; Metabolomics; Lettuce (*Lactuca sativa* L.).

Exploring agrivoltaic systems with FarmDESIGN: A multi-objective optimization approach

Lorenzo Ferretti [1,*], Jeroen Groot [2], Ottorino-Luca Pantani [1], Francesco Serafini [1], Aldo Dal Prà [3], Margherita Santoni [3], Andrea Ademollo [4], Niccolò Ulivi [4], Carlo Carcasci [4], Matthias Lorimer [1], Fabio Olmastroni [1], Gaio Cesare Pacini [1]

[1] Department of Agricultural, Food, Environmental and Forestry Sciences (DAGRI), University of Florence, Piazzale delle Cascine 18, 50144 Florence, Italy
[2] Plant Production System, Wageningen University & Research, P.O. Box 430, 6700 AK Wageningen, the Netherlands
[3] Institute of BioEconomy-National Research Council (IBE-CNR), Via Giovanni Caproni 8, 50145 Florence, Italy
[4] Department of Industrial Engineering (DIEF), University of Florence, Via di Santa Marta 3, 50139 Florence, Italy

* *Corresponding author: Lorenzo Ferretti (lorenzo.ferretti@unifi.it)*

Abstract. The FarmDESIGN model (FD) is a farm-level simulation framework that operates through a multi-objective evolutionary optimization algorithm. It has been extensively applied to smallholder agricultural systems across different regions of the world to assess farming practices, technologies, and policy interventions, as well as to examine trade-offs and synergies among diverse indicators. The model has also supported the identification of potential optimization pathways within farming systems. Agrivoltaic (AV) systems combine elevated photovoltaic (PV) panels with crop production on the same land area, allowing the simultaneous generation of agricultural outputs and renewable energy. In this study, FD was applied to perform a multi-indicator exploration of how different land use affect the FEW nexus. The analysis was based on empirical data and proxy indicators derived from peer-reviewed AV field trials conducted under organic farming conditions in Italy and Germany including both single crops and rotations. Following an agroecological approach, the model was parameterized using a multidimensional set of indicators related to the productive, economic, and environmental dimension of an agroecosystem: crop yield and quality (expressed through Radiation Use Efficiency, RUE), electricity production (EP), operating profit (OP), water balance (Crop Water Content ratio, CWC), and ES provisioning (using the Functional Biodiversity Index, FBI). Overall, FD proved to be a flexible and useful tool for analyzing AV systems which can be conceptually framed as a novel form of agroforestry, in which the tree canopy is replaced by photovoltaic panels. Results revealed clear trade-offs among indicators. For instance, EP and OP were negatively correlated with environmental indicators (FBI and CWC), while RUE was negatively correlated with EP and positively correlated with OP. The study highlights the need for long-term study - particularly from diversified crop rotations and multi-year trials - to reduce reliance on assumptions and improve the accuracy of the model outputs.

Keywords: FarmDESIGN; Agrivoltaics; Food-energy-water nexus; Organic farming; Methodological paper.

Smart grapevine disease assessment based on multi-source sensing systems

Antonio Catania, Massimo Vincenzo Ferro *, Carlo Greco, Santo Orlando

Department of Agricultural, Food and Forest Science, University of Palermo. Viale delle Scienze 4 - 90128 Palermo, Italy

* *Corresponding author: Massimo Vincenzo Ferro (massimovincenzo.ferro@unipa.it)*

Abstract. Grapevine trunk diseases represent a significant challenge in vineyard management and require reliable approaches for early diagnosis and spatial monitoring. In a previous study, the authors found that multispectral drone imagery provides spectral differences between healthy and diseased vines. Following these preliminary findings, the objective of the present study was to advance toward a predictive decision-support framework based on multi-source canopy observations and seasonal agronomic measurements. The experiment was conducted in a five-year-old Chardonnay vineyard located in southern Italy. Multispectral imagery was acquired using a DJI Mavic 3M, while canopy temperature data were collected with a DJI Matrice 350. Canopy-level hyperspectral measurements were performed using a field spectroradiometer to capture detailed spectral responses of healthy and symptomatic vines. Multi-source features extracted from UAV were used within a tree-based ensemble model to generate high-resolution disease prediction maps and identify spatial hotspots. The inclusion of canopy temperature improved the spatial consistency and predictive performance of the model. Vines located within the detected hotspot areas were further investigated through targeted hyperspectral measurements, which revealed clear optical differences between healthy and symptomatic, with increased reflectance around 550 nm and reduced reflectance around 750 nm. These vines were also subjected to systematic pruning wood sampling during the dormant season. Shoot pruning weight (SPW) measurements and wood characterization were used to estimate woody biomass and assess plant structural condition, providing paired information on vine status. The integration of multi-source features and pruning assessments supports the development of decision support systems, contributing to automated disease monitoring and digital transition in vineyard management.

Keywords: Vineyard management; Disease detection; Precision viticulture.

Delineation of vineyard management zones through multi-sensor geostatistical data fusion

Salvatore Amato, Giulio Calderone, Massimo Vincenzo Ferro *

Department of Agricultural, Food and Forest Science, University of Palermo. Viale delle Scienze 4 - 90128 Palermo, Italy

* *Corresponding author: Massimo Vincenzo Ferro (massimovincenzo.ferro@unipa.it)*

Abstract. Precision viticulture relies on high-resolution spatial and temporal data to characterize intra-vineyard variability and support site-specific management. The integration of proximal and remote sensing enables the collection of multi-source datasets describing soil conditions and vine vigor at fine spatial scales. The objective of this study was to evaluate the suitability of a multi-sensor geostatistical approach for the delineation of management zones in a Mediterranean vineyard. The experiment was conducted in a Catarratto vineyard located in western Sicily, characterized by complex topography with slopes up to 15%. The vineyard was monitored over two growing seasons (2023–2024) to assess the influence of soil conditions and vegetative vigor on vineyard spatial patterns. Soil physical and chemical variability was mapped using the towed proximal sensing platform Veris iScan, which measured soil apparent electrical conductivity (EC), soil organic matter (OM), soil texture, and cation exchange capacity (CEC), providing detailed spatial information on soil fertility across the vineyard. Soil penetration resistance (SPR) measurements were also performed to assess compaction-related variability. Vine canopy vigor was monitored at three key phenological stages, flowering, veraison, and pre-harvest, using multispectral imagery acquired from a UAV platform. Vegetation indices derived from the imagery revealed significant spatial differences in vine vigor across the study area. Multi-source soil and canopy datasets were integrated using multivariate geostatistical techniques to estimate regionalized factors and delineate three iso-frequency management zones. The resulting zones reflected consistent spatial patterns linked to both soil properties and vine growth response. The proposed digital workflow demonstrates the potential of multi-sensor data fusion and geostatistical modeling to support variable-rate applications and targeted soil management, contributing to the digital transition toward more efficient and sustainable vineyard systems.

Keywords: Precision viticulture; Geostatistics; Digital Soil Mapping; Management zones.

Circular economy strategies for urban soil restoration: Reusing crushed asphalt in a de-sealing project in Prato, Italy

Beatrice Fiore [1,*], Giovanni Mastrolonardo [1], Laura Giagnoni [2], Federico Selvi [1], Giovanni Argenti [1], Leonardo Verdi [1], Gregorio Fantoni [1], Bianca Rompato [1], Giacomo Certini [1]

[1] Dipartimento di Scienze e Tecnologie Agrarie, Alimentari, Ambientali e Forestali (DAGRI), Università di Firenze, P. le delle Cascine 18, 50144 Firenze, Italy
[2] Department Civil, Environmental, Architectural Engineering and Mathematics (DICATAM), University of Brescia, I-25123 Brescia, Italy

* *Corresponding author: Beatrice Fiore (beatrice.fiore@unifi.it)*

Abstract. Soil sealing is a major driver of ecosystem degradation in urban areas, severely impairing vital soil functions. While de-sealing is increasingly promoted as a compensatory strategy, its large-scale implementation is often hindered by high operational costs and the significant requirement for imported topsoil. A field experiment was conducted in Prato (Italy) on a newly de-sealed parking area. This study evaluates the technical feasibility of a circular economy approach based on reusing crushed asphalt—generated during the removal of pavement—as a component for constructing soils for urban greening. For this purpose, we tested mixtures of excavated urban soil and 5% (by weight) compost with increasing proportions of crushed asphalt (0, 10, 25, and 50% by weight) revegetated by establishment of a turfgrass. Annual monitoring showed that asphalt incorporation at the highest asphalt dose (50%) modifies soil texture and reduces bulk density, thereby influencing water availability. However, chemical fertility remained stable, with no persistent reductions in nutrient availability. Even biochemical parameters, such as soil respiration and enzyme activities, as well as greenhouse gas emissions, were not significantly affected in any treatment. Hence, the presence of asphalt, even at the highest doses, did not significantly impair vegetation establishment, biomass production, or species diversity during the short-term monitoring period. Our findings demonstrate that the tested levels of crushed asphalt incorporation do not preclude the functional recovery of urban soils, at least in the short term. This strategy thus appears to be a cost-effective and sustainable solution to promote de-sealing and urban redevelopment.

Keywords: Depaving; Technosols; Urban soil restoration; Asphalt reuse; Soil biological quality.

Shaping the ambrosia beetle community: the role of environmental drivers in chestnut-dominant areas

Eleonora Vittoria Fontana *, Chiara Ferracini

Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy

* *Corresponding author: Eleonora Vittoria Fontana (eleonora.fontana@unito.it)*

Abstract. This research explores the environmental determinants shaping the ambrosia beetle community (Coleoptera: Curculionidae: Scolytinae and Platypodinae) across chestnut-growing areas of Piedmont region, Italy. Using a total of 48 ethanol-baited traps during the 2024–2025 monitoring period, we assessed beetle assemblage in managed chestnut orchards and mixed environments. The monitoring allowed to capture 118,286 specimens, with the native *Xyleborinus saxesenii* (Ratzeburg) emerging as the dominant species (95% of the total captures). Notably, the survey recorded the presence of three exotic species: *Anisandrus maiche* Stark, *Xylosandrus crassiusculus* (Motschulsky), and *Xylosandrus germanus* (Blandford). Our analysis highlights that local community composition is strongly affected by geographic and ecologic factors. Specifically, the humid conditions promoted higher alpha diversity and proved to be more adapted to invasive species establishment, likely facilitated by a high density of different host plants. Conversely, the xerothermic climate and increased ecological stability appeared to enhance the resilience of native species. These results suggest that while chestnut-dominant areas act as ecological refuge, their susceptibility to biological invasion is highly site-specific. Further investigations are required to understand how the population dynamics can evolve, also in response to shifting environmental conditions.

Keywords: Scolytinae; Beetle assemblage; Non-native species; Host tree association; Ethanol-baited traps.

Seasonal flight activity and management of *Arocatus melanocephalus* and *Corythucha ciliata* in an urban environment: the case study of Turin (NW Italy)

Michela Miglio, Eleonora Vittoria Fontana *, Chiara Ferracini

Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy

* *Corresponding author: Eleonora Vittoria Fontana (eleonora.fontana@unito.it)*

Abstract. This study evaluated the seasonal flight activity of two insect pests and the effectiveness of control strategies in an urban environment. Specifically, the research focused on the elm seed bug, *Arocatus melanocephalus* (Fabricius) (Heteroptera: Lygaeidae), and the sycamore lace bug, *Corythucha ciliata* Say (Heteroptera: Tingidae). Both species represent a considerable nuisance in public places, with the first primarily affecting elm trees (*Ulmus* spp.), and the latter the plane trees (*Platanus* spp.). Monitoring was conducted in four sites per species in Turin, NW Italy in 2025. Eight yellow sticky traps were deployed per site and replaced weekly (*A. melanocephalus*: April–July; *C. ciliata*: May–October), and branch-beating (five branches/five trees) was applied as well. In the laboratory, the total number of individuals recorded through the use of traps and branch-beating was counted. To reduce the pest outbreaks, winter pruning for both species, and systemic trunk injections with abamectin (New Corradi Method) for *C. ciliata* were evaluated. Their effectiveness was evaluated by comparing pruned and treated trees versus control trees (unpruned and untreated). Monitoring data confirmed a single annual generation for *A. melanocephalus*, and highlighted a higher presence of the pest in early April (start of feeding by overwintering adults) and mid-June (peak population). The statistical analysis confirmed that pruning significantly reduced the infestation density compared to unpruned controls. Furthermore, historical and climatic data suggested that high temperatures and low rainfall in early spring may act as key drivers for species abundance. For *C. ciliata*, three annual generations were observed, with a peak in August. While pruning proved negligible for *C. ciliata*, systemic trunk injections achieved up to 90% pest reduction. Combining these findings with a continuous long-term monitoring is crucial for defining optimal intervention windows and to optimize tree health and mitigate public nuisance.

Keywords: Sycamore lace bug; Elm seed bug; Sticky traps; Sustainable management; Urban insect pest.

Effects of *Trichoderma asperellum* Samuels, Lieckf. & Nirenberg on growth and production traits in local tomato and bean landraces

Simone Buratti, Andrea Giacomelli, Nicolò Tonini, Graziano Rossi, Carolina Girometta, Giulia Franzoni *

Department of Earth and Environmental Sciences, University of Pavia, Via S. Epifanio 14, 27100 Pavia, Italy

* *Corresponding author: Giulia Franzoni (giulia.franzoni@unipv.it)*

Abstract. Sustainable agronomic practices increasingly rely on the use of microbial biostimulants to enhance crop quality and resilience to environmental stresses. Among these, *Trichoderma* spp. Showed to improve nutrient use efficiency, stimulate plant metabolism, and enhance tolerance to abiotic stress. The present study (RUSTICO project, funded by Fondazione LGH E.T.S.) evaluated the effects of a *Trichoderma asperellum* strain, on plant performance, applied to the substrate at sowing in plug trays of common bean (*Phaseolus vulgaris* L.) and tomato (*Solanum lycopersicum* L.). Five landraces were selected to preserve and valorise traditional genetic resources: two bean varieties ('Gambolò' and 'Vigevano'), one runner bean ('Pietragavina'), and two tomato varieties (long-shaped fruit like 'San Marzano' and flattened-ribbed fruit like 'Riccio di Parma'). Seeds were provided by the Plant Germplasm Bank of the University of Pavia. Seedlings were transplanted in open field and plant height was recorded before and after transplanting, while chlorophyll content was monitored weekly using SPAD measurements. Preliminary results indicate genotype-dependent responses to *T. asperellum* application, with the most pronounced effects observed during early growth stages. Treated plants exhibited higher germination in both species, regardless of variety. In tomato, treated plants showed reduced shoot height, suggesting a potential shift in carbon allocation toward root development or secondary metabolism. SPAD readings revealed variety-specific patterns: in long-shaped fruit variety, treated and control plants showed similar values overall, with higher SPAD values in treated plants toward the end of the trial; in flattened-ribbed fruit variety, treated plants exhibited slightly higher SPAD values, particularly at early stages. Similarly, bean landraces displayed genotype-dependent responses. The treatment led to increased SPAD values, particularly during the late stages of the crop cycle in Gambolò. Further analyses will investigate fruit quality traits to assess the role of this treatment in sustainable crop management and stress adaptation.

Keywords: *Trichoderma asperellum*; Landraces; Microbial biostimulants.

Impact of TsvlRNA1 infection on the *Trichoderma–tomato* interaction under stress conditions

Fulco Frascati [1,*], E. Bizzarri [1], A. Giorni [1], F. Cicko [1], S. Pagnoni [2], C. Formiglia [3], C. Caruso [1,3], L. Bertini [1]

[1] Department of Ecological and Biological Sciences, University of Tuscia, Largo dell'Università snc, 01100 Viterbo, Italy
[2] Department of Agricultural and Environmental Sciences, Production, Landscape, Agroenergy, University of Milan, via Celoria 2, 20133 Milan, Italy
[3] Institute for Sustainable Plant Protection (IPSP-CNR), Strada delle Cacce, 73, 10135 Torino, Italy

* *Corresponding author: Fulco Frascati (fulco.frascati@unitus.it)*

Abstract. *Trichoderma* species are well known for supporting plant growth and reinforcing stress resilience, not only by suppressing pathogens but also by priming systemic defenses that enhance the plant's ability to cope with environmental and biological challenges. In contrast, the effect of viroid-like RNAs in beneficial fungi remain largely understudied, although they have recently emerged as a key research topic due to their potential influence on fungal biology and plant–fungus interactions. In this study, we investigated the role of a viroid-like RNA (TsvlRNA1) in two *Trichoderma* species, *T. harzianum* (strain T100) and *T. spirale* (strain T45), generated by anastomosis from a T45 donor carrying the viroid. Using isogenic lines either carrying (+) or lacking (-) the TsvlRNA1, we evaluated the tripartite plant-fungus-viroid interaction in tomato (*Solanum lycopersicum* cv. San Marzano nano) under biotic (*Botrytis cinerea* infection) and abiotic (salinity) stress conditions. Neither *T. harzianum* T100 nor *T. spirale* T45 lines showed a substantial impact on tomato plant growth parameters overall, indicating the absence of a pronounced biostimulatory effect. However, plants treated with the *T. spirale* T45 (+) displayed a modest but statistically significant increase in selected growth parameters compared with non-colonized plants. Under stress conditions, both fungal isogenic lines exerted similar effects on tomato plants, primarily through the induction of physiological priming of stress-response pathways. Notably, this fungus-induced priming appears to be further strengthened in the presence of TsvlRNA1, resulting in an improved plant response to both biotic and abiotic stresses. This enhanced primed state may contribute to increased stress tolerance through optimized defense activation and resource reallocation. Overall, our findings suggest that TsvlRNA1 may play a modulatory role in *Trichoderma*–plant interactions and plant stress resilience, although further investigation is required to fully elucidate the underlying mechanisms.

Keywords: *Trichoderma*; Viroid like element; *Solanum lycopersicum*; Defence priming; Stress resilience.

Vermicompost as a sustainable strategy to enhance yield and functional quality of tomato

Giovanna Marta Fusco [1,*], Ida Di Mola [2] , Mauro Mori [2], Eugenio Cozzolino [3], Biagio Morrone [4], Fulvio Trasacco [5], Petronia Carillo [1]

[1] Università degli Studi della Campania "Luigi Vanvitelli", Caserta, 81100, Italia
[2] Università degli Studi di Napoli "Federico II", Portici, 80055, Italia
[3] CREA - Centro di Ricerca Cerealicoltura e Colture Industriali, Caserta, 81100, Italia
[4] Università degli Studi della Campania "Luigi Vanvitelli", Aversa, 81031, Italia
[5] BIOS MIMESIS Società Agricola Innovativa S.r.l., Aversa, 81031, Italia

* *Corresponding author: Giovanna Marta Fusco (giovannamarta.fusco@unicampania.it)*

Abstract. Vermicompost, produced through the biological transformation of residual biomass by earthworms, represents a key resource within circular economy strategies applied to agriculture. Its use as an organic fertilizer allows the valorization of livestock waste, reduces environmental impacts, and sustainably improves soil fertility. This study evaluated the effects of four fertilization strategies on *Solanum lycopersicum* L. grown in loamy and clay soils: an unfertilized control (NF), a mineral fertilization (MIN), a vermicompost (VC, derived from buffalo manure and applied at nitrogen rates equivalent to MIN), and a residual treatment (R-VC, soil previously fertilized with vermicompost during a cauliflower crop). MIN produced the highest yields, reaching up to 110 t ha^{-1}, mainly due to an increase in the number of fruits. However, VC also produced high yields (>80 t ha^{-1}), confirming its effective use as a sustainable alternative to conventional fertilisation. VC significantly enhanced fruit nutritional quality, increasing lycopene content (+32%), total polyphenols (+13%), and several functional amino acids, including γ-aminobutyric acid (GABA) (+38%), glutamine (+24%), glutamate (+10%), and asparagine (+39%) compared to NF. Significant increases were also observed in monoethanolamine (MEA) (+37%) and ornithine (+36%), metabolites involved in stress response and photosynthetic efficiency. Although MIN showed the highest total amino acid content (176.34 mg g^{-1} DW), VC promoted a more balanced biochemical profile enriched in antioxidants. The R-VC treatment maintained a persistent positive effect, with increases of 10–20% compared to NF. Multivariate analysis revealed a clear separation among treatments: MIN was primarily associated with yield-related traits and protein content, whereas VC promoted the accumulation of sugars, lycopene, and antioxidants, indicating distinct and complementary metabolic strategies. Overall, these results demonstrate that vermicompost, both as a direct fertiliser and through its residual effects, represents a sustainable agronomic strategy for improving the yield, nutritional quality and physiological resilience of tomatoes in horticultural systems.

Keywords: *Solanum lycopersicum* L.; Circular economy; Metabolic profile; Antioxidants.

A high-quality chromosome-level genome of cultivated cardoon provides insights into bioactive metabolic pathways

Luciana Gaccione [1], Edoardo Vergnano [1], Matteo Martina [1], Sergio Lanteri [1], Antonio Elia [2], Giulia Conversa [2], Giovanni Mauromicale [3], Sara Lombardo [3], Lorenzo Barchi [1,*]

[1] DiSAFA, Plant Genetics, University of Turin, 10095 Grugliasco (TO), Italy
[2] DAFNE, University of Foggia, 71100 Foggia (Italy)
[3] Di3A, University of Catania, 95123 Catania (Italy)

* *Corresponding author: Lorenzo Barchi (lorenzo.barchi@unito.it)*

Abstract. *Cynara cardunculus* L. (2n = 2x = 34) is a Mediterranean species comprising three taxa: globe artichoke (*var. scolymus*), cultivated cardoon (*var. altilis*), and their wild progenitor, wild cardoon (*var. sylvestris*). Among them, cultivated cardoon stands out for its high biomass yield and its remarkable capacity to accumulate natural bioactive compounds (NBCs) under low-input agricultural conditions, making it a promising crop for sustainable production systems and pharmaceutical applications. Arbuscular mycorrhizal fungi (AMF) form mutualistic associations with cultivated cardoon roots, enhancing nutrient and water uptake and influencing the quantity and composition of NBCs. However, the genetic and molecular mechanisms underlying NBC modulation in response to AMF colonization remain largely unexplored. To establish a genomic framework for investigating these processes, we generated the first chromosome-scale genome assembly of cultivated cardoon (accession 'Altilis 41'). Long-read Oxford Nanopore Technologies sequencing produced 63 Gb of data (~58× coverage). De novo assembly using Hifiasm resulted in 332 contigs with an N50 of 12.5 Mb and a total genome size of 973.85 Mb. Chromosome-scale scaffolding was achieved using Hi-C data processed with the Arima pipeline and YAHS, followed by manual curation. Structural annotation integrated ab initio prediction (Helixer) and evidence-based approaches (BRAKER3), identifying 31,581 protein-coding genes. BUSCO analysis recovered 97.9% of conserved single-copy orthologs, indicating high completeness. This high-quality 'Altilis 41' genome provides a valuable resource for investigating the molecular basis of plant–mycorrhizal interactions. Ongoing transcriptomic analyses of mycorrhized and non-mycorrhized plants will identify differentially expressed genes associated with AMF interaction and NBC biosynthesis, supporting strategies to enhance bioactive compound production in sustainable cropping systems.

Keywords: *Cynara cardunculus* var. *altilis*; Oxford Nanopore sequencing; chromosome-scale genome assembly; AMF; Bioactive compounds.

Acknowledgments: This work was supported by project Prin 2022 20225HAJE7 - Tuning of a sustainable cropping model for the production of bioactive compounds in *Cynara cardunculus* var. *altilis* (BioAltilis).

Optimizing chestnut rootstock production through LED-based light management: recent advances and implications for nursery performance

Giovanni Gamba [1,2,*], Dario Donno [1,2], Lorenzo Rosso [1,2], Davide Lucien Patono [3], Gabriele Loris Beccaro [1,2]

[1] Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy
[2] Chestnut R&D Center – Regione Gambarello, 23, 12013 Chiusa di Pesio (CN), Italy
[3] Plant Flow Solutions – Via Quarello 15/A, 10135 Torino, Italy

* *Corresponding author: Giovanni Gamba (giovanni.gamba@unito.it)*

Abstract. The introduction of LED technology in horticulture has greatly expanded research on light-driven plant responses. Beyond its effects on photosynthesis and growth, light also plays a key role in promoting adaptation to abiotic stress and acclimatation to fluctuating environmental conditions. Most studies, however, focus on herbaceous food and ornamental species, while the effects of artificial lighting on tree crops remain largely unexplored. In chestnut (*Castanea* spp.), research is particularly scarce and mostly limited to micropropagation. Cutting propagation, widely used for producing chestnut rootstocks, is constrained by the high proportion of undersized individuals it generates. Investigating tailored light spectra that enhance plant growth and metabolism could support the production of high-quality and resilient cutting rootstocks. This work reports the main findings of multiple trails conducted over the last two years focusing on the role of different light spectra in shaping the early development of chestnut cuttings. Four light receipts with variable composition of Red, Blue, Green, and Far-red were compared in growth chambers under controlled environmental conditions. The hybrid rootstock Marsol CA07 (*Castanea crenata* × *C. sativa*) produced by cutting at the Chestnut R&D Center was used. Monitoring included biometric measurements, physiological traits (stomatal conductance, leaf chlorophyll content, chlorophyll fluorescence, gas exchange), and analyses of primary (fructose, glucose, and sucrose) and secondary metabolism (polyphenolic fingerprint). Red–blue combinations enhanced pigmentation, secondary metabolite accumulation, and leaf morphology, whereas far-red, particularly when supplied together with green, influenced the primary metabolism. Once the most effective spectra were identified, the subsequent step involved assessing their capacity to prime plants for water-stress conditions. Overall, the findings enabled the identification of light spectra best suited for cutting-propagated chestnut rootstocks, addressing knowledge gap and offering practical implications for nursery and commercial production systems.

Keywords: Clonal rootstocks; LED lighting; Propagation; Stomatal conductance; Water stress.

Monitoring ancient chestnut trees with innovative real-time sensor network for soil health assessment

Giovanni Gamba [1,2,*], Lorenzo Rosso [1,2], Sara Negri [1], Simone Marchisio [3], Silvia Stanchi [1], Eleonora Bonifacio [1,2], Gabriele Loris Beccaro [1,2]

[1] Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy
[2] Chestnut R&D Center – Regione Gambarello, 23, 12013 Chiusa di Pesio (CN), Italy
[3] Impresa Verde Cuneo, Piazza Foro Boario 18, 12100 Cuneo, Italy
* *Corresponding author: Giovanni Gamba (giovanni.gamba@unito.it)*

Abstract. Traditional chestnut groves (*Castanea sativa* Mill.) have been sustaining mountain communities for centuries. Commonly established on north-facing sites and on marginal and poor soils, nowadays most of those groves have been abandoned. The few still under management resemble natural forest stands rather than permanent cropping systems, and are often characterized by senescent trees, steep slopes, and poorly structured compacted soils prone to erosion. Most of the growers limit their activities to grass mowing and nut collection. This approach, combined with the inherent soil characteristics and the systematic removal of burs and leaves, has contributed to soil degradation and, consequently, to declining yield and vegetative status. Sustainable and replicable agronomic approaches to improve soil health and, consequently, plant physiological status are needed, and their identification represents the aim of the present work. Activities were carried out in a centuries old grove located in Cuneo province (NW-Italy). As a baseline, soil properties including key physical, chemical, and hydrological attributes, together with yield, fruit quality, and plant physiological performance were preliminarily assessed. Soil analyses revealed a high organic matter (OM) content and a good C/N ratio in the first 20 cm. Below this depth, the soil became compacted. Both total and available P were low. As a first step, to re-balance P, a 25% organic phosphate fertilizer (132 kg ha^{-1}) was surface-applied during winter across the site. In spring, a shallow aeration was performed using a rolling lawn aerator to increase soil porosity and water-holding capacity. During the growing season, the physiological status of chestnut trees was monitored with Treetalker® sensors providing real-time measurements, complemented by ground-based LAI assessment and remote-derived NDVI patterns. Overall, the study provided an integrated basis for investigating how soil management may affect tree performance and soil health.

Keywords: IoT; Sap flow; Soil tillage; *Castanea sativa*; Treetalker.

Developing and promoting sustainable strategies for the valorization of agricultural residues in the international context: the case of cocoa as a model of a circular economy

Matteo Garau [1,2,*], Benjamin Amedi Afful [3], Patrick Enchill [4], Michael Osei [5], Samuel Twum Adjei [5], Laura Atuah [5], Vincent Logah [3], Mauro Lo Cascio [1,6], Stefania Sole [1], Giuseppe Todde [1], Tom Sizmur [7], Paola Castaldi [1,2], Giovanni Garau [1,2]

[1] Department of Agricultural Science – University of Sassari, Viale Italia 39/a, 07100, Sassari (SS), Italy
[2] Desertification Reserch Centre (NRD) – University of Sassari, Viale Italia 39/a, 07100, Sassari (SS), Italy
[3] Department of Crop and Soil Sciences – Kwame Nkrumah University of Science and Technology, AK -K449-5351, Kumasi, Ghana
[4] Department of Theoretical and Applied Biology – Kwame Nkrumah University of Science and Technology, AK -K449-5351, Kumasi, Ghana
[5] Department of Horticulture – Kwame Nkrumah University of Science and Technology, AK -K449-5351, Kumasi, Ghana
[6] Euro-Mediterranean Centre on Climate Change (CMCC) Foundation – Via de Nicola 9, 07100 Sassari, Italy
[7] Department of Geography and Environmental Science – University of Reading, RG6 6DW, Reading, UK
* *Corresponding author: Matteo Garau (mgarau@uniss.it)*

Abstract. Cocoa pod husk (CPH) is the major solid residue of cocoa production and is commonly left to decompose on-farm, contributing to greenhouse gas (GHG) emissions and representing a lost resource for farmers. This study evaluates the valorisation of CPH through vermicomposting with biochar (vermichar) to obtain a stable amendment capable of reducing GHG emissions during treatment and the carbon footprint of cocoa production. Fresh CPH was mixed with cattle manure (1:1, w/w) and amended with 0, 4 and 8% (w/w) CPH biochar. *Eudrilus eugeniae*, a locally available earthworm species, was used for a 60-day vermicomposting under mesocosm conditions. Chemical parameters (pH, electrical conductivity, organic C, total N, P, K, Ca, Mg), culturable bacteria and fungi, and GHG fluxes (CO_2, CH_4, N_2O) were monitored every 10 days. Biochar addition significantly increased pH and favoured higher N and K contents at maturity, while affecting microbial activity and dynamics during the process. Bacterial counts decreased 1.8-2.2-fold in the first 10 days and then stabilised, whereas biochar initially suppressed fungal CFU but, particularly at 8%, enhanced fungal abundance in the final product. The vermicomposting process was a source of CO_2, CH_4 and N_2O, but increasing biochar rates reduced cumulative CH_4 and N_2O emissions compared with the control, indicating a mitigation potential for the most climate-relevant gases. In particular, vermichar showed lower global warming potential over 60 days than vermicompost. A cradle-to-farm-gate life cycle assessment (functional unit: 1 kg cocoa) highlighted that mineral fertiliser use is the main driver of energy demand (64 MJ kg^{-1}) and GHG emissions (3103 g CO_2e kg^{-1}), while complete substitution of mineral fertilisers with vermichar reduced cumulative energy demand and carbon footprint by about 95%. Overall, CPH-based vermichar emerges as a promising strategy to recycle cocoa residues, mitigate GHG emissions, and support more sustainable cocoa production systems in Ghana.

Keywords: Organic waste; Vermicomposting; Vermichar; Nutrient cycling; Sustainable agriculture.

Effects of social media influencers on willingness to pay for plant-based foods: Evidence from a BDM field experiment

Chiara Gelici *, Fabio Boncinelli, Leonardo Casini

Department of Agriculture, Food, Environment, and Forestry (DAGRI) – University of Florence, Piazzale delle Cascine 18, 50144 Firenze (FI), Italy

* *Corresponding author: Chiara Gelici (chiara.gelici@unifi.it)*

Abstract. Plant-based diets are increasingly promoted for their environmental and health benefits, yet consumer adoption remains limited due to barriers related to taste expectations, price sensitivity, habits, and perceived inconvenience. At the same time, social media has become a central channel for food-related communication, with influencers playing a growing role in shaping attitudes and behavioral intentions. However, causal evidence on their effectiveness in influencing willingness to pay (WTP) for plant-based products is still scarce. Therefore, this study aims to investigate whether exposure to social media posts by influencers promoting plant-based eating affects consumers' WTP for plant-based burgers, drinks, and cold cuts. It also compares the persuasive effectiveness of two influencer types, an athlete and a medical doctor, keeping the textual content constant and varying only the visual source. The experiment is conducted in a field setting with 150 young adults (aged 18–35) who do not follow vegetarian or vegan diets, randomly assigned to one of three experimental treatments: control (neutral message), athlete influencer, or medical doctor influencer. A mixed experimental design is adopted, with one between-subject factor (control vs. athlete vs. doctor) and within-subject factors (pre- and post-exposure; products evaluated) to maximize statistical power and control for potential anchoring effects. Participants state their WTP in an incentivized Becker–DeGroot–Marschak (BDM) auction, ensuring incentive compatibility and truthful reporting. Treatment effects are estimated using mixed-effects models with individual-level random effects, focusing on changes in WTP between rounds. Expected results suggest that exposure to influencer posts increases WTP for plant-based products, with a stronger effect for the athlete than for the doctor. Thus, this study contributes to research on digital communication and sustainable diets, offering insights for policymakers and marketers designing campaigns to promote plant-based consumption.

Keywords: Plant-based products; Social media influencers; Willingness to pay; Becker-DeGroot-Marschak mechanism.

Assessing seawater intrusion impacts on summer crops in the Po River Delta using long-term remote sensing data

Aurora Ghirardelli [1,*], Xue Chenli [2], Paolo Tarolli [1]

[1] Department of Land, Environment, Agriculture and Forestry, University of Padova, Agripolis, Viale dell'Università 16, 35020 Legnaro (PD), Italy
[2] China Aero Geophysical Survey and Remote Sensing Center for Natural Resources, 100083 Beijing, China

* *Corresponding author: Aurora Ghirardelli (aurora.ghirardelli@unipd.it)*

Abstract. Seawater intrusion (SWI) poses an increasing threat to coastal agricultural, particularly in low-lying deltas where climate change, sea-level rise, and freshwater scarcity interact. The Po River Delta in northern Italy is among the most vulnerable Mediterranean hotspots of SWI, where recurrent salinization episodes have raised concerns for crop productivity and long-term agricultural sustainability. Despite its strategic importance, a systematic assessment of how SWI has affected agricultural patterns and crop stress over multiple decades has been lacking. This study provides the first long-term, spatially explicit analysis of crop distribution and salinity-related vegetation stress in the Po River Delta. We combine multi-decadal Landsat surface reflectance observations (2000–2024) with a machine learning framework to classify the major summer crops of the region, soybean, rice, maize, and alfalfa. Seasonal spectral indices linked to vegetation stress and soil salinity were derived for the main growing period, allowing the investigation of crop-specific responses, seasonal variability, and recurrent spatial patterns of stress. The results reveal persistent and coherent signals of salinity-related stress across the delta, with coastal areas consistently emerging as hotspots and pronounced differences observed among crop types. Stress patterns show clear seasonal dynamics, with early summer conditions appearing particularly sensitive to saline influence. Overall, this work bridges a critical knowledge gap by reconstructing the historical evolution of salt-induced agricultural stress at a regional scale, while remaining consistent with available local observations. The proposed framework offers a transferable approach to identify salinity-prone areas and supports the development of targeted adaptation strategies, including crop planning, land-use management, and improved water governance in coastal agricultural regions increasingly affected by SWI.

Keywords: Seawater intrusion; Salinization; Landsat; Crop classification; Coastal agriculture.

Effect of *Trichoderma asperellum* on the Ottofile Pavese maize landrace under two environmental conditions

Andrea Giacomelli *, Simone Buratti, Giulia Franzoni, Riccardo Frati, Carolina Girometta, Graziano Rossi, Nicolò Tonini, Michela Landoni

Department of Earth and Environmental Sciences – University of Pavia, Via S. Epifanio 14, 27100 Pavia (PV) Italy

* *Corresponding author: Andrea Giacomelli (andrea.giacomelli02@universitadipavia.it)*

Abstract. Maize (*Zea mays* L.) must comply with established mycotoxin thresholds for both human food and animal feed. Mycotoxins are toxic secondary metabolites produced by several fungi genera, including *Fusarium spp.* and *Aspergillus spp.* These genera are involved in the production of fumonisins (B1 and B2), zearalenone (ZEN), and deoxynivalenol (DON). To limit mycotoxin production, agronomic practices and post-harvest management are crucial. An interesting approach is the use of biocontrol agents, like *Trichoderma asperellum*, which is applied in maize cultivation as plant protectant, due to its biofungicidal activity against mycotoxin-producing fungi. Maize traditional varieties (landraces) are dynamic populations with high socio-cultural and scientific interest. One of the factors that has limited, and continues to limit, landrace cultivation since the Green Revolution is their low yield. One reported effect of *T. asperellum* as a seed coating is the enhancement of plant growth, nutrient uptake, and drought resistance. In this study, the effect of *T. asperellum* on the maize landrace Ottofile Pavese was evaluated by comparing treated plants with an untreated control in a randomized complete block design. The experiment was conducted at two sites in the province of Pavia, Romagnese (Oltrepò Pavese hills) and Landriano (Po valley), to assess crop performance under different environmental conditions. Soil characteristics and meteorological data were correlated with agronomic parameters, including germination rate, plant development, chlorophyll content, and yield, as well as the mycotoxin content. Preliminary results indicate increased chlorophyll content in treated plants grown in the hilly environment, whereas no significant differences were observed in the Po valley site. A second year of cultivation is planned for the 2026 growing season.

Keywords: Maize landrace; *Trichoderma asperellum*; Biostimulant; Biocontrol; Sustainable crop production.

Chitinolytic activity and EPS production of bacteria isolated from amphibian culturable microbiota

Oscar G. Gialdini [1,*], Beatrice Farda [1], Enrico Lunghi [1,2], Marika Pellegrini [1,2]

[1] Department of Life, Health and Environmental Sciences, University of L'Aquila, 67100 L'Aquila, Italy
[2] Eco Nat, academic spin-off of the University of L'Aquila, via dell'Aringo 34, 67100 L'Aquila, Italy

* *Corresponding author: Oscar Giuseppe Gialdini (oscargiuseppe.gialdini@graduate.univaq.it)*

Abstract. At the present time, one of the groups of vertebrates that are facing a vast biodiversity loss is that of amphibians. Among the many causes related to the current populations' decline there are habitat loss, climate change and fungal diseases, mainly due to fungi belonging to the *Batrachochytrium* genus. Recent discoveries have brought to light the role that bacteria constituting the amphibian skin microbiota can have in countering pathogens and inhance the host's tolerance to environmental stress. As part of the PhD project PNRR - DM 630/2024 – M4C2 – Inv. 3.3 – CUP E11I24000270001 "Anfibi e microbiota: indagine sulle comunità batteriche e sulla loro importanza ecologica", it was carried out a metabolic characterization of the strains isolated from skin swabs cultures of three Italian amphibian species: *Bombina pachypus*, *Salamandra salamandra* and *Speleomantes italicus*. The study mainly focused on those activities considered useful against fungal pathogens and drought stress, that are chitinase and exopolysaccharide (EPS) production. Both traits have been tested using semi-quantitative methods by culturing the strains on selective media: colloidal chitin agar and congo red agar. After that, the strains that resulted positive for at least one of the traits have been genetically identified using 16S rRNA genes.

Keywords: Microbiology; Amphibians; Ecology; Microbiota; Genomics.

No alcohol, many prices: a quantile regression analysis of the No- and Low-alcohol wine market

Caterina Fucile Franceschini [1], Elisa Giampietri [1,2,*], Eugenio Pomarici [1], Giuliana Di Maria [3], Antonio Seccia [3]

[1] Department of Land, Environment, Agriculture and Forestry (TESAF), University of Padova, viale dell'Università 16, 35020 Legnaro (PD), Italy
[2] Department of Agronomy, Food, Natural Resources, Animals and Environment, University of Padova, viale dell'Università 16, 35020 Legnaro (PD), Italy
[3] Department of Humanities, University of Foggia, via Arpi, 176, 71121 Foggia, Italy
* *Corresponding author: Elisa Giampietri (elisa.giampietri@unipd.it)*

Abstract. The No- and Low-alcohol (NoLo) wine market has experienced rapid growth in recent years, driven by changing consumer preferences and health-related considerations. However, empirical evidence on price formation and value drivers across market segments remains limited. This study investigates the determinants of NoLo wine prices by applying a quantile regression approach, which captures heterogeneity in attribute effects across the price distribution rather than focusing on average outcomes. Using an original dataset constructed from the websites of major international retailers and individual producer websites, the analysis examines product and firm characteristics such as alcohol content, wine type, origin certification, sustainability labels, grape variety, dealcoholization techniques, packaging, awards, and country of origin. Given the non-normal distribution of prices, a quantile regression was used for capturing pricing differences across low, middle, and high price segments. Results indicate that the impact of product attributes on NoLo wine prices differs markedly across quantiles. Country-of-origin effects generally increase along the price distribution, with some exceptions (e.g., Austria and Sweden). Grape origin information consistently and increasingly enhances prices across quantiles, while awards and producer specialization mainly affect higher-priced segments. Partial dealcoholization is penalized in mid-range prices, compared to total dealcoholization. The absence of grape variety information reduces prices especially at lower quantiles, whereas information on the dealcoholization technique displays heterogeneous but consistently positive effects across the price distribution. Overall, NoLo wine value is shaped not only by reduced alcohol content but also by informational, technological, and reputational attributes that consumers use to infer product quality. These findings reveal substantial heterogeneity in pricing mechanisms and highlight the importance of attribute differentiation across price segments. The analysis offers implications for producers, marketers, and policymakers, particularly regarding pricing strategies and labelling regulations aimed at enhancing market transparency.

Keywords: No- and Low-alcohol wine; price determinants; quantile regression.

Whole-genome sequencing and phenotyping of neglected and underutilized vegetable melons from the Salento diversity centre (Southern Italy)

Marzia Guerriero [1,*], Francesco Arcieri [1], Chiara Delvento [1], Gaetano Giudice [1], Marco Santo Cannarella [1], Luigi Ricciardi [1], Concetta Lotti [2], Stefano Pavan [1]

[1] Department of Soil, Plant and Food Sciences, University of Bari Aldo Moro, Via Amendola 165/A, 70126 Bari, Italy
[2] Department of Agricultural, Food and Environmental Sciences, University of Foggia, Foggia, Italy

* *Corresponding author: Marzia Guerriero (marzia.guerriero@uniba.it)*

Abstract. The species *Cucumis melo* L. includes two neglected and underutilized vegetable crops, cucumber melon (C. *melo* subsp. *melo* var. *chate*) and snake melon (C. *melo* subsp. *melo* var. *flexuosus*). In particular, cucumber melon was highly popular in Mediterranean civilizations during Antiquity and the Middle Ages, whereas today its cultivation is mostly confined to the Salento area of southern Italy. Here, we describe the collection and characterization of thirteen cucumber melon and two snake melon populations from Salento. Whole-genome resequencing of DNA pools was performed to investigate genetic diversity within and among populations. The cucumber melon population UBGCMC111, most widely cultivated and marketed, exhibited the lowest heterozygosity, possibly reflecting more intense selection by farmers. Hierarchical clustering revealed genetic divergence of UBGCMC111 and UBGCMC053, the latter originating from a unique area of Salento with linguistic and cultural ties to Greek heritage. Despite some unique patterns of variation, snake melons clustered together with cucumber melons, suggesting overall genetic similarity. A total of 1,307 alleles were fixed and private to different populations under study, potentially valuable for their traceability. Some of them were associated with genes possibly underlying deeply grooved and pale green pepo phenotypes of the populations UBGCMC111 and UBGCMC124, respectively. Replicated field trials enabled germplasm characterization and the selection of agronomically superior populations. Overall, this study safeguards valuable C. *melo* genetic diversity from further genetic erosion. Additionally, it provides genomic and phenotypic data laying a foundation for integrating unexplored genetic resources into mainstream agrifood systems and breeding programs.

Keywords: Cucumber melon; Snake melon; Whole-genome resequencing; Diversity; Private alleles.

"Just-in-Time" irrigation: Sensor-based strategies for maximizing water use efficiency

Nicolò Iacuzzi *, Noemi Tortorici, Teresa Tuttolomondo

Department of Agricultural, Food and Forest Sciences (SAAF), University of Palermo, Viale delle Scienze, 90128 Palermo, Italy

* *Corresponding author: Nicolò Iacuzzi (nicolo.iacuzzi@unipa.it)*

Abstract. The Mediterranean region is currently warming at a rate 20% faster than the global average, with critical temperature increases already reaching 1.5°C above pre-industrial levels. In regions such as Sicily, extreme drought events—exemplified by 330 days without precipitation in 2024—pose an existential threat to agriculture, a sector that accounts for 70% of global water consumption. Traditional irrigation management, predominantly based on the FAO-56 model, often fails to account for spatial-temporal soil variability and real-time plant requirements, leading to potential over-irrigation or significant crop stress. This study evaluates the transition from predictive/modeling approaches to reactive "Just-in-Time" irrigation strategies. The primary objective was to maximize Water Use Efficiency (WUE) and sustainability by employing direct soil moisture monitoring to trigger irrigation events precisely when critical thresholds are reached. The methodology involved a three-year field trial on processing tomatoes, utilizing advanced IoT-based sensing technologies—specifically TEROS 12 and TEROS 22 (Meter®) sensors—to monitor soil Volumetric Water Content (VWC), Matric Potential (Ψ), and Electrical Conductivity (EC). Experimental data demonstrate that sensor-based management significantly outperformed standard modeling. Sensor-driven irrigation reduced water requirements compared to CROPWAT 8.0 estimates across all trial years (e.g., from 5254.21 to 4607.48 m^3 ha^{-1} in 2023). The "Just-in-Time" approach maintained optimal soil water potential within precisely defined thresholds, thereby mitigating the cumulative errors inherent in indirect estimation methods. The convergence of advanced sensing and real-time data analytics offers a robust solution for sustainable water resource management. Although barriers such as initial capital costs and technical expertise persist, "Just-in-Time" irrigation can reduce water consumption by up to 30%, fostering agricultural resilience against escalating global water stress.

Keywords: Climate change adaptation; IoT in Agriculture; Precision irrigation; Smart water management; Soil moisture sensors.

Preliminary metrological characterization of low-cost MEMS inclinometer for tree stability assessment: From laboratory to field

Ilaria Incollu [1,*], Yamuna Giambastiani [2], Andrea Giachetti [3], Tommaso Tognetti [2], Giuliano Secchi [1], Irene Fattoretto [1], Ilaria Zorzi [2], Jessica Scriva [2], Francesca Giannetti [1]

[1] Geolab Laboratory of Forest Geomatics, Department of Agriculture, Food, Environment and Forestry, University of Florence, 50145 Florence, Italy
[2] Bluebiloba Startup Innovativa SRL., 50126 Florence, Italy
[3] Department of Civil and Environmental Engineering, University of Florence, 50126 Florence, Italy
* *Corresponding author: Ilaria Incollu (ilaria.incollu@unifi.it)*

Abstract. Urban trees provide important benefits but can also pose safety risks when stability is reduced. Visual Tree Assessment (VTA) is typically the first step in risk analysis and is sometimes complemented by instrumental methods such as dynamic and static tests. Static pulling tests provide quantitative information on anchorage, but their cost and logistics limit use to site-specific applications. This study evaluates a low-cost Micro-Electro-Mechanical Systems (MEMS) inclinometer for quasi-static inclination measurements during a static pulling test, combining a laboratory calibration against a geometric reference with field comparisons against a professional high-precision inclinometer commonly used in static pulling tests. In the laboratory, using a calibrated tilting beam and a 120 s averaging window, the MEMS sensor yielded absolute errors on the order of a few hundredths of a degree (up to ≈0.015◦) compared to the geometric expectation. In the field, comparisons were performed in the relative domain (baseline on the first stable plateau) along the longitudinal component, showing high concordance with the reference high-precision inclinometer commonly used in arboricultural pulling tests (e.g., $r \geq 0.99$, RMSE ≈ 0.04–0.07, Deming slope ≈ 1.02–1.05). These results support the feasibility of low-cost MEMS for static tilt assessment. Given battery-powered wireless operation and simple processing, they indicate a potential for wider deployments in repeated or scheduled quasi-static assessments (e.g., during controlled pulling tests), complementing professional instrumentation.

Keywords: MEMS inclinometer; Tree stability; Static pulling test; Low-cost sensors; Urban forestry.

Biocontrol agents strategies to minimize mycotoxin contamination in wheat under different tillage systems

Marco Laiolo *, Stefano Maruccia, Raffaele Meloni, Mattia Scapino, Valentina Scarpino, Massimo Blandino

Department of Agricultural, Forest and Food Sciences (DISAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy

* *Corresponding author: Marco Laiolo (m.laiolo@unito.it)*

Abstract. Cereals are the main global food source, and wheat is the leading crop by cultivated area. Current European strategies promote conservative and regenerative agriculture, encouraging the reduction of agronomic input, including the transition from conventional (CT) to minimum tillage (MT) to reduce emissions, costs and soil erosion. However, MT increases fungal inoculum due to previous crop residue occurrence on the soil surface, and therefore the wheat infection of *Fusarium* Head Blight (FHB) agents and the mycotoxin contamination, particularly deoxynivalenol (DON). As cereal cropping systems increasingly shift toward conservative agriculture and reduced use of chemical pesticides, this study aims to evaluate the use of biological control agents (BCAs) as a preventive strategy to limit the severity of fungal diseases and the contamination by regulated mycotoxins (deoxynivalenol and zearalenone) as well as emerging mycotoxins (moniliformin and enniatins). A four-year split-plot field experiment was carried out with soil tillage (CT *vs* MT) as main factor and fungal control treatments as sub-factor; untreated control, BCA application on soil at the stem elongation stage (*Trichoderma asperellum* and *T. gamsii*), chemical fungicide (F) application at flowering, and their combination (BCA+F). In both tillage conditions, BCA application increased grain yield compared to untreated plots (+7%), while BCA+F provided the highest yield (+26%) and test weight (+5%). On average, MT increased FHB incidence by 35% and DON contamination by 151% compared to CT. For both soil tillage, BCA reduced FHB incidence and DON contamination (-10%), while fungicide showed a higher effect in MT (-63%) compared to CT (-50%). In MT, DON was 14% lower for BCA+F than F alone, while in CT no significant differences were detected between F and BCA+F. In MT conditions, BCA could represent a viable alternative or complement to chemical fungicide, reducing potential FHB agents inoculum and resulting in a lower sanitary risk.

Keywords: Biocontrol agent; BCA; *Fusarium* Head Blight; Mycotoxins; Regenerative Agriculture.

Enhancing durum wheat growth and drought tolerance through microbial-enriched soil amendments

Marco Laiolo [1,*], Noemi Gatti [2], Noureddine Besselma [3], Stefano Maruccia [1], Raffaele Meloni [1], Mattia Scapino [1], Fernando De Palo [1], Alessandra Salvioli di Fossalunga [2], Daniel Said Pullicino [1], Emanuela Gobbi [3], Gianpiero Vigani [2], Massimo Blandino [1]

[1] Department of Agricultural, Forest and Food Sciences (DISAFA), University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy
[2] Department of Life Sciences and Systems Biology (DBIOS), University of Turin, Via Verdi 8, 10124 Turin, Italy
[3] Department of Molecular and Translational Medicine, University of Brescia, Viale Europa 11, 25123 Brescia, Italy

* *Corresponding author: Marco Laiolo (m.laiolo@unito.it)*

Abstract. Durum wheat is the most widely cultivated cereal crop in the Mediterranean region, where increasing climate variability is causing pronounced yield instability. To ensure long-term food security and agricultural sustainability, regenerative practices capable of enhancing agroecosystem resilience to abiotic and biotic stresses are increasingly required. A greenhouse pot experiment was conducted to evaluate the effects of different microbial-enriched soil amendments (BioA), produced through solid-state fermentation of a substrate composed of wet straw (70%) and fruit residues (30%), on durum wheat growth and phenotypic traits. The experimental design followed a factorial arrangement combining five BioA treatments – control without BioA application at soil before sowing; BioA without microbial inoculation; BioAT, inoculated with *Trichoderma afroharzianum* T-22; BioAM, inoculated with the arbuscular mycorrhizal fungus *Rhizophagus irregularis*; and BioATM, co-inoculated with both microorganisms – and two water regimes: well-watered conditions and drought stress, imposed by suspending irrigation from stem elongation to the booting stage, followed by a six-day recovery during heading. Wheat growth was monitored using a set of vegetation indices – including leaf chlorophyll content, NDVI, NPCI, PSRI, digital biomass and leaf area index – measured daily with the PlantEye FieldScans system. In addition, physiological parameters were assessed using a porofluorimeter. Aboveground biomass was determined at flowering. The results indicate that soil application of BioA, particularly when combined with beneficial microorganisms, can enhance drought resilience in wheat. While BioA alone promoted biomass accumulation and partially maintained stomatal function under stress conditions, BioAT and BioAM treatments improved plant water status and delayed senescence, although photosynthetic activity remained constrained. The BioATM treatment was the most effective, integrating improved water uptake, pigment protection, and recovery of photosynthetic function under drought. Overall, these findings highlight the synergistic potential of microbial consortia in enhancing the functional performance of biostimulants on wheat, which warrants further validation under open-field conditions.

Keywords: Regenerative agriculture; *Trichoderma* spp.; Microbial-enriched soil amendments; Arbuscular mycorrhizal fungus; Crop phenotyping.

Carrot flour-enriched pasta with improved nutritional properties and *in vitro* antioxidant activity counteracted inflammatory pathways in human colon cell line

Alessia Lisi [1,*], Giusy Rita Caponio [2], Maria Calasso [1], Grazia Tamma [2], Ilenia Ceglie [1], Leonardo Mancini [1], Graziana Difonzo [1], Fabio Minervini [1], Maria De Angelis [1]

[1] Università degli Studi di Bari Aldo Moro, Dipartimento di Scienze del Suolo, della Pianta e degli Alimenti
[2] Università degli Studi di Bari Aldo Moro, Dipartimento di Bioscienze, Biotecnologie e Ambiente

* *Corresponding author: Alessia Lisi (alessia.lisi@uniba.it)*

Abstract. Wheat-based pasta, a staple food for many populations, represents a potential vehicle for bioactive compounds and micronutrients. Although some wheat varieties naturally contain high levels of these micronutrients, they are often underrepresented in conventional pasta products. This study aimed to enhance the nutritional and functional properties of fresh pasta by incorporating 12.5% orange or purple carrot flour. Pasta containing orange (O) or purple (P) carrot flour and a conventional pasta (control) were characterized in terms of nutritional composition, sensory profile and microbiological stability. The antioxidant and anti-inflammatory properties were investigated using *in vitro* assays with the human Caco-2 cell line. The enriched pastas could be labelled as "rich in fibre", while only pasta O could be labelled as a “source of vitamin A”. Both enriched pastas showed lower starch hydrolysis index and predicted glycaemic index. The enriched samples exhibited increased antioxidant capacity, attributable to the high content of phenolic compounds and anthocyanins in P and β-carotene in O. Exposure of Caco-2 cell to pasta digests in the presence of a synthetic pro-oxidant did not result in significant differences in reactive oxygen species levels. However, P digest, after colonic fermentation, induced a decrease of NF-κB phosphorylation, suggesting an inhibitory effect on the pro-inflammatory response. Both enriched pastas led to a decrease in vimentin expression, while an increase in E-cadherin expression was exclusively observed in cells treated with the P digest, as confirmed by immunofluorescence analysis. Microbiologically, all pasta samples were stable for 110 days. Overall, using carrot flour, particularly from purple cultivars, has proved to be an effective strategy of improving the nutritional and functional properties of fresh pasta while maintaining good sensory profile.

Keywords: Enriched pasta; Carrot flour; Beta-carotene; Dietary fibre; Antioxidant activity; Anti-inflammatory activity.

Prickly pear seed flour and adjunct lactobacilli as additional ingredients to fermented milk with potential health and nutritional benefits

Rosangela Limongelli [1], Giusy Rita Caponio [2], Alessia Lisi [1,*], Ilenia Ceglie [1], Grazia Tamma [2], Federica Volontè [3], Matteo Spagnuolo [1], Fabio Minervini [1], Maria De Angelis [1]

[1] Università degli Studi di Bari Aldo Moro, Dipartimento di Scienze del Suolo, della Pianta e degli Alimenti
[2] Università degli Studi di Bari Aldo Moro, Dipartimento di Bioscienze, Biotecnologie e Ambiente
[3] Sacco Srl, Cadorago (CO), via Manzoni 29/A

* *Corresponding author: Alessia Lisi (Alessia.lisi@uniba.it)*

Abstract. Fermentation of food by-products using lactic acid bacteria is a promising strategy for conferring functional properties to foods. Processing prickly pear fruits, which can be grow in marginal areas without specific agronomic input, generates significant quantity of by-products. These include the seeds, which can be dried and ground to produce a flour rich in fibre, minerals, and phenolic compounds. The impact of incorporating prickly pear seed flour (PPS) in combination with selected commercial lactobacilli (*Lacticaseibacillus casei* BGP93, *L. casei* LC4P1, *Lacticaseibacillus rhamnosus* LRB, *Lactiplantibacillus plantarum* LPAL), some of which exhibit probiotic potential, on the production of a fermented milk was investigated, and its nutritional properties were evaluated. Preliminary protocol optimization involved examining different percentages of PPS flour added before and after fermentation. The best formulation was obtained by adding 5% PPS flour after fermentation, along with the addition of commercial lactobacilli. Adjunct lactobacilli and yogurt starters were quantified using culture-dependent technique. The inclusion of PPS flour resulted in levels of fibre higher than 3%, as well as increased levels of minerals such as iron, magnesium, potassium, and phosphorus. *In vitro* antioxidant capacity (DPPH· and FRAP assays) was found to be higher in fermented milk supplemented with PPS and *L. casei* BGP93. Furthermore, fermented milk extracts were tested on Caco-2 cell lines, confirming the antioxidant and anti-inflammatory activities associated with the combined use of PPS and *L. casei* BGP93. These results suggest the suitability of supplementing PPS flour with adjunct lactobacilli to develop functional fermented milk with greater availability of phenolic compounds. Finally, sensory analysis was performed to evaluate the product's sensorial characteristics, demonstrating that the inclusion of PPS flour is a viable strategy for developing a novel functional yogurt with high consumer appeal.

Keywords: Prickly pear; By-products; Yogurt; Antioxidant activity; Anti-inflammatory activity.

Early metabolic markers of *Flavescence dorée* infection for sustainable grapevine management

Amelia Locatelli [1,*], Davide Magrin [1], Simone Stefano [1], Luciana Galetto [2], Cristina Marzachì [2], Renzo Bagnati [1], Alice Passoni [1]

[1] Mass Spectrometry for One Health Unit, Department of Environmental Health Sciences, Istituto di Ricerche Farmacologiche Mario Negri IRCCS, Via Mario Negri 2, Milan, Italy
[2] Istituto per la Protezione Sostenibile delle Piante IPSP-CNR, Consiglio Nazionale delle Ricerche, Strada delle Cacce 73, Turin, Italy

* *Corresponding author: Amelia Locatelli (amelia.locatelli@marionegri.it)*

Abstract. *Flavescence dorée* (FD) is one of the most severe phytosanitary diseases affecting European viticulture and represents a major threat to the sustainability and productivity of the viti-vinicultural supply chain. This grapevine infection causes substantial yield and quality losses and requires mandatory control measures, including intensive vector management and the removal of infected plants or, sometimes, entire vineyards, resulting in significant economic and environmental costs. Grapevines undergo metabolic reprogramming in response to biotic stress factors such as phytoplasma infection. Therefore, the identification of early diagnostic analytical methods capable of detecting infection-induced metabolic alterations at asymptomatic stages is essential to improve vineyard management and promote more sustainable disease control strategies. This study aimed to investigate metabolic changes associated with FD infection in grapevine leaves to identify early candidate biomarkers useful for the timely detection of infected plants. Grafted cuttings *Vitis vinifera* cv. Barbera plants were exposed to FD-infected insect vectors under controlled conditions, while non-exposed plants served as controls. Leaf samples from exposed symptomatic and asymptomatic plants were collected three months after exposure, corresponding to the onset of symptom development. Both adaxial and abaxial leaf surfaces were analyzed, with four biological replicates per experimental group. An untargeted mass spectrometry imaging (MSI) approach followed by comparative statistical analyses revealed clear metabolic differences between unexposed and exposed leaves, including asymptomatic samples. These results indicate that FD infection induces biochemical alterations before the appearance of visible symptoms. Several discriminant features were identified and are currently undergoing annotation and validation through LC–MS/MS analyses. Future investigations will assess whether the metabolites altered under controlled conditions are also associated with FD infection in field-grown plants. This integrated strategy has the potential to open new opportunities for sustainable vineyard management and could be extended to the monitoring of other plant diseases.

Keywords: *Flavescence dorée*; Grapevine; Sustainable viticulture; Early infection biomarkers; Metabolomics.

Development and validation of a microbial consortium to mitigate kiwi vine decline syndrome (KVDS)

Raffaele Loffredo [1,*], Giuseppina Magaraci [1], Ida Romano [1], Olimpia Pepe[1], Alessandra Salvioli di Fosselunga [2], Francesco Berruto [2], Valentina Fiorilli [2], Simone Bosco [3], Davide Carmelo Spadaro [3], Valeria Ventorino [1]

[1] Department of Agricultural Sciences, University of Naples Federico II, Piazza Carlo di Borbone 1, Portici (NA), Italy
[2] Department of Life Sciences and Systems Biology, University of Torino, Viale PA Mattioli 25, Torino, Italy
[3] Department of Agricultural, Forest, and Food Sciences, University of Torino, Largo Paolo Braccini, Grugliasco (TO), Italy

* *Corresponding author: Raffaele Loffredo (raffaele.loffredo@unina.it)*

Abstract. Kiwi Vine Decline Syndrome (KVDS) represents a severe threat to kiwi-fruit production and is frequently associated with soil-borne pathogens and waterlogging conditions. This study aimed to identify, produce, and validate a beneficial microbial consortium composed of plant growth-promoting rhizobacteria (PGPR) and arbuscular mycorrhizal fungi (AMF) to mitigate disease impact and improve plant resilience. The bacterial strains *Kosakonia pseudosacchari* TL13, *Azotobacter chroococcum* 76A, *Methylobacterium* populi VP2, and *Priestia megaterium* EL5, were selected for their multiple plant growth-promoting traits, including siderophore production, indole-3-acetic acid synthesis, phosphate solubilization, nitrogen fixation ability, and tolerance to abiotic stresses. The AMF *Rhizophagus irregularis*, a model obligate biotroph widely used in commercial formulations, was also included in the consortium. Mass production of selected strains was optimized through fermentation scale-up, downstream processing, cryoprotection, and lyophilization to obtain a prototype formulation. Greenhouse trials were performed on one-year-old *Actinidia deliciosa* cv. Hayward plants inoculated with *Phytopythium vexans*, an emerging phytopathogenic oomycete affecting diverse plant host, and exposed to waterlogging stress, through submersion. Multiple treatments evaluated preventive and post-stress applications of the microbial consortium. These treatments reduced disease progression (AUDPC) compared to pathogen-inoculated controls. Microbiota analyses revealed significant effects of microbial inoculum along with pathogenic treatment on bacterial and fungal community structure. These findings underline the potential of a multifunctional microbial consortium as a sustainable tool to mitigate KVDS.

Keywords: PGPR; Arbuscular mycorrhizal fungi; *Actinidia deliciosa*; *Phytopythium vexans*; Microbiota analyses.

Acknowledgments: This work was supported by Fondazione Cariplo, Project AGER 3, grant no. 2022–3307. “From SOil to Soil: origin and remediation to KIWIfruit Vine Decline Syndrome (SOS-KIWI)”.

Integrating multiple indicators through spatial analysis to provide a comprehensive interpretation of two farming areas in the Roero (Italy)

Paolo Longo *, Lorenzo Bruenetti, Fabrizio Cannizzaro, Cristiana Peano

Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy

* *Corresponding author: Paolo Longo (paolo.longo@unito.it)*

Abstract. Biodiversity loss in farmland is increasingly associated with structural and functional simplification of agroecosystems. In many regions, intensification has reduced crop diversity and rotational complexity while promoting larger fields and more homogeneous land-use patterns. At the same time, evidence from agroecology and landscape research suggests that diversified cropping systems and heterogeneous landscapes can better support biodiversity and key ecosystem functions, with potential benefits for farmers through pest suppression, reduced reliance on synthetic inputs, and greater resilience to variability and shocks. Despite this, research often addresses these dynamics from a single analytical perspective. Farm- and field-oriented approaches typically focus on management-related aspects such as field size, crop diversity, and proxies of rotational complexity. Conversely, agroecological and landscape-oriented studies tend to operate at broader spatial scales, emphasizing metrics such as land-use composition and fragmentation patterns. Here we aim to identify a set of indicators that best complement each other by combining field-level and landscape-level perspectives. We will compute the selected indicators through GIS-based spatial analyses for two agricultural areas within the Roero (Piedmont, Italy). The indicators will be used to compare the two sub-areas and to improve the characterization of agricultural systems by jointly considering agronomic features and the landscape/ecological context. By integrating these two perspectives, we aim to obtain a more comprehensive interpretation of the agroecosystems under study, serving as a tool for further investigation and for local stakeholders.

Keywords: Spatial analyses; Farm indicators; Landscape indicators; Agroecology.

Assessing the impact of soil and crop-based calibration strategies on OPTRAM-derived soil moisture estimates

Alfredo Lorenzo [1,2], Paolo Tarolli [1,*]

[1] Department of Land, Environment, Agriculture and Forestry, University of Padova, Agripolis, viale dell'Università 16, Legnaro, PD, 35020, Italy
[2] BF Educational S.r.l., Via Luigi Cavicchini 2, 44037 Jolanda di Savoia (FE), Italy

* *Corresponding author: Paolo Tarolli (paolo.tarolli@unipd.it)*

Abstract. The Optical Trapezoid Model (OPTRAM) is a widely adopted method for estimating surface soil moisture from remote sensing data, based on the distribution of pixels in the NDVI–STR (Shortwave-infrared Transformed Reflectance) feature space. Calibration of OPTRAM parameters typically involves deriving wet and dry edges across a study area using a single, uniform parameterset. Recent studies have shown that crop-specific calibration can improve model performance. However, the influence of soil characteristics, alone or in combination with crop type, has received limited consideration in existing calibration frameworks. This work aimed to investigate the variability of OPTRAM parametrization when stratified by soil type, crop type, and soil–crop combinations. Sentinel-2 imagery and existing soil and land cover datasets were used to construct NDVI–STR distributions for each class. Parameter sets were derived accordingly and applied to generate soil moisture maps. The resulting outputs were compared to assess the impact of each calibration approach on the spatial patterns of estimated soil moisture. The findings provide preliminary insights into how different calibration strategies affect OPTRAM outputs and highlight the potential of incorporating both soil and crop information to improve model adaptability in heterogeneous agricultural landscapes.

Keywords: Soil moisture; Optical remote sensing; NDVI; Google earth engine; OPTRAM.

Sustainable tomato production through PGPR-based microbial formulations: effects on yield, fruit quality, and plant-associated microbiomes under reduced nitrogen input

Giuseppina Magaraci [1,*], Ida Romano [1], Mauro Mori [1], Eugenio Cozzolino [2], Olimpia Pepe [1,2], Valeria Ventorino [1,2]

[1] Department of Agricultural Sciences, University of Naples Federico II, Portici, Naples, Piazza Carlo di Borbone 1, Portici (NA), Italy
[2] Task Force on Microbiome Studies, University of Naples Federico II, Naples, Italy
[3] Council for Agricultural Research and Economics (CREA), Research Centre for Cereal and Industrial Crops, Caserta

* *Corresponding author: Giuseppina Magaraci (giuseppina.magaraci@unina.it)*

Abstract. Tomato (*Solanum lycopersicum* L.) is a key vegetable crop worldwide, often requiring high nitrogen (N) fertilizer inputs to maximize yield and fruit quality, which can harm the environment. Improving nitrogen use efficiency (NUE) through the application of plant growth-promoting rhizobacteria consortium (PGPRc)-based formulations represents a promising strategy to reduce fertilizer inputs while sustaining crop performance. This study evaluated the effects of three different PGPRc-based formulations on processing tomato cultivated under natural outdoor conditions in mesocosms and under two nitrogen fertilization regimes, corresponding 100% and 30% of crop N requirement. The tested formulations included a powdered bioformulate based on freeze-dried microbial cells, a liquid bioformulate consisting of an alginate–castor oil emulsion, and a granular bioformulate obtained through solid-state fermentation on coffee silverskin, an agro-industrial by-product. The impact of microbial-based formulations on soil- and root-associated microbial communities was assessed alongside their effects on crop yield and on the physical, chemical, and nutritional quality traits of tomato fruits. Overall, PGPR-based formulations improving the negative effects of reduced nitrogen fertilization, maintaining marketable yield and preserving or enhancing fruit quality traits compared to full fertilization, indicating a compensatory effect driven by microbial inoculation. Microbiota analyses indicated a significant impact of the different bioformulation on the soil bacterial and fungal communities, primarily affecting rhizosphere community structure with carrier-dependent effects that were more pronounced under low nitrogen availability. Predicted functional profiling indicated an enrichment of plant growth–promoting traits, including auxin biosynthesis, nitrogen cycling, and siderophore-mediated iron acquisition, linking microbial inoculation to improved nutrient use efficiency and crop performance. Among the tested formulations, the coffee silverskin–based bioformulate was particularly effective under reduced nitrogen input, sustaining yield, improving fruit quality, and promoting a more resilient tomato-associated microbiota. Overall, integration of selected PGPR consortia with suitable carriers represents a promising strategy for sustainable, low-input tomato production systems.

Keywords: PGPR-based formulation; Nutritional stress; Processing tomato crop; Yield and quality fruits; Soil microbiome.

Acknowledgements: This work was supported by PRIN 2022CYBRYT MicroBioCaps and Agritech National Research Center and received funding from the European Union Next-GenerationEU (PIANO NAZIONALE DI RIPRESA E RESILIENZA (PNRR) – MISSIONE 4 COMPONENTE 2, INVESTIMENTO 1.4 – D.D. 1032 17/06/2022, 450 CN00000022).

Assessing urban forest above-ground biomass using airborne LiDAR-derived structural metrics

Felice Maggipinto *, Francesca Ardito, Vincenzo Giannico, Giovanni Sanesi

Department of Soil, Plant and Food Sciences, University of Bari Aldo Moro, Bari, Italy

* *Corresponding author: Felice Maggipinto (f.maggipinto4@phd.uniba.it)*

Abstract. Urban forests play a key role in providing ecosystem services, particularly in carbon sequestration and storage, helping to mitigate climate change. In this context, the quantification of above-ground biomass (AGB) represents a central component for assessing the ecological value of urban and peri-urban areas. The structural characterization of forest stands is closely linked to the majority of ecosystem services they provide. However, field-based surveys required for biomass estimation are often time-consuming and resource-intensive, especially in complex urban environments. A promising approach to overcome these limitations lies in the integration of in situ measurements with remote sensing data, particularly high-resolution data such as airborne Light Detection and Ranging (LiDAR). The aim of this study is to assess urban forest volume and biomass through structural metrics derived from LiDAR data. To this end, allometric models based on canopy height information are explored. Field-based AGB estimates, derived from dendrometric measurements (tree height, diameter at breast height, and species) and integrated with wood density data, are used as reference information for model calibration. Within this framework, the study explores the potential of LiDAR-based approaches for urban biomass estimation, with particular emphasis on their transferability and possible applications in the analysis and management of urban forest systems.

Keywords: Ecosystem services, Above-ground biomass, LiDAR, Urban forest, Allometric modelling.

Designing a functional food ingredient from artichoke by-products: evaluation of nutritional quality and health-related potential

Lia Mansueto [1,*], Giusy Rita Caponio [2], Roccangelo Silletti [1], Antonella Pasqualone [1], Graziana Difonzo [1]

[1] Department of Soil, Plant and Food Sciences, University of Bari Aldo Moro, Via Amendola 165/A, 70126, Bari, Italy
[2] Department of Bioscience, Biotechnology and Environment, University of Bari Aldo Moro, Via Orabona 4, 70125, Bari, Italy

* *Corresponding author: Lia Mansueto (l.mansueto4@phd.uniba.it))*

Abstract. The consumption of ready-to-eat foods has increased markedly in recent years due to convenience, ease of preparation, and extended shelf life. However, these products are frequently characterized by an unbalanced nutritional profile, with high fat and sugar contents. Bakery products represent a suitable and versatile food matrix for the incorporation of functional ingredients aimed at improving nutritional quality. In this context, plant-derived ingredients may provide both technological functionality and health-related benefits. Among them, artichoke (*Cynara scolymus*), beyond its traditional culinary use, is a rich source of bioactive compounds, including 3,5-di-*O*-caffeoylquinic acid, 3,4-di-*O*-caffeoylquinic acid, apigenin-7-*O*-rutinoside, and luteolin, as well as inulin, dietary fiber, and minerals, which have been associated with hypoglycemic and prebiotic effects. Artichoke processing, particularly the production of frozen or preserved products, generates large amount of by-products such as bracts and stems. These by-products retain a considerable amount of the valuable compounds found in artichokes. The study aimed to obtain a functional food ingredient from artichoke bracts and stems and to characterize its chemical and nutritional composition. The artichoke by-product ingredient (ABI) was evaluated for dietary fiber content, total polyphenol content, antioxidant capacity, and polyphenol bioaccessibility in order to assess its functional potential. The results demonstrated that ABI is characterized by a high dietary fiber content and a relevant concentration of polyphenols exhibiting antioxidant activity. Furthermore, the bioaccessibility of polyphenols suggests that a significant fraction of these compounds may become available after gastrointestinal digestion and be associated with metabolic and gastrointestinal health-related properties. Overall, the production of ABI represents a sustainable strategy for the recovery and valorization of artichoke processing by-products, providing a functional ingredient suitable for application in food formulation, including bakery products.

Keywords: Plant-based ingredients; Bakery products; Dietary fiber; Artichoke by-products.

InBiOf project: Process and product innovation in organic medicinal plant production

Fabiana Marino [1], Matteo Caser [1,*], Cosimo Matteo Profico [1], Cosimo Sarti [1,2], Saeid Hazrati [3], Andrea Ertani [1], Silvana Nicola [1]

[1] Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy
[2] Department of Physics – University of Trento, Via Sommarive 14, 38123 Povo (TN), Italy
[3] Department of Agronomy and Plant Breeding– Azarbaijan Shahid Madani University, Faculty of Agriculture, Tabriz, 53714-161, Iran

* *Corresponding author: Matteo Caser (matteo.caser@unito.it)*

Abstract. The InBiOf project focuses on process and product innovation in organic medicinal plant production, aiming to improve sustainability, crop performance and product quality within certified organic supply chains. The project is based on interaction among researchers, producers and stakeholders, considering the technical specificities of different territorial contexts. InBiOf addresses several critical issues of the sector, including the limited availability of certified organic propagation material, the need to optimize agronomic practices under organic management, and the improvement of post-harvest phases and product valorisation. In this context, the University of Turin (UNITO) contributes to the development of an organic supply chain for medicinal plant species representative of the territory, including *Mentha spicata* L., *Lavandula angustifolia* Mill. and *Thymus serpyllum* aggr. UNITO activities focus on the establishment of organic nursery production through the recovery and propagation of local genetic resources, including local accessions of lavender and thyme and selected varieties of mint ("Casablanca", "Nanah-Fliyou" and "El brouj"), aimed at ensuring the availability of high-quality plant material suitable for organic cultivation. Agronomic trials evaluate the response of the selected species to the application of substances with biostimulant activity, based on aqueous extracts of borage, nettle and moringa with the objective of improving crop performance and product quality. Further activities concern the comparison between traditional hot-air drying systems and low-temperature drying systems, to identify the most suitable techniques for preserving the qualitative characteristics of officinal products, particularly essential oils. UNITO also contributes to the study and development of innovative products based on medicinal plants, intended for food and cosmetic applications, in collaboration with organic farms and processing facilities. Overall, the InBiOf project contributes to the definition of good agricultural and processing practices for organic medicinal plants, promoting integration between production, processing and transformation and ensuring direct transferability to farms.

Keywords: Local genetic resources; Drying systems; Biostimulant; Product quality; Plant propagation material.

COrALp - food and ornamental plants of the spontaneous flora of the Latin Alps: Investing in the protection and enhancement of biodiversity for a greater connection between city and mountain

Fabiana Marino [1,*], Cosimo Matteo Profico [1], Enrico Pomatto [1], Hossein Sheikhi [2], Paola Gullino [1], Matteo Caser [1], Federica Larcher [1], Marco Devecchi [1], Marco Mucciarelli [3], Tiziana Ulian [3], Maria Consolata Siniscalco [3], Silvana Nicola [1]

[1] Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy
[2] Horticultural Sciences Department, College of Agriculture and Natural Resources – University of Tehran, Karaj, Iran
[3] Department of Life Sciences and Systems Biology (DBIOS) – University of Turin, Via Accademia Albertina 13, 10123 Turin (TO), Italy

* *Corresponding author: Fabiana Marino (fabiana.marino@unito.it)*

Abstract. COrALp is a cross-border project funded under the Interreg VI-A France-Italy (ALCOTRA) programme, focusing on the protection and valorisation of spontaneous plant species of the Latin Alps with food and ornamental value, as well as medicinal and other potential uses. The Latin Alps represent a transboundary area characterised by high plant biodiversity resulting from the coexistence of Alpine and Mediterranean floristic elements. This biodiversity is increasingly affected by climate change, land-use changes, abandonment of traditional practices and ecological degradation. The project addresses these challenges through coordinated scientific and technical cooperation between Italian and French partners. Project activities are structured to improve knowledge, conservation and use of native Alpine flora. COrALp develops a systematic identification and selection of spontaneous species with alimurgic, ornamental and medicinal potential through the analysis of scientific literature, historical herbarium collections and field surveys. These data are integrated into a shared georeferenced transboundary database supporting species mapping and selection. Participatory approaches involving local communities, schools and stakeholders integrate scientific criteria with traditional knowledge. Selected species are subject to conservation actions both *in situ* and *ex situ*, including seed collection following standardised protocols and long-term germplasm preservation in seed banks. Advanced propagation techniques, including seed and *in vitro* methods, are developed to improve plant availability and quality. Agronomic trials and biochemical analyses assess cultivation requirements and potential uses of selected species. A specific component focuses on the application of native Alpine species in urban environments through pilot actions based on Nature-Based Solutions, such as urban gardens, perennial flowerbeds, green roofs and vertical green elements in selected Italian and French cities. COrALp delivers transferable tools, including databases, technical guidelines and demonstration sites, supporting the integration of Alpine spontaneous flora into conservation strategies, urban planning and local development pathways within the ALCOTRA area.

Keywords: Alpine flora valorisation; Biodiversity; Cross-border cooperation; Nature-based solutions.

Light matters: optimizing LED spectra to enhance *in vitro* propagation of European chestnut

Lorenzo Antonio Marino *, Paola Ruffa, Eric Mozzanini, Davide Lucien Patono, Stefania Savoi, Daniela Torello Marinoni, Vera Pavese

Department of Agricultural, Forest and Food Sciences (DISAFA), University of Turin (UNITO), Largo Paolo Braccini, 2, 10095 Grugliasco, TO, Italy

* *Corresponding author: Lorenzo Antonio Marino (lorenzoantonio.marino@unito.it)*

Abstract. European chestnut (*Castanea sativa*) is one of the most economically important woody species in Piedmont, valued for its timber and quality nuts. Despite the high industrial demand for chestnuts, traditional propagation methods (*e.g.,* cuttings and grafting) are often time-consuming, seasonally limited, and insufficient to meet the growing need for large-scale plant production. Alternatively, plant tissue culture represents an effective tool for germplasm preservation and plant propagation, ensuring the quick supply of high-quality material to nurseries. However, *C. sativa* is considered a recalcitrant species *in vitro*, and available micropropagation protocols still result in low multiplication, rooting, and acclimatization rates. To overcome these challenges, a promising new strategy involves regulating light quality and intensity at each stage of micropropagation using light-emitting diodes (LEDs) as the light source. Recent studies on plum and pear have highlighted that LED treatment can boost shoot and rooting development. Therefore, this study investigated the potential of LED lighting on *Castanea sativa* (cv. 'Marrone') micropropagation, evaluating its impact from multiplication to rooting and acclimatization phases. *In vitro* chestnut plants were exposed to four LED spectra with specific wavelengths and to fluorescent lamps used as a control. Among the tested spectra, Red:Blue:Far-red and Red:Blue:Green:Far-red proved to be the most effective for chestnut micropropagation, improving both the multiplication index and increasing the rooting percentage compared to the control lamps. Furthermore, the LED spectra also induced anatomical and physiological modifications, improving chestnut survival rates during the acclimatization stage. This LED-based approach aims to provide a breakthrough solution to boost chestnut micropropagation protocols, offering an efficient, cost-effective strategy for large-scale nursery production.

Keywords: *Castanea sativa*; Micropropagation; Rooting; Acclimatization; Woody species.

Rediscovering genetic diversity in Piedmontese common beans through regeneration and molecular profiling

Matteo Martina *, Anna Maria Milani, Elsa Martini, Giuseppe Caputo, Ezio Portis, Cinzia Comino

Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy

* *Corresponding author: Matteo Martina (matteo.martina@unito.it)*

Abstract. Local landraces of common bean (*Phaseolus vulgaris* L.) represent an important component of agricultural biodiversity in marginal areas of North-Western Italy, where traditional varieties have historically played a key agronomic and cultural role. The FA.PI. project (Regeneration and characterization of Piedmontese bean landraces), funded by the Piedmont Region under the framework of CSR 2023-2027 (Call SRA16/1/2024), aims to regenerate, phenotypically evaluate and genetically characterize local bean ecotypes preserved in the Germplasm Bank of the DISAFA, University of Turin. The collection includes historical accessions collected between the late 1970s and mid-1980s, many of which are no longer cultivated and are considered at high risk of genetic erosion. Project activities involve seed regeneration under field conditions, detailed phenotypic characterization using standardized morphological descriptors, and molecular analysis based on next-generation sequencing technologies. A genotyping-by-sequencing (GBS) approach is being applied to bulked plant samples to generate SNP-based genetic profiles for each accession. These data allow the evaluation of genetic diversity within and among landraces, the identification of genetically distinct materials, and the detection of possible cases of misclassification. Molecular results will support the selection of representative accessions for potential registration in the Italian National Register of Agricultural Biodiversity. For a subset of historically relevant ecotypes, molecular and phenotypic data will be integrated with sensory profiling to generate comprehensive identity cards aimed at valorisation and dissemination. Here, we report the first results of the project, with particular emphasis on regeneration outcomes and preliminary molecular characterization of Piedmontese common bean landraces, highlighting their genetic uniqueness and their potential value for conservation and future breeding activities.

Keywords: Common bean; Landraces; Agrobiodiversity conservation; Genotyping-by-sequencing (GBS); Genetic diversity.

From historical accessions to genomic data: Regeneration and molecular analysis of Italian sweet pepper landraces

Matteo Martina *, Anna Maria Milani, Elsa Martini, Giuseppe Caputo, Cinzia Comino, Ezio Portis

Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy

* *Corresponding author: Matteo Martina (matteo.martina@unito.it)*

Abstract. The conservation and valorisation of local crop genetic resources represent a key strategy to counteract the erosion of agrobiodiversity and to support sustainable breeding programs. The Pepper GeneBank project, funded by the Piedmont Region under the framework of CSR 2023-2027 (Call SRA16/1/2024), focuses on the regeneration, phenotypic evaluation and molecular characterization of Italian sweet pepper (*Capsicum annuum* L.) landraces preserved in the Germplasm Bank of the Department of Agricultural, Forest and Food Sciences (DISAFA), University of Turin. The collection includes historical accessions of local ecotypes collected in North-Western Italy between the 1970s and 1980s, many of which have undergone limited or no regeneration since their original acquisition. Project activities include seed viability assessment, controlled regeneration under isolation conditions, detailed phenotypic characterization using standardized descriptors, and genotypic analysis based on next-generation sequencing approaches. A genotyping-by-sequencing (GBS) approach is being used on accession-specific bulked samples to produce dense SNP datasets. These profiles will support estimates of within- and among-accession variation, help flag likely synonymies/homonymies, and ultimately discriminate distinct genetic resources. Molecular data will also be used to verify the genetic integrity of regenerated materials and to support their future registration in national databases dedicated to agricultural biodiversity. In parallel, selected pure lines derived from historical selection programs are being multiplied and combined to develop heterogeneous materials with a broad genetic base, in line with the current European regulations on heterogeneous material. Here, we present the first results of the project, focusing on seed regeneration efficiency and preliminary molecular characterization of a subset of local pepper landraces, providing new insights into their genetic structure and supporting their long-term conservation and sustainable use.

Keywords: Pepper; Landraces; Agrobiodiversity conservation; Genotyping-by-sequencing (GBS); Genetic diversity.

BSA-seq identifies a chromosome 12 candidate region controlling leaf budburst timing in chestnut

Silvia Ruggirello, Matteo Martina *, Lorenzo Rosso, Paola Ruffa, Anna Maria Milani, Nadia Valentini, Roberto Botta, Ezio Portis, Daniela Torello Marinoni

Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy

* *Corresponding author: Matteo Martina (matteo.martina@unito.it)*

Abstract. Time of leaf budburst (TLB) is a key adaptive polygenic trait in woody species, marking the transition from winter dormancy to active vegetative growth. Its timing strongly influences the synchronization between plant development and seasonal environmental conditions, with important consequences for frost avoidance, growth performance, and local adaptation, particularly under changing climatic conditions. A *Castanea sativa* population was derived from a cross between two parental genotypes, Bouche de Bétizac (BB) and Madonna (MAD) with contrasting phenotypes. The F1 population of BB × MAD was used for a BSAseq analysis. The plants were classified into TLB classes (1–9) and separated into high and low bulks. A bioinformatic pipeline was used to analyse the data and annotate the genes. The regions associated with contrasting phenotypes of the bulks were identified on chromosome 12 through G' analysis and compared with QTLs in the previously identified parental QTL map. The candidate region of 12.3 Mb (from 20.18 Mb to 32.47 Mb) overlapped with a QTL identified in the BB parental map at 21.18 Mb. *SnpEff* was used to annotate the variants identified in the selected region and literature analysis supported the effect of high-impact variants (stop-gained and stop-lost) on gene candidates. Candidate genes included *CSI3* linked to cellulose accumulation and cell wall expansion in meristematic tissues, *CLC-f* involved in osmotic regulation and growth restart after dormancy and *APSR1* which regulates auxin transport via *PIN7*-mediated signalling and vegetative growth restart. In conclusion, this study suggests that different genes and cellular mechanisms are involved in budburst, and that variants in these genes may delay vegetative restart.

Keywords: *Castanea sativa*; leaf budburst; BSA-seq; QTL mapping; vegetative restart.

Effects of habitat fragmentation on two forest-dwelling small mammals in fragmented agricultural landscape

Matilde Martini *, Giovanna Donati, Anna Monaco, Maria Chiara Fabbri, Riccardo Bozzi

Department of Agriculture, Food, Environment, and Forestry (DAGRI) – University of Florence, Via delle Cascine 5, 50144 Florence (FI), Italy

* *Corresponding author: Matilde Martini (matilde.martini@unifi.it)*

Abstract. Habitat fragmentation is a structural component of many agricultural and agroforestry landscapes, where woodland patches are surrounded by a cultivated matrix. Understanding how landscape configuration influences wildlife populations is essential not only for biodiversity conservation, but also for the sustainable management of multifunctional rural systems. Small mammals can serve as effective bioindicators of landscape functionality, as their abundance and demographic structure reflect habitat configuration and connectivity. In this study, we investigated species-specific responses to fragmentation of two forest-dwelling rodents with different ecological traits: the hazel dormouse (*Muscardinus avellanarius*), a forest specialist with limited dispersal ability, and the yellow-necked mouse (*Apodemus flavicollis*), a more generalist species able to move across agricultural areas. The study was conducted in a fragmented agricultural landscape surrounding the Appennino Lucano – Val d'Agri – Lagonegrese National Park (southern Italy), where remaining forest habitat was approximately 25% of the total agroforestry landscape. Deciduous oak fragments were selected along gradients of size and isolation. Populations were monitored in 2025 using capture–mark–recapture methods. Individuals were marked and sex, age, reproductive status, and body mass were recorded. We evaluated the effects of fragment size and isolation (patch scale), matrix composition (landscape scale), and fragment habitat quality on relative abundance and sex ratio of the two species. Relative abundance of both species showed a weak association with fragment size but declined significantly with increasing isolation, indicating that spatial configuration is a key factor influencing small mammal distribution in agroforestry mosaics. Matrix composition had limited detectable effects, while fragment habitat structure was associated with variation in sex ratio. These results highlight how landscape structure influences small mammal populations in agricultural contexts and demonstrate the value of indicator species for guiding spatial planning. Managing patch isolation and maintaining structural connectivity within agroforestry systems may enhance ecological functionality without compromising productive land use.

Keywords: Habitat fragmentation; Agroforestry landscape; Forest-dwelling small mammals.

Nature-based solutions assessment for reducing sediment yield and nutrient loads in the Canale d'Aiedda basin

Rose Mary [1,*], Giovanni Francesco Ricci [1], Anna Maria De Girolamo [2], Ossama Mohamed Mahmoud Abdelwahab [1], Adrian Lopez-Ballesteros [3], Javier Senent-Aparicio [3], Francesco Gentile [1]

[1] Department of Soil, Plant and Food Sciences (DISSPA) – University of Bari Aldo Moro, Italy
[2] Water Research Institute IRSA, National Research Council, Bari, Italy
[3] Department of Civil Engineering – Catholic University of San Antonio, Campus de Los Jeronimos, Murcia, Spain

* *Corresponding author: Rose Mary (rose.javed@uniba.it)*

Abstract. Soil erosion and nutrient pollution are major drivers of land and water degradation, particularly in Mediterranean regions characterized by intensive agriculture, seasonal rainfall, and intermittent river systems. Excessive nitrogen and phosphorus losses from agricultural areas promote eutrophication, degrade aquatic ecosystems, and impact downstream coastal environments. In response, the European Union has established integrated policy frameworks aligned with the Sustainable Development Goals and the European Green Deal, promoting Nature-Based Solutions (NBSs) as sustainable alternatives to conventional mitigation measures. In Italy, many agricultural catchments are highly vulnerable to erosion and nutrient losses, necessitating targeted conservation practices supported by the Common Agricultural Policy. So, the main objective of this study was to assess the effectiveness of Nature-Based Solutions in reducing soil erosion and nutrient loads at the basin scale in the Canale d'Aiedda basin (Apulia, Southern Italy), with particular emphasis on evaluating individual and combined interventions. The Soil and Water Assessment Tool (SWAT) was implemented and calibrated at the catchment scale to reliably represent hydrological processes, sediment dynamics, and nutrient transport under different management scenarios. The main results highlight distinct performance among the evaluated scenarios. Vegetative filters strips showed increasing effectiveness with buffer width, achieving sediment reductions of 21-57%, Total Nitrogen (TN) reduction of 9-27%, and Total Phosphorus (TP) reductions of 19-51%. Contour farming produced sediment reduction up to 25%, TN reductions up to 6%, and TP reductions up to 20%. The combined implementation of filter strips and contour farming consistently yielded the greatest overall benefits, with sediment reductions of 37-44%, TN reduction of 14-18%, and TP reductions of 32-39%, demonstrating a clear synergistic effect at the watershed scale. These findings underline the importance of integrated NBS strategies for maximizing environmental benefits under the Mediterranean agricultural conditions.

Keywords: Soil Erosion; Nature-Based Solutions (NBSs); SWAT Model; Sediment and Nutrient Transport; Mediterranean Watershed.

From sustainability to tradition: Heterogeneous attitudes in wine consumption

Giulia Mastromonaco *, Antonina Sparacino, Valentina Maria Merlino, Federica Rosa, Stefano Massaglia

Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy
[2] RV STUDIO S.R.L, Corso Langhe 1, 12042, Alba, CN, Italy

* *Corresponding author: Giulia Mastromonaco (giulia.mastromonaco@unito.it)*

Abstract. Sustainable consumption has become an increasingly central dimension of food-related choices, reflecting a broader shift in consumer values in which ethical and environmental considerations complement traditional quality attributes. Within this framework, wine represents a particularly relevant product due to its strong link with the territory, cultural significance and exposure to climate change challenges. Sustainability concerns, information-seeking behaviours and traditional consumption patterns coexist in shaping wine purchasing decisions, generating heterogeneous attitudinal orientations that deserve deeper investigation across different consumer contexts. This study aimed to identify and characterise distinct attitudinal profiles underlying wine purchasing preferences by jointly considering sustainability orientation, attention to product information and local origin and climate change concerns. Data were collected through an online survey administered to 1,692 consumers responsible for household wine purchases in four European countries: Italy, Germany, Belgium and Spain. Seven attributes relating to purchasing preferences, sustainability and climate change considerations, and consumption expectations were analysed using Principal component analysis (PCA). The PCA revealed three latent attitudinal dimensions: Sustainability-oriented attitude, Informed localism, and Traditional consumption orientation. Factor scores derived from these components were then used to inform a Cluster Analysis (CA), which identified four distinct attitudinal profiles. The results highlighted significant differences among consumers. Some profiles were characterised by a strong focus on sustainability and a low level of attachment to traditional consumption patterns, while others demonstrated habit-driven preferences and pay limited attention to sustainability and product information. Another cluster showed high levels of involvement across all dimensions, combining sustainability concerns with information-seeking behaviour and traditional consumption attitudes. Overall, the findings emphasise the multifaceted nature of attitudes towards wine consumption and the coexistence of progressive and traditional approaches within European markets. This information is useful for producers, marketers and policymakers who want to create targeted communication strategies and sustainability initiatives that match different consumer profiles.

Keywords: Cluster analysis; Wine attitudes; Principal Component Analysis; Consumer profiles; Label.

Are consumers ready for AI in agriculture? Socio-demographic differences in acceptance and uncertainty: A CUB models analysis

Giulia Mastromonaco *, Valentina Maria Merlino, Antonina Sparacino, Lorenzo Baima, Simone Blanc, Luisella Celi, Filippo Brun

Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy

* *Corresponding author: Giulia Mastromonaco (giulia.mastromonaco@unito.it)*

Abstract. The agricultural sector is undergoing a profound digital transformation aimed at enhancing productivity, environmental sustainability, and economic resilience. In this evolving landscape, artificial intelligence (AI) has emerged as a pivotal technology for optimising agricultural practices and facilitating informed decision-making. However, the adoption of AI-based solutions is not just a technical matter; consumers may exhibit different levels of acceptance, which can lead to response uncertainty, especially in the context of emerging technologies. These attitudes are strongly influenced by socio-demographic characteristics. In this context, the aim of this study was to investigate how socio-demographic characteristics influence both the level of acceptance of eleven AI-based technologies applied in agriculture, such as Deep Learning, Big Data, and Drones, and the degree of uncertainty in expressing such acceptance. An online survey was conducted on a representative sample of Italian consumers, who were asked to indicate their level of favourability towards each technology using a Likert scale. Responses were analysed using a probabilistic model, namely the Combination of a discrete Uniform and a shifted Binomial distribution (CUB). This modelling approach allows the simultaneous assessment of acceptance and response uncertainty and is particularly suitable for emerging technologies such as AI, where opinions may still be weakly formed or ambivalent. The results show that, among the socio-demographic variables considered, age and income significantly affect both acceptance and uncertainty for most of the AI technologies analysed. In particular, higher income levels were associated with greater acceptance and lower uncertainty across almost all AI applications, while older age groups exhibited higher acceptance, followed by younger consumers, although with greater response uncertainty. These findings highlight the importance of considering both preference intensity and uncertainty when analysing consumer attitudes towards AI in agriculture, providing useful insights for policymakers, technology developers, and stakeholders involved in the digital transition of the agri-food sector.

Keywords: AI technologies; CUB models; Consumer acceptance; Socio-demographic; Uncertainty.

Sustainability, climate change and territory: Urban–rural and regional differences in fruit and vegetable purchasing attitudes in Italy

Giulia Mastromonaco *, Antonina Sparacino, Stefano Massaglia, Selene Ollani, Alice Varaldo

Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy

* *Corresponding author: Giulia Mastromonaco (giulia.mastromonaco@unito.it)*

Abstract. The production and consumption of fruits and vegetables is increasingly affected by environmental pressures, climate change and growing sustainability concerns. This raises questions about the long-term resilience of agri-food systems. Meanwhile, the post-Covid Era context has reshaped food purchasing behaviours, with greater attention to health, environmental impacts and product origin. Against this backdrop of change, fruit and vegetable consumption is a crucial area in which to assess whether territorial and profile differences in purchasing attitude exist. This offers valuable insights into how contextual factors influence food choices in Italy. This study aimed to investigate differences in attitudes toward purchasing fruits and vegetables in the post-pandemic period. Data were collected through an online survey of 2,300 consumers responsible of households' fruit and vegetable purchases. The analysis focused on four key dimensions: intention to purchase organic products, intention to purchase local products, interest in sustainably certified fruit and vegetable supply chain and consumers' expectations regarding changes in fruit and vegetable consumption in relation to climate change. Sociodemographic characteristics, area of residence (urban vs. extra urban) and region of origin were included as covariates. The results showed that where people live significantly influenced their purchasing attitudes. Specifically, consumers living in urban areas demonstrated a stronger preference for organic products and greater interest in sustainability certified fruit and vegetable supply chain, than those living in rural areas. Regional differences mainly emerged in attitudes toward organic and local products, with different regions standing out for each purchasing orientation. Furthermore, socio-demographic characteristics significantly impacted various purchasing attitudes and preferences and, in the context of climate change, they also influenced consumers' expectations regarding future consumption patterns. Finally, consumers were profiled according to the channels through which they purchased these products and with which frequencies, providing a more comprehensive picture of fruit and vegetable purchasing attitudes in Italy.

Keywords: Fruit and vegetable; Attitudes; Consumer profiles; Regional.

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Improving the nutritional value of semolina pasta through fermented tomato by-products

Mariapaola Mazzarelli [1,*], Alessia Lisi [1], Giusy Rita Caponio [2], Mirco Vacca [1], Leonardo Mancini [1], Graziana Difonzo [1], Grazia Tamma [2], Fabio Minervini [1], Maria Calasso [1], Maria De Angelis [1]

[1] University of Bari Aldo Moro, Department of Soil, Plant and Food Sciences
[2] University of Bari Aldo Moro, Department of Biosciences, Biotechnologies and Environment

* *Corresponding author: Mariapaola Mazzarelli (m.mazzarelli2@phd.uniba.it)*

Abstract. The tomato is one of the most widely produced vegetables in the world. The tomato industry generates a by-product known as tomato pomace (TP), representing a promising source of micronutrients such as dietary fibers, minerals, and vitamins as well as bioactive compounds with antioxidant and antimicrobial potential. A biotechnological approach including lactic acid bacteria fermentation has been evaluated to enhance the nutritional value of TP flour. An increase in antioxidant activity and total free amino acids, compared to the untreated raw materials, highlighted the potential of lactic acid bacteria to positively affect TP properties. Fermented and unfermented ingredients have been characterized and used to fortify (0 to 15 %) wheat-based conventional fresh pasta made under pilot-plant scale. Pasta containing TP or fermented TP flour and a conventional pasta (control) were characterized in terms of physical and chemical characteristics, nutritional composition, sensory profile and microbiological stability. The antioxidant and anti-inflammatory properties were also investigated using *in vitro* assays with the human Caco-2 cell line. The prebiotic potential was investigated by *in vitro* gastrointestinal digestion followed by simulated gut fermentation. Due to the high contents fiber and according to the Regulation of the European Community No. 1924/2006 fortified pasta can be labelled as a "source of fiber". The use of unconventional non-wheat flours increased the content of minerals and affects the shelf life as compared to the control pasta. Fermentation with lactic acid bacteria led to significant increase in total free amino acids and decrease in *in vitro* glycaemic index values compared to pasta made only with semolina. A potential prebiotic activity suggested the suitability of the TP enriched pasta with respect to acting as a prebiotic source supporting the growth of beneficial bacteria. Sensory analysis highlighted a strong effect of the fortification on the sensory profile of pasta.

Keywords: Tomato pomace; Fortified pasta; Lactic acid bacteria; Nutritional value.

A framework for evaluating enterprise contributions to sustainable development strategies

Gabriele Menegaldo *, Lucia Rocchi, Luisa Paolotti, Arianna Tiralti, Carla Cortina, Antonio Boggia

Department of Agricultural, Food and Environmental Sciences (DSA3) – University of Perugia, Via Borgo XX Giugno 74, 06121 Perugia (PG), Italy

* *Corresponding author: Gabriele Menegaldo (gabriele.menegaldo@dottorandi.unipg.it)*

Abstract. Since its adoption, in September 2015, the Agenda 2030 for sustainable development has played a key role in the policy and territorial planning of European Union. To achieve the objectives in its tree dimension, economic, social and environmental, countries have elaborated the National Sustainable Development Strategy (NSDS) to integrate the principles of Agenda 2030 into their specific socio-economic contexts. Measuring and monitoring progress, in relation to the Sustainable Development Strategy, is a crucial task to have feedback from the application of the strategy itself and achieve its goals. For this reason, during the years, research and the institutions have been developed a widely sets of indicators, which can assess the contribution of the regions to national strategy. These sets are based on regional and, when available, sub-regional data, which show the general trend for that area, but don't capture individual contribution, especially for the economic-productive context. The aim of this research is developing a specific indicator framework that allow to assess the contribution of companies to achieve the targets of Regional Sustainable Development Strategy (RSDS) and, consequentially, the Italian Strategy, considering the Umbria region. Furthermore, this level of analysis can be useful for decision-making purposes to identify the areas that need greater support for these final years of the Agenda and for the development of the post-2030 Agenda.

Keywords: Agenda 2030; Sustainability; Indicator framework; Companies assessment.

Optimizing water use and soil health in agriculture: The role of microbial solutions and natural amendments

Amedeo Mignini *, Beatrice Farda, Marika Pellegrini

Department of life, Health and Environmental Sciences (MeSVA) - University of L'Aquila, Via Vetoio 40, 67100 L'Aquila, Italy

* *Corresponding author: Amedeo Mignini (amedeo.mignini@graduate.univaq.it)*

Abstract. Water resource management is a fundamental challenge for highly productive agricultural areas, such as the Fucino Plain (AQ), where water scarcity is exacerbated by climate change and extreme weather events. In this scenario, the employment of microbial formulations and natural soil improvers has been identified as a novel strategy to optimise water usage, thereby enhancing soil water retention capacity and crop resilience to water stress, particularly in vulnerable agricultural contexts. The scientific importance of these approaches lies in their ability to improve the physical, chemical and biological properties of the soil. The application of microbial formulations containing beneficial bacteria and fungi has been demonstrated to stimulate soil particle aggregation processes, thereby enhancing porosity and structural stability. These microorganisms also promote the solubilisation of nutrients, thereby optimising their availability to plants, and improve the air/water balance, increasing water absorption efficiency and crop resistance to water stress. Biochar, a natural soil conditioner with high porosity and specific surface area, has been shown to increase the water retention capacity of the soil, thereby improving water stability and reducing water loss through evaporation and percolation under stress conditions. The project involves the selection and characterisation of microbial formulations and soil improvers, the development of application protocols and validation in experimental contexts, both in the laboratory and in the field. The anticipated outcomes encompass enhanced water use efficiency, augmented crop resilience, and optimised physical and biological characteristics of the soil. These interventions are expected to enhance the sustainability and resilience of horticulture in the Fucino Plain, thereby mitigating the impact of water scarcity. The results will provide insights for developing sustainable water management solutions. Concrete applications in vulnerable areas will provide a replicable model for other regions facing similar challenges.

Keywords: Water resource; Microbial formulations; Biochar; Sustainable agriculture; Crop resilience.

Culture-dependent and metagenomic characterization of sourdough from Senatore Cappelli, black chickpea, and a mixture thereof to select autochthonous starters for functional bread production

Domenico Nuzzolese [1], Pascal Bonnarme [2], Eric Dugat-Bony [2], Fabio Minervini [1,*], Pasquale Filannino [1], Maria De Angelis [1]

[1] Università degli Studi di Bari Aldo Moro, Dipartimento di Scienze del Suolo, della Pianta e degli Alimenti, Bari, Italy

[2] UMR SayFood, Université Paris-Saclay, INRAE, AgroParisTech, Palaiseau, France

* *Corresponding author: Fabio Minervini (fabio.minervini@uniba.it)*

Abstract. Senatore Cappelli (SC), an ancient durum wheat cultivar, and the Apulian black chickpea (BC) represent two emblematic matrices of Mediterranean agrobiodiversity, capable of thriving under extreme climatic conditions and offering nutritional profiles rich in fibre, proteins, and bioactive compounds. This study aimed to enhance their value through the development of type-I sourdoughs and the selection of autochthonous microbial strains with high technological potential, intended for the production of functional breads. Three sourdoughs (SC, BC, and a 70:30 SC:BC blend) were initiated through spontaneous fermentation and then subjected to ten back-slopping cycles. Microbial evolution was monitored using culture-dependent and metagenomic approaches, showing dynamics that differed from those typically observed in traditional matrices. In parallel, the analysis of volatile compounds revealed a progressive increase in aromatic complexity, with distinct profiles for each sourdough. Lactic acid bacteria and yeasts were isolated from each sourdough during the various refreshment cycles, enabling the selection of autochthonous strains based on their acidification and leavening capacities (for lactic acid bacteria and yeasts, respectively), as well as their antioxidant power and ability to degrade antinutritional molecules. The most promising strains were then chosen to create mixed starters for producing sourdough bread. The resulting doughs and breads were evaluated through comprehensive technological and functional characterization, including dough development, structural properties, crumb alveolar architecture, bioactive compound content, aromatic profile, shelf life, and digestibility. The ultimate aim was to develop baked products with high nutritional and sensory quality, integrating tradition, sustainability, and biotechnological innovation. Overall, this work supported the integration of local biodiversity and controlled fermentations to obtain new functional breads, enhancing cereal and legume supply chains typical of Mediterranean regions and offering new opportunities for the food industry.

Keywords: Sourdough microbiota; Metagenomic profiling; Culture-dependent analysis; Autochthonous starters; Functional bread.

Which future for cultured proteins in Europe? Analysis of value chain dynamics and business model resilience

Francesca Monticone *, Giulia Rossi, Antonella Samoggia

Department of Agricultural and Food Sciences (DISTAL) – University of Bologna, Viale Fanin 50, 40127 Bologna (BO), Italy

* *Corresponding author: Francesca Monticone (francesca.monticone2@unibo.it)*

Abstract. The cultured meat and seafood (CM-CSF) industry is emerging as an alternative to conventional livestock and seafood production, in response to the environmental impacts of intensive farming. While the sector promises potential environmental benefits, these outcomes remain uncertain due to challenges on investment, policy and consumers' acceptance. Given the novelty of the sector, its value chains and business models remain under-researched, a gap this study aims to address. This research addresses two questions: what business models are currently adopted by CM-CSF companies, and how these business models respond to future scenarios shaping the industry development. To achieve this, the study utilises a conceptual framework that integrates Global Value Chain analysis with Business Model Stress Testing to assess resilience against future uncertainties. Data collection includes a literature review to map CM-CSF value chains and business models, validated by an expert workshop and 4 in-depth expert interviews. Subsequently, 16 semi-structured interviews with CM-CSF stakeholders across 9 European countries were carried out. The interviews consisted of 2 steps. First, the analysis of buyer-supplier power relations in the five identified business models. Second, each business model was stress-tested against 8 future scenarios involving shifts in investment, policy and consumer acceptance. Preliminary findings indicate that value chain governance remains in flux, with relationships predominantly relying on trust and standardised specifications rather than established hierarchies. The stress-testing of business models reveals that policy and investment are the most critical drivers for future stability. While a hybrid investment model is generally preferred, there is notable polarisation regarding the role of public funding. Furthermore, a centralised European policy framework and familiarity-driven acceptance are seen as essential for industry growth, though current restrictions on product tasting present a barrier to understanding consumer preferences. This ongoing study aims to provide robust policy and industry recommendations for the protein transition.

Keywords: cultured meat; cultured seafood; value chain governance; business model; business model stress testing.

A market analysis of legume-based dry pasta: Innovation in sustainable food production

Enrica Morea *; Giovanni Ottomano Palmisano; Rocco Roma; Domenico Carlucci; Annalisa De Boni

Department of Soil, Plant and Food Sciences (Di.S.S.P.A.) - University of Bari, via Giovanni Amendola 165/A, 70126 Bari, Italy

* *Corresponding author: Enrica Morea (enrica.morea@uniba.it)*

Abstract. Modern food systems are facing the challenges to develop more sustainable agricultural practices, and to grant nutritious, sustainable and affordable foods preventing non-communicable diseases related to malnutrition. At the same time, consumers, especially in developed countries, show increasing interest in foods preventing or reducing diet-related diseases or providing advantageous nutritional characteristics. Legumes have been widely recognized as a valuable source of proteins alternative to the animal ones, due to their high nutritional value, content in dietary fibres, vitamins, minerals, and bioactive compounds. New awareness and consumption trends are influencing the food industry, which is offering an increasingly wide range of innovative legume-based foods. These include baked goods, fresh and dry pasta, snacks, meat substitutes, gluten-free and high-protein foods. Several companies in the dry pasta market have introduced innovative products by replacing, wholly or partly, traditional durum wheat semolina with legumes flour or legume protein. In 2025, legume pasta (made from chickpeas, lentils, peas and broad beans) dominated the food market, with consumption in Italy increasing by 23%. However, this type of product is characterised by high prices, particularly compared to traditional semolina pasta, which only contains water and durum wheat semolina. This aspect should raise concerns about the possibility that, despite the limited environmental impact and positive health effects, the high costs make these products accessible only to a niche market of high-income consumers. The main objective of this study is to inquiry the emerging market of legume dry pasta by analysing its market prices to evaluate the market performance of each product attribute. To this end, the hedonic price method was applied to obtain information to report firms' differentiation and communication strategies, as well as to suggest policy measures and interventions to improve consumers' affordability and the economic, environmental, and social sustainability of this product.

Keywords: Market analysis; Sustainability; Marginal areas development; Agrifood competitiveness; Alternative protein source.

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Characterization of fungal communities in raw cork from standing trees and their potential role in 2,4,6-trichloroanisole formation

Camilla Morittu [1,2,*], Edoardo Scali [3], Luca Sarais [1], Pino Angelo Ruiu [1], Fabio Marroni [4], Sara Pinosio [5], Andrea Piotti [5], Alberto Camboni [6], Adriana Vilia [1], Matteo Garbelotto [3], Giovanni Emiliani [7], Bruno Scanu [2], Salvatore Seddaiu [1]

[1] Agricultural Research Agency of Sardinia, AGRIS Sardegna, Via Limbara 9, Tempio Pausania, Italy
[2] Department of Agricultural Sciences, University of Sassari, Viale Italia 39/A, Sassari, Italy
[3] Department of Environmental Science, Policy and Management (ESPM), University of California, Berkeley, California, USA
[4] Department of Agricultural, Food, Environmental and Animal Sciences, University of Udine, Via delle Scienze 206, Udine, Italy
[5] Institute of Biosciences and BioResources (IBBR), National Research Council (CNR), Via Madonna del Piano 10, Sesto Fiorentino, Firenze, Italy
[6] Sugherificio Ganau S.P.A., Zona Industriale, Tempio Pausania, Italy
[7] Institute for Sustainable Plant Protection (IPSP), National Research Council (CNR), Via Madonna del Piano10, Sesto Fiorentino, Firenze, Italy

* *Corresponding author: Camilla Morittu (cmorittu@agrisricerca.it)*

Abstract. Cork oak (*Quercus suber* L.) is a mediterranean species of significant ecological and socio-economic value. Its management can influence cork quality, as well as the potential accumulation of 2,4,6-trichloroanisole (TCA). The TCA molecule is detectable by humans at extremely low concentrations and is responsible for substantial economic losses in the cork and wine industries. It is formed through the enzymatic activity of several microorganisms that methylates the precursor 2,4,6-trichlorophenol (TCP). Therefore, monitoring TCA levels and associated microbial communities from the earliest stages of the production chain, is crucial to ensure high-quality cork. In this study we characterized the fungal communities associated with raw cork from standing trees. Additionally, we investigated the associations between the fungal community and the occurrence of TCA. We collected 80 samples from 10 trees across 8 shrub-like cork oak stands in Sardinia. The fungal community was characterized using an integrated approach combining traditional culturing and metabarcoding techniques. Isolation techniques identified 66 OTUs (Operational Taxonomic Units), with Aspergillaceae, Cytosporaceae, and Hypocreaceae as the most frequently recorded families. Through metabarcoding, 2,832 ASVs (Amplicon Sequence Variants) were analysed, with the Aspergillaceae, Dermateaceae, and Hypocreaceae being the most abundant families. Among the species isolated in culture, *Cytospora cedri* was associated with TCA concentrations below the sensory threshold in wine, whereas *Trichoderma caerulescens* was linked to concentrations above it. The two methods revealed partially overlapping but distinct profiles. Traditional isolation results in viable cultures which can be used to assess the potential conversion of TCP into TCA. However, this approach is limited to cultivable species, whereas metabarcoding provides a broader overview of the fungal community without the possibility of further functional confirmation. This study highlighted the role of microorganisms associated with TCA accumulation and their potential impact on cork quality, revealing critical issues in the production chain from the earliest stages.

Keywords: *Quercus suber*; 2,4,6-trichloroanisole (TCA); Fungal community; Cork taint; Forest management.

Phosphate-solubilising *Bacillus* consortium as a strategic tool for durum wheat production

Carmelo Mosca *, Noemi Tortorici, Teresa Tuttolomondo, Nicolò Iacuzzi

Department of Agricultural, Food and Forest Sciences (SAAF) – University of Palermo, Viale delle Scienze 13, Building 4, 90128 Palermo, Italy

**Corresponding author: Carmelo Mosca (carmelo.mosca01@unipa.it)*

Abstract. Reducing synthetic fertilizer inputs while maintaining crop performance is a major challenge in Mediterranean durum wheat systems, where soil characteristics particularly limit phosphorus availability and constrain canopy development. This study evaluated the physiological, yield, and quality responses of the crop, as well as soil and plant phosphorus dynamics, following the application of a multi-strain Bacillus consortium under fertilized and unfertilized field conditions. Experiments were conducted in open field conditions at two contrasting Sicilian sites (Campo Carboj and Sparacia) in 2023 and 2024, using a randomized complete block design with three replicates. Treatments included seed coating, soil spraying at three rates, and combined seed + soil applications (S0-S7). Post-harvest soil available P and plant traits were assessed, alongside physiological indicators of canopy function (SPAD chlorophyll index, stomatal conductance (Gs), and NDVI) across key BBCH stages. Across both sites, microbial inoculation increased soil P_2O_5 availability, with the strongest responses at Sparacia (clay-rich, highly P-immobilizing soils), where several microbial treatments produced increases comparable to mineral fertilization. Microbial application enhanced crop physiology, particularly at Sparacia: non-fertilized treatments increased plant height (up to +23%), sustained higher SPAD values, improved stomatal conductance, and elevated NDVI from tillering through grain filling, indicating improved canopy vigor under nutrient limitation. However, these physiological improvements did not fully explain yield increases, which were greater at Campo Carboj, peaking in S5, S6, and S7. Overall, combined seed + soil applications (notably S6-S7) provided the most robust improvements, supporting the agronomic value of multi-modal inoculation strategies. The consortium partially compensated for fertilizer reduction by enhancing soil P availability and sustaining physiological and productive performance, with effects varying by site and driven by edaphic context.

Keywords: Biostimulants; Nutrient mobilization; Sustainable agriculture; Microbial inoculants; Mediterranean environment.

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Automation and tele-management of precision irrigation systems

Ahmed Moustafa *, Ossama M.M. Abdelwahab, Giovanni Francesco Ricci, Francesco Gentile

University of Bari Aldo Moro, Department of Soil, Plant and Food Sciences, Via Amendola 165/A, 70126, Bari, Italy.

* *Corresponding author: Ahmed Moustafa (a.moustafa1@phd.uniba.it)*

Abstract. Agriculture faces critical water scarcity challenges, with irrigation consuming approximately 70% of global freshwater resources while efficiency often remains below 50%. Traditional irrigation methods, reliant on fixed schedules or farmer intuition, frequently result in either water wastage through over-irrigation or yield losses from under-irrigation. This research presents the development and upcoming field validation of an innovative Decision Support System (DSS) for precision irrigation management in industrial tomato cultivation. The proposed system integrates multiple cutting-edge technologies into a comprehensive platform: soil moisture sensors for real-time monitoring of water availability, weather station data integration for meteorological forecasting, evapotranspiration (ET) calculations based on FAO-56 Penman-Monteith methodology, satellite-derived vegetation indices (NDVI) for crop growth stage assessment, machine learning algorithms for predictive irrigation scheduling, IoT-enabled wireless sensor networks for seamless data transmission, cloud-based computing architecture for centralized data processing and storage, and a mobile application interface providing farmers with real-time recommendations and remote system control. The primary objective is to maximize water savings while maintaining or improving crop yields through data-driven, adaptive irrigation scheduling that accounts for soil-plant-atmosphere dynamics. The system will be validated through field trials on industrial tomato production scheduled for the upcoming growing season, with comprehensive evaluation of water use efficiency, crop productivity, system reliability, and economic feasibility. This research contributes to the transition from reactive to predictive water management in agriculture, addressing critical gaps in long-term field validation and practical implementation of IoT-enabled precision irrigation technologies.

Keywords: Precision irrigation; Decision support systems; Internet of Things; Evapotranspiration; Vegetation indices.

The journey of mango: How the shipping systems affect fruit quality, consumer acceptance, and environmental impact

Cosimo Taiti [1], Bruno Bighignoli [1,*], Giulia Mozzo [1], Elettra Marone [2], Elisa Masi [1], Diego Comparini [1], Edgardo Giordani [1]

[1] Department of Agricultural, Food, Environmental and Forestry Sciences and Technologies (DAGRI), University of Florence, Viale delle Idee 30, 50019 Sesto Fiorentino, Italy
[2] Faculty of Biosciences and Technologies for Agriculture, Food and Environment, University of Teramo, Via R. Balzarini, 1, 64100 Teramo, Italy

* *Corresponding author: Bruno Bighignoli (bruno.bighignoli@unifi.it)*

Abstract. Mango (Mangifera indica L.) is a popular tropical fruit enjoyed worldwide, with Europe being a significant importer of this fruit. Its climacteric nature and short shelf-life pose challenges for maintaining quality, while emissions from transportation threaten the sustainability of the supply chain. This highlights the importance of low-impact logistics in maintaining fruit quality. This study aimed to evaluate the quality of fresh mangoes in Italy by comparing the different shipping systems (air, sea, and road) for seven cultivars sourced from seven countries. Quality assessment included pomological analysis, PTR-ToF-MS for volatile profiling (n = 11 cultivars × 2 years × 3 replicates), and consumer sensory analysis (n = 65 for untrained panellists in 1 year, n = 8 for trained panellists over 2 years). Results indicated that air and truck transport better preserved fruit quality compared to sea freight, primarily due to shorter transit times, which allowed for harvesting at more advanced ripeness stages. The combination of PTR-ToF-MS and PLS-DA effectively differentiated samples based on the method of transport, showcasing its potential as a quick quality monitoring tool. Mangoes transported by air showed significantly higher levels of volatile organic compounds (VOCs), a 29% greater total soluble solids (TSSs) content, and a 44% lower acidity (TA). Sensorial tests indicated that consumers preferred these mangoes. However, air transport resulted in 30 times higher CO2 emissions per kg of fruit compared to sea freight (~642,117 CO2e (kg) vs. ~19,132 CO2e (kg)), highlighting a critical dilemma between sustainability and quality. These findings provide a framework for developing hybrid logistics strategies that strike a balance between preserving quality and environmental responsibility. Additionally, they support the development of European mango cultivation, which can optimise harvest timing, reduce emissions, and enhance fruit quality.

Keywords: Mango fruit; Shipping methods; Consumer and sensory evaluations; VOCs profiling; GHG emissions.

Interaction between oak-infesting ambrosia beetles and plant pathogenic fungi in declining cork oak forests in Sardinia

Antonio Mulas [1,*], Camilla Morittu [1], Luca Sarais [1], Santino Fancellu [1], Pino Angelo Ruiu [1], Benedetto Linaldeddu [3], Carlo Bregant [3], Andrea Lentini [2], Roberto Mannu [2], Maurizio Olivieri [2], Salvatore Seddaiu [1]

[1] Servizio della Ricerca per la Sughericoltura e la Selvicoltura, Agris Sardegna, Tempio Pausania, Italy
[2] Dipartimento di Agraria, Università degli Studi di Sassari, Sassari, Italy
[3] Dipartimento Territorio e Sistemi Agro-Forestali, Università degli Studi di Padova, Legnaro, Italy

* *Corresponding author: Antonio Mulas (amulas@agrisricerca.it)*

Abstract. Oak decline is a complex disease with a multifactorial etiology, resulting from the combined or sequential action of multiple stressors. In this dynamic context, the impact of biotic and abiotic factors is variable, with insects and pathogens consistently playing a crucial role. Ambrosia beetles (Curculionidae: *Scolytinae*, *Platypodinae*) are particularly relevant in these processes. Unlike typical wood-borers, they do not feed on wood but cultivate symbiotic fungi within their galleries. This obligate mutualism is mediated by specialized structures, called "mycangia", that transport fungal propagules. While fungi provide nutrients to the beetles, the insects inadvertently facilitate the dissemination of pathogenic fungi. One of the most aggressive cork oak pathogens is *Diplodia corticola*, responsible for recurrent outbreaks across the Mediterranean basin. To investigate beetle-fungus interactions, a study was conducted in Sardinian cork oak forests from May 2024 to October 2025. Field work consisted in entomological monitoring via ethanol-baited aerial traps and the felling of four trees per site exhibiting severe decline symptoms. Five cross-sections per tree were collected to assess insect colonization and to isolate the fungal community associated with beetle galleries. Taxonomic identification of insects and fungi was performed on morphology and confirmed via molecular analysis. Multiple ambrosia beetle species were recorded, with *Xyleborinus saxesenii* and *Xyleborus monographus* being the most frequently observed species in traps and wood sections, respectively. Notably, *Platypus cylindrus*, typically associated with declining oak trees, was detected only sporadically. The beetle-associated fungal community included *Geosmithia fassatiae* (Hypocreales), a putative ambrosia beetles' symbiont, and *Diplodia corticola* as dominant pathogen. This study emphasizes the importance of an integrated approach to forest health management to limit oak decline, considering the interplay among environmental conditions, insect vectors, fungal communities, and host susceptibility.

Keywords: *Quercus suber*; Oak decline; Ambrosia beetles; *Diplodia corticola*; Sardinia.

Acoustic priming as a sustainable strategy to enhance drought tolerance and physiological resilience in *Olea europaea*

Hafiza Komal Naeem *, Diego Comparini, Bruno Bighignoli, Giulia Mozzo, Felipe Yamashita, Luciana Renna, Giovanni Stefano, Elisa Masi

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

* *Corresponding author: Hafiza Komal Naeem (hafizakomal.naeem@unifi.it)*

Abstract. Contemporary olive cultivation faces unprecedented threats from climate change and escalating pathogen pressure, necessitating the development of sustainable, non-chemical agricultural interventions. This study investigates the application of acoustic vibrations as an innovative physical elicitor to prime the physiological defense mechanisms of *Olea europaea*. In a controlled indoor experiment, olive plants were subjected to a six-month acoustic priming phase at 120 Hz, while a control group was maintained without vibration exposure. Following this period, both groups were subjected to a progressive drought regime maintained at 25% field capacity. To evaluate the plants' adaptive capacity, a sequential stress-recovery-stress model was implemented. This involved three strategic rewatering events at increasing intervals to simulate escalating drought severity: early-stage (Week 5), intermediate-stage (Week 6.5), and advanced-stage (Week 8). The severity of the drought was directly correlated with the increased duration of water deprivation between these stages. Final samples were collected at Week 10 under severe, prolonged drought conditions. Physiological stability was monitored via Relative Water Content (RWC) and gas exchange parameters (LI-COR 6400XT). To determine the biochemical basis of this resilience, we quantified peroxidase (POD) and superoxide dismutase (SOD) activities, as well as chlorophyll and polyphenol levels. Furthermore, confocal microscopy was employed to visualize the accumulation of Reactive Oxygen Species (ROS). Results demonstrate that acoustic vibration enhances drought tolerance. Vibrated plants consistently maintained higher water retention and demonstrated superior physiological stability across all stages of drought progression. Most notably, the "vibro" group exhibited significantly improved resilience and recovery kinetics following each of the three rewatering events. These findings establish a baseline for vibration-induced stress tolerance and highlight acoustic stimulation as a promising, sustainable strategy for improving plant resilience in water-scarce environments.

Keywords: Acoustic priming; Drought tolerance; *Olea europaea*; Physiological resilience; Sustainable agriculture.

InVEST-SDR modeling of soil erosion mitigation strategies in Southern Italy

Addolorata Maria Netti [1*], Ossama M.M. Abdelwahab [1], Giovanni Francesco Ricci [1], Anna Maria De Girolamo [2], Francesco Gentile [1]

[1] Department of Soil, Plant and Food Sciences (DiSSPA) – University of Bari, Via Amendola 165A, 70126 Bari (BA), Italy
[2] Water Research Institute, National Research Council, Viale F. De Blasio 5, 70132 Bari, Italy

* *Corresponding author: Addolorata Maria Netti (addolorata.netti@uniba.it)*

Abstract. Soil erosion poses a serious threat to agricultural sustainability and water quality in Mediterranean watersheds, where the combined effects of climate variability, complex topography, and intensive land use intensify sediment transport processes. Nature-Based Solutions (NBSs) have gained increasing attention as sustainable strategies to mitigate soil erosion while enhancing ecosystem services. This study applies the InVEST Sediment Delivery Ratio (SDR) model to quantify soil erosion dynamics and to assess the effectiveness of different NBS scenarios in the Carapelle watershed (506 km²), a representative agricultural river basin in Southern Italy. The InVEST SDR model was calibrated and validated using observed sediment yield data from 2007 and 2008 and ran for 20 years. After parameter optimization, the model reproduced measured sediment exports with a deviation of only 4.3%, confirming its reliability for watershed-scale assessments in Mediterranean environments. Four NBS scenarios were evaluated against baseline conditions: contour farming, no-tillage, cover crops, and a combined scenario integrating no-tillage and cover crops. Baseline soil loss ranged from 2.43 to 3.88 t ha^{-1} yr^{-1}, while sediment export varied between 0.86 and 1.30 t ha^{-1} yr^{-1}. Among the individual practices, no-tillage proved to be the most effective, achieving average reductions in sediment export of 72.2%. Cover crops and contour farming showed moderate but consistent reductions in erosion and sediment yield. The combined NBS scenario delivered the best overall performance, reducing sediment export by up to 75.9% and soil loss by 70.5% over the simulation period. Spatial analyses highlighted that forested and shrubland areas provide high sediment retention services, whereas agricultural areas exhibit the greatest potential for improvement through NBS implementation.

Keywords: Soil erosion; Sediment delivery ratio; Nature-based solutions; InVEST model; Mediterranean watershed

Do pharmaceutical active compounds in reclaimed wastewater affect the *in vitro* growth of soilborne pathogens and biocontrol fungi?

Pietro Nigro [1,*], Pompea Gabriella Lucchese [1,2], Francesco De Mastro [1], Gennaro Brunetti [1]

[1] Dipartimento di Scienze del Suolo, della Pianta e degli Alimenti (DiSSPA) – Università degli Studi di bari – Aldo Moro, Via Amendola 165/A 70126, Bari
[2] Centro di Ricerca, Sperimentazione e Formazione in Agricoltura – Basile Caramia, via Cisternino 281, 70100, Locorotondo (BA)

* *Corresponding author: Pietro Nigro (p.nigro13@phd.uniba.it)*

Abstract. Agricultural production in the Apulia Region is increasingly constrained by low water availability and by several soilborne pathogens, among which *Fusarium oxysporum* f. sp. *lycopersici* and *Verticillium dahliae* are particularly difficult to manage. The use of treated wastewater is considered a valuable strategy to support sustainable crop production and reduce freshwater consumption. However, irrigation with reclaimed wastewater may introduce pharmaceutically active compounds (PhACs) and their metabolites into agroecosystems. Carbamazepine, clarithromycin, diclofenac, metoprolol, and their metabolites are among the most frequently detected PhACs in treated effluents. In addition, PhACs and metabolites may interact with soil microbial communities, potentially affecting microbial growth and ecological functioning. In this research, the effects of selected PhAC metabolites (dihydroxycarbamazepine, 4-hydroxydiclofenac, 5-hydroxydiclofenac, N-desmethyl clarithromycin, metoprolol acid, acridine, licarbazepine, and 3-hydroxycarbamazepine) were assessed using in vitro growth assays against *F. oxysporum* f. sp. *lycopersici*, *Trichoderma asperellum*, *T.* gamsii, and two pathotypes of *V. dahliae* (defoliating and non-defoliating). Preliminary results indicate that, across the tested concentrations, these metabolites do not significantly affect the growth of the pathogenic fungi. In contrast, some metabolites appear to promote faster growth of the antagonistic fungi *T. asperellum* and *T. gamsii*. Further work is ongoing to clarify species-specific responses and to investigate the environmental fate and bioavailability of the tested metabolites under agroecosystem-relevant conditions.

Keywords: PhACs; Metabolites; Reclaimed wastewater; Soilborne pathogens.

Upcycling Nergi® through fermentation and acetification for vinegar production and obtention of protein-rich biomass

Selene Ollani [1,*], Maria Augusta de Carvalho Silvello [2], Nicole Roberta Giuggioli [1], Ingrid Aguiló-Aguayo [2], Maribel Abadias [2]

[1] Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy
[2] IRTA Fruitcentre - Postharvest, Parc Agrobiotech, 25194 Lleida, Spain

* *Corresponding author: Selene Ollani (selene.ollani@unito.it)*

Abstract. Research is moving towards sustainable technologies in the food system to obtain highly nutritive products. In the context of upcycling, baby kiwi (*Actinidia arguta* cv. Tahi® – Nergi®) unsuitable for fresh market was selected for fermentation, a biochemical process able to transform the matrix into two products: a liquid alcoholic fraction and a solid protein-rich biomass. The research was carried out in collaboration with UniTO DISAFA at the IRTA Fruitcentre in Lleida starting from the hypothesis that baby kiwi (BK) discarded before or after storage are usually overripe and high in sugars that can furtherly be fermented by yeasts. Two yeast strains (*Saccharomyces cerevisiae* WDCM00058 and *Saccharomyces pastorianus* CECT11037) were selected for the fermentation process. A Design of Experiment approach was used to determine the best ratio between BK pulp, water and nitrogen in the fermenting substrate. The best conditions were applied in a 2L-bioreactor and the obtained alcoholic liquid fraction was subsequently converted into vinegar and the protein content of the solid biomass was analysed as possible side-stream ingredient. Results showed that 40% of BK was the maximum amount to be used without changing the initial conditions, meaning the yeasts could find an advantageous environment even at low pH (3.4-3.6). Nitrogen supplementation was not essential. The bioreactor process occurred confirming the small-scale results. After the inoculation of vinegar mother, the production of acetic acid was verified at 0, 5, 10, 45 and 60 days together with the residual ethanol content. The ethanol yield obtained from both fermentations was lower than the expected amount, opening to considerations on the sugar availability in the initial matrix. Acetification legally did not reach the vinegar stage as acetic acid content barely reached 1%. The biomass retrieved after fermenting with the yeasts contained 14.91% and 14.54% of proteins respectively, showing potential for other value-added products.

Keywords: Nergi®; Fermentation; By-product valorisation; Protein biomass; Vinegar.

Kiwifruit quality characteristics and the consumer preference choice to the purchase in the north of Italy

Selene Ollani *, Antonina Sparacino, Giuggioli Nicole Roberta

Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy

* *Corresponding author: Selene Ollani (selene.ollani@unito.it)*

Abstract. Kiwifruit is valued for its nutritional and functional properties, contributing to its strong market relevance. Consumer behavior is influenced by multiple intrinsic, extrinsic and credence attributes, as well as by environmental factors such as the retail place of purchase, which in recent years has undergone changes in quality management and assortment strategies. The aim of this study was to investigate the relationship between objective quality traits, consumer preferences and retail context for different kiwifruit types (*Actinidia deliciosa* cv. 'Hayward' the green one and *Actinidia chinensis* cv. 'Hort16A' the yellow one). Kiwifruit samples were collected from supermarkets, hypermarkets and discount stores and analyzed for quality parameters. Consumer preferences were assessed through a Best–Worst Scaling (BWS) survey involving 12 intrinsic, extrinsic and credence attributes, administered to consumers from Piemonte and Veneto. BWS results identified texture/consistency, appearance and origin as the most relevant attributes, whereas price and certification attributes were less discriminating. Green kiwifruit showed significantly higher perceived consistency/texture and appearance compared with yellow and baby kiwifruit, confirming the higher maximum firmness levels observed in the qualitative product analysis. Nevertheless, the variability of consumer evaluations suggests a lack of homogeneity in firmness across retail place of purchase, indicating a potential influence of point-of-sale handling and assortment practices. Yellow kiwifruit was characterized by lower firmness perception and higher perceived variety, in line with the higher total soluble solids content detected in the qualitative analysis, indicative of a more advanced ripening stage. Overall, the integration of objective quality measurements and consumer preference data highlights distinct quality profiles among kiwifruit types and underlines the role of retail channels in shaping product consistency and consumer perception.

Keywords: *Actinidia*; Quality attributes; Market; Preferences; Consumer profiles.

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Stakeholder preferences for post-fire restoration practices in protective mountain forests

Azzurra Orlando *, Raffaella Marzano, Giovanna Sacchi, Silvia Novelli

Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy

* *Corresponding author: Azzurra Orlando (azzurra.orlando@unito.it)*

Abstract. In protective mountain forests, post-fire restoration is becoming a critical challenge due to the rising frequency and intensity of wildfires associated with climate change. While scientific literature has extensively analysed the technical and environmental effectiveness of post-fire restoration techniques, empirical evidence on public preferences remains limited. Research has focussed on biophysical and technical aspects, leaving the social dimension of sustainability unexplored. Consequently, public perception of benefits and citizens' preferences regarding restoration strategies are still poorly understood. This study aims to identify stakeholders' perceptions of wildfire-related damages and their preferences for post-fire restoration techniques. Four focus groups were conducted in a mountainous area of north-western Italy, which was affected by a major wildfire in October 2017. The discussion involved three types of local stakeholders: practitioners and operators from the wood supply chain; local and regional policymakers and administrators; and two groups of citizens. Participants were asked to identify and prioritise ecosystem services at risk from forest fires. They were then invited to discuss key post-fire restoration practices with the support of photographs. The discussions were recorded, transcribed, and analysed through qualitative content analysis using specialised software. The results show that, when all four stakeholder groups are analysed together, hydrogeological stability emerged as the ecosystem service considered the most important, while natural regeneration, defined as a non-intervention approach allowing natural forest recovery, was prioritised as the key post-fire restoration practice. Examining the focus groups separately reveals significant differences in perceptions; for example, salvage logging is considered relevant mainly by practitioners, whereas soil and slope stability emerge as priorities for policymakers and citizens. With regard to social sustainability, these differences highlight the importance of targeted communication strategies tailored to the specific groups involved, as well as the need to integrate these perspectives into decision-making through information exchange between local communities and higher-level decision-makers.

Keywords: Post-fire restoration; Stakeholder participation; Focus group; Wildfires; Protective forests.

Bacillus haynesii WVC18 enhances vegetative growth and ornamental traits in Poinsettia and Cyclamen

Elia Pagliarini *, Diana Di Gioia, Francesca Gaggìa

Department of Agricultural and Food Sciences, University of Bologna, Via Fanin 44, Bologna, Italy

* *Corresponding author: Elia Pagliarini (elia.pagliarini2@unibo.it)*

Abstract. Floriculture relies heavily on intensive chemical inputs, creating environmental and economic pressures that demand sustainable alternatives. This study evaluated the potention of *Bacillus haynesii* WVC18, a patented plant growth-promoting rhizobacterium (PGPR) isolated from waste vegetable compost, as a biostimulant for two high-value ornamental crops: poinsettia (*Euphorbia pulcherrima*) and cyclamen (*Cyclamen persicum*). The strain was characterized in vitro for phosphate, potassium, and zinc solubilization, siderophore production, and indole-3-acetic acid (IAA) synthesis, revealing robust PGP capabilities with γ-hemolytic biosafety confirmation. Greenhouse trials examined three cultivars of each species under standard commercial protocols, comparing control plants with that receiving biweekly *B. haynesii* WVC18 inoculations via sub-irrigation. The results demonstrated significant agronomic improvements across all varieties. Poinsettias treated with *B. haynesii* WVC18 had 90% greater fresh foliar weight in the white cultivar, red and orange varieties produced twice as many pigmented bracts. Root biomass increased significantly ($p < 0.001$) across all genotypes. Cyclamen showed comparable benefits, with fresh leaf weight increasing by over 50% and root biomass almost doubling. Photosynthetic pigments (chlorophyll-*a* and chlorophyll-*b* and carotenoids) increased by around 100% in treated plants of both species, while anthocyanin content in bracts and flowers increased significantly, particularly in red and orange poinsettia varieties and red/violet cyclamen. Quantitative PCR confirmed successful rhizosphere colonization, with bacterial populations increasing from ~5×10^5 to 2.0×10^7 CFU g^{-1} soil. These findings establish *B. haynesii* WVC18 as an effective biostimulant for ornamental crops, enhancing both vegetative growth and aesthetic quality through direct phytohormone production, nutrient mobilization, and rhizosphere modulation. This study represents one of the first applications of this novel *Bacillus* species in floriculture, offering a concrete strategy to reduce chemical fertilizer dependence while maintaining marketable quality in greenhouse production systems.

Keywords: *Bacillus haynesii*; Plant growth-promoting rhizobacteria; Biostimulant; Ornamental horticulture; Sustainable agriculture.

Preliminary screening of the herbicidal and fungicidal potential of essential oils from woody pruning biomass

Valeria Palchetti [1,2,*], Pierre Leonel K Tafokeu Taguimjeu [3], Andrea Carolina Baptista Ruiz [2], Cassandra Detti [1], Francesco Ferrini [1,2], Antonella Gori [1,2], Marie Laure Fauconnier [3], Cecilia Brunetti [1,2]

[1] Department of Agriculture, Food, Environment and Forestry (DAGRI), University of Florence, Firenze, 50144, Italy
[2] Institute for Sustainable Plant Protection (IPSP), National Research Council, Sesto Fiorentino, 50019, Italy
[3] Laboratory of Chemistry of Natural Molecules, Gembloux Agro Bio Tech, University of Liège, Belgium
* *Corresponding author: Valeria Palchetti (valeria.palchetti@unifi.it)*

Abstract. Essential oils are emerging as natural alternatives to synthetic plant protection products due to their richness in bioactive secondary metabolites. In line with circular-economy principles, this study explores essential oils extracted from woody pruning biomass of four ornamental nursery species: *Laurus nobilis*, *Liquidambar styraciflua*, ×*Cupressocyparis leylandii* and *Cinnamomum camphora*. Plant material was subjected to steam distillation, and the resulting essential oils were analyzed by GC–MS to determine their chemical profiles. To obtain preliminary insights into their potential applications in plant protection, two categories of biological assays were performed: herbicidal activity screening and fungicidal tests. Herbicidal activity was evaluated through foliar applications at 3% on two model species representative of dicotyledons (*Trifolium incarnatum*) and monocotyledons (*Lolium perenne*), assessed at two phenological stages. These assays aimed to detect phytotoxic responses rather than confirm herbicidal efficacy against true weed targets. The most active essential oil was subsequently tested at 1.5% and 0.5% to investigate dose-dependent effects. Fungicidal activity was assessed through direct-contact assays against *Fusarium verticillioides* and *Aspergillus flavus*, initially at 100 µL, followed by evaluations at 50, 10 and 5 µL for the two most active oils. The same treatments were also tested under fumigation to examine activity through volatiles. Among the evaluated extracts, essential oils from *L. nobilis* and *C. camphora* exhibited the strongest activities. *L. nobilis* induced marked phytotoxic effects, significantly reducing *T. incarnatum* viability at 3% and 1.5%, and affecting *L. perenne* at 3%, although the monocot species showed lower sensitivity. *C. camphora* displayed moderate phytotoxicity, primarily at the highest concentration. In fungicidal assays, both oils showed >93% inhibition at 100 µL, maintaining substantial activity at 50 µL, while fumigation caused no detectable toxicity. These results show the potential of pruning-derived essential oils for natural plant protection and highlight the need for further studies on target weeds.

Keywords: Essential oils; Pruning residues; GC-MS; Herbicidal activity; Fungicidal activity.

Evaluating the economic sustainability of agritourism models: A multicriteria framework in the Alta Murgia area

Giuseppe Parete *, Claudio Acciani

Department of Soil, Plant and Food Sciences (DiSSPA) – University of Bari Aldo Moro, Via Amendola 165/a 70126 Bari (BA), Italy

* *Corresponding author: Giuseppe Parete (giuseppe.parete@uniba.it)*

Abstract. The economic sustainability of agritourism enterprises is often assessed through partial indicators, mainly focused on profitability or financial performance. Such approaches are not always suitable for capturing the complexity of small and medium-sized rural businesses. Agritourism represents a hybrid business model, combining agricultural and tourism activities, and therefore requires analytical tools able to address productive, organizational, and market-related aspects simultaneously. This study proposes an integrated approach to the assessment of agritourism economic sustainability, understood as the ability of the enterprise to generate value, remain viable over time, and operate effectively in the market. The analysis is applied to the rural context of the Alta Murgia area in Southern Italy. The main objective is to develop and apply a multicriteria evaluation model to measure the economic sustainability of agritourism farms and educational farms. The model combines operational indicators related to the structure of the offer, commercial resilience, and market capacity. The methodological framework is articulated into two phases. In the first phase, a structured questionnaire administered to agritourism entrepreneurs collects information on firm characteristics, operational strategies, and perceptions of economic conditions. In the second phase, a panel of experts (including academics, institutional actors, and representatives of professional associations) participates in a two-level Analytic Hierarchy Process (AHP) to assign relative importance weights to the identified requirements and functional components. These weights are then used within the PROMETHEE method to conduct a comparative evaluation of enterprises. The expected results will identify which dimensions of economic sustainability are considered most relevant by local stakeholders and will highlight differences among agritourism business models. From a theoretical perspective, the study contributes to a clearer and more operational understanding of firm-level economic sustainability in rural areas. From a practical perspective, it provides a useful decision-support tool for policymakers, practitioners, and local actors involved in agritourism development.

Keywords: Agritourism; Educational farms; Economic sustainability; Multicriteria decision analysis; AHP-PROMETHEE.

Characterising postharvest physiology of wild strawberry tree (*Arbutus unedo* L.) fruit under contrasting storage temperatures using respiration rates and chlorophyll fluorescence-derived indices

Giovanni Pascucci [1,*], Sara Beltrami [1], Cassandra Detti [1], Ermes Lo Piccolo [1], Andrea Baptista [2], Valentina Lazazzara [2], Francesca Alderotti [2], Cecilia Brunetti [1,2], Lorenzo Bini [1], Francesco Ferrini [1,2], Edgardo Giordani [1], Antonella Gori [1,2]

[1] Department of Agriculture, Food, Environment and Forestry, University of Florence, Viale delle Idee 30, Sesto Fiorentino, I-50019 Florence, Italy
[2] Institute for Sustainable Plant Protection, National Research Council of Italy (CNR), Via Madonna del Piano 10, Sesto Fiorentino, I-50019 Florence, Italy

* *Corresponding author: Giovanni Pascucci (giovanni.pascucci@unifi.it)*

Abstract. Strawberry tree (*Arbutus unedo* L.) fruit is considered highly perishable and underutilised, which limits its valorisation as a fresh product and strengthens the need for clear cold-chain benchmarks. In this work, the temperature-dependent postharvest dynamics of wild strawberry tree fruits during storage were measured by comparing non-refrigerated conditions (17°C) and cold storage (4°C). A total of 128 fruits at an intermediate stage of ripening (yellow-orange) were individually labelled and monitored for 12 days. Fruit respiration was measured with a LI-6800 Portable Photosynthesis System coupled to a customized airtight fruit chamber, while ethylene was quantified from the sealed headspace by GC-MS at four sampling times. Fruit respiration and weight loss were recorded, along with other non-destructive analyses such as skin colour (colorimeter, CIELAB) and fluorescence-derived indices (flavonol and chlorophyll indices using a handheld sensor, Multiplex®). In addition, analyses of firmness, °Brix, and titratable acidity, as well as biochemical sampling for HPLC analyses of soluble sugars, polyphenols, and carotenoids, were performed. Preliminary results showed that storage at 4°C reduced metabolic activity compared with17°C, as revealed by lower respiration, reduced weight loss, and delayed softening (higher firmness retention), indicating a slower progression of fruit senescence and better preservation of fruit quality. These patterns are consistent with a climacteric-like behaviour during storage. Multiplex® measurements supported the characterisation of flavonoid and chlorophyll compounds, anchoring optical signatures to biochemical changes. Finally, the combined dataset was used to calibrate predictive models linking fluorescence indices and HPLC-quantified metabolites, thereby enabling rapid, non-destructive screening of these fruits to guide harvest-to-processing logistics and cold chain decisions.

Keywords: *Arbutus unedo*; Multiplex sensor; Postharvest quality; Fluorescence indices, Fruit respiration.

Evaluation and optimization of soybean productivity by AquaCrop model integrated with multispectral data

Giulia Pastacaldi *, Graziano Ghinassi, Simone Orlandini, Leonardo Verdi, Anna Dalla Marta

Department of Agricultural, Food, Environmental and Forestry Sciences and Technologies, University of Florence, Florence, Italy

* *Corresponding author: Giulia Pastacaldi (giulia.pastacaldi@unifi.it)*

Abstract. Soybean (Glycine max L.) productivity is strictly governed by water availability, which poses a significant challenge in the face of climate-driven drought and increasing competition for resources. Enhancing Water Productivity (WP) has therefore become a fundamental priority for global food security. This study evaluates regulated deficit irrigation (RDI) as a strategic approach to optimising water use efficiency while maintaining the economic profitability of soybean cultivation. The research is based on two years of field experiments designed to determine crop water requirements and develop optimised irrigation schedules. The study focused on evaluating the response of soybeans by comparing grain yield and observed water productivity under full irrigation (FI) and RDI regime that provided 70% of FI during growing and maturation stages. A key part of the study involved using the FAO AquaCrop model, which has been calibrated for soybeans and is highly effective at simulating yield in water-limited environments. To overcome the limitations of traditional modelling, the AquaCrop model was assimilated with multispectral data from a ground-based camera (Micasense Altum PT), as well as remote sensing data from Sentinel-2 (Copernicus). Preliminary results demonstrate that integrating multi-source data may reduce parameter uncertainty and enhances irrigation precision. Ultimately, adopting RDI strategies supported by advanced data assimilation offers a sustainable way to reduce production costs and preserve water resources while avoiding severe yield loss.

Keywords: Regulated deficit irrigation; *Glycine max L;* AquaCrop model; Water Productivity; Remote sensing

Biotechnological strategies to increase sweet chestnut tolerance to ink disease under climate change

Vera Pavese [1,*], Lorenzo A. Marino [1], María T. Martínez [2], Pablo Piñeiro [2], Elena Corredoira [2], Martina Ferrero [1], Anita Fuda [1], Guglielmo Lione [1,3], Paolo Gonthier [1,3], Silvia Sabbadini [4], Luca Capriotti [4], Bruno Mezzetti [4], Daniela Torello Marinoni [1], Roberto Botta [1], Andrea Moglia [1]

[1] Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy
[2] Biological Mission of Galicia (MBG-CSIC), Santiago de Compostela Headquarters, Av. de Vigo s/n, 15705 Santiago de Compostela, A Coruña, Spain
[3] Interdepartmental Centre for Innovation in the Agro-Environmental Sector (AGROINNOVA), University of Turin, Largo Paolo Braccini 2, 10095 Grugliasco (TO), Italy
[4] Department of Agricultural, Food and Environmental Sciences, Marche Polytechnic University, Ancona, Italy

* *Corresponding author: Vera Pavese (vera.pavese@unito.it)*

Abstract. Climate change is intensifying biotic stress pressures in European forests and agroecosystems, increasing the severity and spread of emerging diseases. Sweet chestnut (*Castanea sativa* Mill.), a species of major ecological and economic importance in Europe, is particularly threatened by ink disease caused by the oomycete *Phytophthora cinnamomi*, highlighting the need for sustainable and effective control strategies. Here, we propose two complementary, non-conventional approaches to enhance chestnut tolerance: CRISPR/Cas9-mediated editing and Spray induced gene silencing (SIGS). First, we knock out the chestnut susceptibility gene *Cspmr4*, which encodes a callose synthase linked to plant pathogen responses. Somatic embryos from two embryogenic lines (CI-9 and CI-3) were transformed with *Agrobacterium tumefaciens*, and kanamycin-resistant embryos were obtained. Editing was confirmed by PCR and Sanger sequencing of the target regions. TIDE and ICE analyses showed fully knock-out in each edited line. Edited somatic embryos and regenerated plants showed improved tolerance to *P. cinnamomi*. In parallel, we tested SIGS as a low-impact strategy to reduce *P. cinnamomi* growth by targeting genes involved in pathogenicity. We produced dsRNAs against five candidate genes (*dcl*, *hmp1*, *gpb1*, *gip*, *npp1*). *In vitro* tests on *C. sativa* inoculated leaves showed that dsRNA targeting *hmp1* reduced mycelial growth by 80% compared with water and GFP-dsRNA controls, supporting the potential of dsRNA sprays against ink disease. Overall, these results could offer a practical and sustainable way to improve sweet chestnut resilience to ink disease under changing climatic conditions.

Keywords: dsRNA; *spray induced gene silencing*; CRISPR/Cas9; Susceptibility genes; *pmr4*.

AI-based pruning and precision thinning as decision support system in apple orchards

Christian Andergassen, Daniel Pichler, Frederik Kurz, Magdalena Peterlin *

Institute for Fruit Growing and Viticulture – Research Centre Laimburg, Laimburg 6, 39040 Auer Ora (BZ), Italy

* *Corresponding author: Magdalena Peterlin (magdalena.peterlin@laimburg.it)*

Abstract. Profitable apple production requires both high yields and consistent fruit quality in order to remain competitive on the market. Yield regulation through winter pruning as well as chemical flower and fruit thinning is therefore a key management practice in modern fruit growing. At the same time, agriculture faces increasing challenges related to sustainability, labour shortages and climate variability. In this context digital technologies, particularly computer vision and artificial intelligence (AI) offer promising opportunities to support decision making and automation in crop management. At the Research Centre Laimburg (Trentino–Alto Adige) several studies are currently investigating vision-based systems for orchard management. One project, conducted in collaboration with *2farm*, focuses on the development of an AI-based pruning system. Tree specific 3D models are generated with simple camera technic commercially available, enabling the digital characterization of tree structure as a basis for pruning decisions. A second ongoing study evaluates the feasibility of different vision-based systems for precision thinning. Apple trees are scanned using a tractor mounted camera system supported by RTK positioning. Creating spatially explicit blooming maps, it provides information of flower clusters or blooming intensity per tree, to support site specific thinning decisions. While spraying, the system uses the predefined maps to determine whether individual trees require thinning. The trial compares two commercial vision-based systems with the standard farmer strategy in a systematic pre-trial, distinguishing between trees with high and low bloom intensity. First results indicate that, depending on the system, precision thinning reduced overthinning in low bloom trees and shows potential positive effects on return bloom. Overall, these preliminary results confirm that AI-based pruning and precision thinning represent promising tools to support farmers decisions and increase the attractiveness and sustainability of future orchard management. Further development and validation are, however, required before widespread practical implementation.

Keywords: Artificial intelligence; Computer vision; Orecision horticulture; AI pruning; Precision thinning.

Xylella fastidiosa on *Leptospermum scoparium* in Salento (Apulia, Italy): First report

Letizia Portaccio *, Athos Pedrelli, Alessandro Bene, Marzia Vergine, Luigi De Bellis, Andrea Luvisi

Department of Biological and Environmental Sciences and Technologies, University of Salento, 73100 Lecce, Italy

* *Corresponding author: Letizia Portaccio (letizia.portaccio@unisalento.it)*

Abstract. *Xylella fastidiosa* (*Xf*) is a Gram-negative, pathogenic bacterium that colonises and obstructs xylem vessels, responsible for infecting numerous plants including citrus, grapevine, olive trees and various ornamental species, with significant economic and environmental impacts. In southern Italy, particularly in Salento, Xf is one of the main phytosanitary emergencies due to its ability to adapt to new hosts and environments. In this context, the identification and characterisation of new hosts is important for understanding the epidemiology of the pathogen and improving containment and management strategies. Among the plant species recently introduced into European agro-ornamental systems is *Leptospermum scoparium* (J.R. Forst. & G.Forst., 1776) (Manuka), belonging to the Myrtaceae family and native to New Zealand, known for its high economic value, for the production of honey and essential oils with recognised antimicrobial properties. This shrub species has recently been introduced into Europe, where it is mainly cultivated as a honey plant and ornamental, specifically in southern Italy, Spain and Portugal. In light of these considerations, this study reports the first detection of *Xf* on Manuka plants in Salento, where infected plants exhibit symptoms such as marginal leaf chlorosis, progressive canopy drying, and plant death. The analyses confirmed the presence of the pathogen in approximately 70% of the symptomatic plants, with a bacterial titer ranging from 103 to 107 CFU/mL. These preliminary observations of *Xf* on Manuka plants in Salento highlight the pathogen's ability to infect recently introduced species. The results emphasise the need to monitor this species to prevent potential phytosanitary risks.

Keywords: Manuka; First detection; New host.

Resilient viticulture and consumer acceptance: evaluating wines produced from pest-resistant grapevines

Elena Radicioni [1,*], Vincenzina Caputo [2], Fabio Boncinelli [1], Leonardo Casini [1]

[1] Department of Agriculture, Food, Environment and Forestry (DAGRI) - University of Florence, Piazzale delle Cascine 18, Florence (FI), 50144, Italy
[2] Department of Agricultural, Food, and Resource Economics (AFRE) - Michigan State University, 446 W Circle Dr, East Lansing (MI), 48824, Stati Uniti

* *Corresponding author: Elena Radicioni (elena.radicioni@unifi.it)*

Abstract. The global wine sector faces increasing challenges from climate change, as extreme weather events intensify pest pressures and reliance on pesticides. In major wine-producing regions such as Italy's Prosecco area and California's Napa Valley, intensive pesticide use has raised environmental and public health concerns among local communities. Pest-resistant grapevine varieties offer a promising solution to reduce chemical inputs while maintaining production viability. Two main technological pathways exist: conventional varietal crossbreeding, leading to new varieties, and gene editing, an emerging biotechnology that enables targeted genomic modifications and may preserve established varietal identities. However, consumer acceptance of these approaches remains insufficiently understood, particularly when considering how proximity to pesticide-intensive production and psychological distance from agricultural externalities may shape preferences. This study adopts a cross-country approach involving consumers in Italy and California, two emblematic examples of Old World and New World wine markets, respectively, using two labelled choice experiments embedded in an online survey. Italian respondents evaluate Prosecco alternatives, while US participants assess Napa Valley Chardonnay options. The choice tasks compare conventional and organic wines with wines derived from pest-resistant varieties developed either through crossbreeding or gene editing. A between-subjects information treatment exposes participants to video testimonies from residents living near production areas who describe pesticide-related health and environmental concerns, enabling analysis of how emotional framing and perceived local impacts influence technological agricultural innovation. Measures of psychological and spatial distance, as well as trust in institutions, are incorporated to test moderating effects. Random parameters logit models are employed to estimate willingness to pay, market shares, and interaction effects across technological and contextual factors. By integrating innovation type, regulatory framing, and proximity constructs, the study provides new insights into how consumers negotiate the trade-off between tradition and biotechnology in wine production, informing both industry strategies and agricultural biotechnology policy debates.

Keywords: Resilient Viticulture; Pest resistance; Gene Editing Techniques; Psychological distance; Consumer acceptance.

Combined bioprocesses for pesticide reduction in cereals: the pivotal role of germination and tailored lactic fermentation

Federico Rametta [1,*], Giuseppe Perri [1], Lorenzo Ciraldo [1], Simona Carbone [1], Marco Laiolo [2], Claudia Sardella [2], Massimo Blandino [2], Francesco De Mastro [1], Gennaro Brunetti [1], Michela Verni [3], Erica Pontonio [1]

[1] Department of the Soil, Plant and Food Science (DiSSPA) – University of Bari Ado Moro, Via Giovanni Amendola 165/a, 70126 Bari, Italy
[2] Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy
[3] Department of Human Science and Quality of Life Promotion – San Raffaele University, Via di Val Cannuta 247, 00166 Rome, Italy

* *Corresponding author: Federico Rametta (federico.rametta@uniba.it)*

Abstract. The persistence of pesticide residues in cereal grains remains a critical concern for food safety. This study assessed the effectiveness of combining germination and lactic acid fermentation to reduce pesticide residues in wheat while preserving nutritional quality. Wheat grains cultivated under conventional or intensified pesticide regimes were subjected to controlled germination, followed by fermentation of native or germinated flours using selected lactic acid bacteria (LAB) strains. Pesticide residues were quantified at each processing stage using QuEChERS extraction coupled with GC–MS/MS and LC–MS/MS. Germination alone resulted in partial reductions of several pesticides, including clopyralid, epoxiconazole, pydiflumetofen, and azoxystrobin, likely due to enzymatic activation, oxidative processes, and microbiota-mediated transformations. Subsequent fermentation of germinated flours with selected LAB strains (*Lactiplantibacillus plantarum, Levilactobacillus brevis, Pediococcus pentosaceus,* and *Limosilactobacillus fermentum*) led to substantial additional degradation, achieving complete removal of azoxystrobin and significant reductions of epoxiconazole (up to 55%) and pydiflumetofen (up to 34%). In contrast, fermentation of non-germinated flours under identical conditions did not significantly affect pesticide levels, underscoring the critical role of germination in preconditioning the grain matrix. Overall, the combined germination–fermentation approach offers a food-compatible and sustainable strategy to mitigate pesticide residues in wheat. These findings highlight the potential of integrating traditional cereal processing techniques with targeted microbial interventions to enhance food safety and consumer confidence.

Keywords: Germination; Lactic acid fermentation; Pesticide degradation; Wheat detoxification; Food safety

Novel feed, novel food: knowledge and uncertainty among Italian consumers on the use of insect-derived products in ruminant diets

Manuela Renna [1], Lara Rastello [1,*], Laura Gasco [2], Lisa Livorsi [2], Pablo G. Toral [3], Rachele De Cianni [4], Valentina Maria Merlino [2]

[1] Department of Veterinary Sciences (DSV) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy
[2] Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy
[3] Instituto de Ganadería de Montaña (CSIC-University of León), Finca Marzanas s/n, 24346 Grulleros, León, Spain.
[4] Department of Agriculture, Food and Resource Economics, Michigan State University, 446 W Circle Drive, 48832 East Laning, MI, USA.

* *Corresponding author: Lara Rastello (lara.rastello@unito.it)*

Abstract. Among the most promising innovative feedstuffs for farm animals, insect-derived products have attracted increasing scientific and industrial interest for their high nutritional value and environmental sustainability. Consumer acceptance of products derived from insect-fed animals was shown to vary depending on the considered animal species. This study investigated Italian consumers' knowledge of legislation on the use of insects as feed and their uncertainty about accepting dairy and meat products obtained from insect-fed ruminants. A structured questionnaire including items on perceived risks and benefits of insect-based feed in relation to sustainability, animal health and potential effects on ruminant-derived food products was distributed across Italy, collecting 1,040 responses. Data from the attitudinal sections were analyzed using PCA and cluster analysis. The PCA (explained variance = 90%) identified three principal components, which allowed the classification of respondents into four consumer segments: "Moderate rejectors" (41%), characterized by a negative perception on the use of insects as feed and related sustainability; "Sustainability-driven" (38%), who strongly believe in sustainability benefits of insects but remain cautious in fully approving their use; "Insect-based feed supporters" (12%), who strongly supported the use of insects; and "Purpose-driven" consumers (9%), who accepted the use of insects but not as a long-term solution. Across clusters, "Moderate rejectors" showed the highest level of uncertainty, accounting for 37% to 69% of total "I don't know" responses for items related to perceived risks and benefits associated with the use of insect-based feed. Conversely, "Sustainability-driven" consumers showed the lowest uncertainty rates (0.4% to 33%). In addition, knowledge gaps regarding European legislation were evident across all the clusters, particularly concerning the legal use of insect oils and the prohibition of insect meals in ruminant nutrition. Knowledge and uncertainty strongly shape consumer attitudes, highlighting the need for targeted communication to support sustainable feed innovations in ruminant production systems.

Keywords: Insect-derived products; Ruminant feeding; Consumer opinion; Sustainable food system.

Transcriptional landscapes of polyphenol oxidases (PPOs) in Triticum adaptation to environmental stress

Alberto Reddavide [1], Anna Maria Pellegrini [2], Anna Paola Minervini [2], Silvia Procino [2], Nunzio D'Agostino [1,*], Francesca Taranto [2]

[1] Department of Agricultural Sciences, University of Naples II, Piazza Carlo di Borbone 1, 80055 Portici (NA), Italy
[2] Institute of Biosciences and Bioresources, National Research Council of Italy (CNR-IBBR), Via G. Amendola 165/A, 70126 Bari, Italy

* *Corresponding author: Nunzio D'Agostino (nunzio.dagostino@unina.it)*

Abstract. Climate change has become an increasingly serious challenge in recent decades, particularly in the Mediterranean region, where water availability is now a major limiting factor for crop productivity. In this context, understanding the impact of climate change on yield and quality-related traits, as well as the molecular mechanisms underlying plant responses to water stress, is essential for the development of sustainable breeding strategies. Wheat is one of the most widely cultivated cereals worldwide and a cornerstone of global food security, as it provides a substantial proportion of human dietary calories. However, environmental stresses such as drought, salinity, and nutrient limitation severely affect both wheat yield and grain quality. A common physiological response to abiotic stress is the overproduction of reactive oxygen species (ROS), which leads to oxidative damage. In this context, polyphenol oxidases (PPOs) have attracted increasing attention due to their role as ROS scavengers. Although PPOs are traditionally associated with tissues browning and discoloration, recent studies have highlighted their involvement in plant stress responses. Emerging evidence suggests that PPOs may act as positive regulators of drought and salt stress tolerance in several plant species. To address these knowledge gaps, we employed targeted RNA sequencing using Ion AmpliSeq™ technology to profile PPO gene expression across multiple bread and durum wheat. We analyzed multiple tissues across four developmental stages, comparing control versus water-limited conditions, and in the presence/absence of plant growth–promoting bacterial consortia. Here, we present the bioinformatics workflow applied to representative samples, aimed at generating a comprehensive PPO gene expression atlas and identifying novel allelic variants. These results provide valuable molecular resources to support wheat breeding and the development of more resilient and sustainable cultivars.

Keywords: Polyphenol oxidases; Targeted RNA-sequencing; Gene expression atlas; Allelic variants; Plant growth promoting bacteria.

Evaluation of CoCas9 using a tomato hairy root screening platform as a rapid and scalable validation workflow for novel CRISPR nucleases in plants

Marco Renzetti [1,2], Daniela Palma [1], Valentina Forte [1], Antonio Casini [3], Francesco Mura [2], Barbara Felici [1], Elisa Brasili [2], Giorgio Morelli [1], Anna Cereseto [4], Fabio D'Orso [1,*]

[1] CREA - Research Centre for Genomics and Bioinformatics, Via Ardeatina 546, 00178 Roma (RM), Italy
[2] Department of Environmental Biology (DBA) - "Sapienza" University of Rome, Piazzale Aldo Moro 5, 00185 Roma (RM), Italy
[3] Alia Therapeutics, Via Visconti di Modrone 18, 20122 Milano (MI), Italy
[4] Department of Cellular, Computational and Integrative Biology (CIBIO) - University of Trento, Via Calepina 14, I-38122 Trento (TN), Italy

* *Corresponding author: Fabio D'Orso (fabio.dorso@crea.gov.it)*

Abstract. Plant genome editing is expected to play a central role in improving food security and environmental sustainability. To broaden the versatility of CRISPR-based technologies, a major research effort is currently focused on the characterisation of unknown and potentially alternative Cas nucleases, with the aim of expanding the available genome editing toolbox. Here, we present a rapid and efficient experimental framework designed to functionally validate novel CRISPR nucleases and sgRNAs in plant systems. This pipeline is based on the use of tomato hairy roots, which allow fast generation of multiple independent transformation events, high transformation efficiency, and early molecular readouts, making them particularly suitable for preliminary screening of emerging tools. As a proof of concept, this approach was applied to CoCas9, a compact Cas9 ortholog isolated from the human microbiome and characterised by the recognition of a degenerate PAM motif. Using a plant-codon-optimised CoCas9, we demonstrate for the first time that this nuclease is functional and effective in plant cells, inducing targeted genome editing events across multiple tomato loci: *DWARF* gene, involved in brassinosteroids biosynthesis; *HQT* gene, essential for chlorogenic acid biosynthesis; and *Woolly* gene, responsible for trichome formation. Editing outcomes included both small insertions/deletions and larger deletions, with efficiencies strongly influenced by sgRNA sequence. To enable a robust quantitative comparison with the standard SpCas9 system, a targeted NGS-based strategy was implemented. Common genomic targets were selected based on a defined PAM consensus compatible with both nucleases, allowing direct evaluation of editing performance. This approach is currently being used to assess and compare conventional and base editing efficiencies between SpCas9 and CoCas9 under equivalent conditions. The proposed workflow establishes a practical and reproducible platform for the rapid *in planta* validation and benchmarking of novel CRISPR nucleases, facilitating their systematic comparison and accelerating the expansion of plant genome editing technologies.

Keywords: CoCas9; CRISPR-Cas; Hairy roots; *Solanum lycopersicum*.

Understanding consumer responses to sustainability and climate change in animal-based products: comparative evidence from Italy and France

Gian Luigi Revelli *, Stefano Massaglia, Giulia Mastromonaco

Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy

* *Corresponding author: Gian Luigi Revelli (gianluigi.revelli@unito.it)*

Abstract. In light of climate change and evolving consumer expectations, the sustainability of animal-based food supply chains has become a central issue in food system transformation. These production systems are associated with environmental pressures, animal welfare concerns, and socio-economic implications. As consumers play a pivotal role through their purchasing decisions, understanding how they perceive sustainability and how this translates into changes in consumption is essential. These attitudes may vary across countries due to differences in cultural traditions, dietary habits, the relevance of origin-certified products, and a country's market role. Comparing countries with strong gastronomic identities, such as Italy and France, therefore, offers valuable insights into nationally embedded sustainability-oriented food choices. This study investigates the relationship between the importance attributed to economic, social, and environmental sustainability indicators and consumers' expected changes in consumption due to climate change concerns across three animal-based supply chains: cheese, cured meat, and fresh meat. A cross-country comparison between Italian and French consumers was conducted. Data were collected through an online survey administered to 2,300 Italian and 2,300 French respondents, responsible for household purchasing. For each supply chain, participants selected the three most important sustainability attributes from a list of 14, and rated on a 5-point Likert scale how their consumption may change due to climate change concerns. Responses were analyzed using Correlation Analysis (CA), considering selected sociodemographic characteristics. Results highlight significant associations between consumption changes and sustainability attributes for cured and fresh meat in Italy, but not in France, whereas French consumers show a more pronounced relationship within the cheese supply chain. In both countries, greater concern for animal welfare is associated with reduced consumption across all three supply chains. Finally, six consumer profiles (two per supply chain) were identified in both countries based on attitudes toward consumption change and the sustainability indicators driving their choices.

Keywords: Animal-based supply chains; Consumer behaviour; Climate change; Correlation analysis; Sustainable food system.

Modular open-source platform for multi-gas soil emission monitoring: design and controlled validation

Niccolò Rimbotti *, Daniele Sarri, Riccardo Lisci, Andrea Pagliai, Carolina Perna, Celine Russo, Marco Vieri

Department of Agricultural, Alimentary, Environmental and Forestry Sciences - Biosystem Engineering Division -DAGRI, University of Florence, Piazzale delle Cascine 15, 50144 Florence, Italy

* *Corresponding author: Niccolò Rimbotti (niccolo.rimbotti@unifi.it)*

Abstract. Soil atmosphere exchanges of trace gases provide key information for agroecosystem management and environmental protection, yet monitoring is often constrained by the cost and limited configurability of high-end analyzers. This work presents a low-cost, fully open-source, modular multi-gas platform designed for static chamber measurements of soil emissions and for simultaneous logging of relevant environmental variables. The system integrates a microcontroller based datalogger (RTC-timestamp), a dedicated gas line (miniature pump, tubing and an analysis chamber), with interchangeable electrochemical/NDIR sensing modules targeting CO_2, H_2S, ethanol and NO_2. In parallel, soil and air temperature and air relative humidity are recorded to support interpretation and post-processing corrections. A two level validation workflow is described. First, the CO_2 module, identified as the most sensitive to sensor specific offsets and drift, was calibrated through a dedicated procedure derived from previous proof of concept activities, using controlled reference concentrations and repeated cycles to quantify repeatability. Second, the complete platform was assessed in a climatic chamber under controlled temperature and humidity regimes using 12 L pots filled with three contrasting substrates (a light, fiber rich soil; a clay soil; and pumice). Each substrate was subjected to two treatments (with and without urea addition), and all pots were uniformly vegetated with the same amount of *Trifolium repens*. Static chamber accumulation measurements were performed using both continuous monitoring and fixed time sampling protocols. Platform outputs were benchmarked against a reference photoacoustic multi gas analyzer (INNOVA) to quantify agreement, uncertainty and potential sensitivity to environmental drivers using regression based metrics (e.g., R^2, RMSE/MAE) and Bland Altman analysis. Results from the climatic chamber experiments indicate that the proposed open platform can reproduce reference trends and support stable flux estimation under controlled conditions, providing a replicable and reprogrammable tool for multi gas investigations.

Keywords: Multi-gas monitoring; Open-source instrumentation; Static chamber method; Soil-atmosphere exchange; Low-cost sensor platform.

New genetics to increase resilience of maize production in a changing climate

Gabriele Rolando *, Francesco Ferrero, Ernesto Tabacco, Giorgio Borreani

Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy

* *Corresponding author: Gabriele Rolando (gabriele.rolando@unito.it)*

Abstract. Increasing temperatures and the growing frequency of extreme weather events have negatively affected crop productivity. In response to these challenges, plant breeding programs have contributed to yield improvement in several countries through the development of hybrids with enhanced agronomic performance, stress tolerance, and nutritional quality. In recent years, new genetic of maize characterized by specific functional traits have been introduced to the market. These include hybrids with improved tolerance to environmental stresses, genotypes with greater yield stability, and materials selected for enhanced starch concentration and improved fiber digestibility compared with conventional hybrids. The present study evaluated in a 3-year period on farms, the performance of these new genetics compared to conventional hybrids with the same maturity group. Parameters assessed included yield and quality traits (i.e. starch content and fiber digestibility). A carbon footprint analysis was conducted using different functional units (kg of dry matter and kg of starch) for all genotypes. In addition, an economic analysis was performed to estimate the economic results associated with the adoption of these improved genetic materials by farmers. Across the trials, water stress-tolerant hybrids achieved higher yields than conventional hybrids in 84% of cases. Hybrids developed for enhanced yield stability exhibited comparable yields but greater resilience under extreme weather conditions. Furthermore, these materials showed increased starch content and improved fiber digestibility in whole-crop silage. Hybrids selected for silage quality presented higher starch concentrations and lower NDF levels than conventional genotypes. Overall, the new genetics were associated with reduced GHG emissions, and improved economic performances. These findings indicate that the adoption of new genetics represents a viable strategy to increase the resilience of maize production systems under climate change. Enhanced tolerance to environmental stress and improved nutritional quality contribute to reduced environmental impacts and higher economic returns, thereby supporting the sustainability of maize production.

Keywords: Maize; Genetic breeding; New genetic traits; Climate change; Sustainability.

From lab to farm: *SOS Kiwi* as an example of communication reaching the end user

Ida Romano [1,*], Giuseppina Magaraci [1], Nadiya Dunayevska [1], Olimpia Pepe [1,2], Valeria Ventorino [1,2]

[1] Department of Agricultural Sciences, Division of Microbiology, University of Naples Federico II, Naples, Piazza Carlo di Borbone 1, Portici (NA), Italy
[2] Task Force on Microbiome Studies, University of Naples Federico II, Naples, Italy

* *Corresponding author: Ida Romano (ida.romano@unina.it)*

Abstract. Kiwi vine decline syndrome (KVDS), known as "*kiwi moria*," is a complex disease responsible for severe yield losses and orchard abandonment in kiwifruit-growing areas. The syndrome is characterized by a progressive deterioration of the root system, reduced plant vigor, leaf chlorosis, and ultimately plant death. Although the disease is economically important, it is hard to manage because it is caused by a mix of soil conditions, microbial imbalances, and plant-environment interactions. The SOS Kiwi project aims to address kiwi vine decline through an integrated approach that connects laboratory research with practical on-farm solutions. The strategy includes controlled greenhouse experiments in which disease symptoms are induced under standardized conditions to better understand causal mechanisms. Within these trials, four selected bacterial strains, *Azotobacter chroococcum* 76A, *Priestia megaterium* EL5, *Methylobacterium populi* VP2, and *Kosakonia pseudosacchari* TL13, and the beneficial mycorrhizal fungus *Rhizophagus irregularis*, were applied to counteract the syndrome and restore soil-plant functionality. High-throughput sequencing, was employed to characterize soil and root-associated microbial communities, monitor their dynamics, and identify key microorganisms involved in disease suppression or progression. These data-driven insights support the selection and optimization of the microbial consortium. The greenhouse trial was complemented by field trials to ensure the transferability and robustness of the proposed solutions. Results showed a clear impact of microbial inoculum in shaping bacterial structure favouriting potential beneficial microorganisms. A key part of the project is its communication strategy. A dedicated board works alongside research to connect academia with farmers, translating results into accessible articles, videos, and social media content. By promoting transparency and dialogue, the project ensures innovations move effectively from lab to farm.

Keywords: Kiwi vine decline syndrome (KVDS); Communication; PGPR; Soil microbiome.

Acknowledgements. This work was supported by Fondazione Cariplo, Project AGER 3, grant no. 2022–3307. "From SOil to Soil: origin and remediation to KIWIfruit Vine Decline Syndrome (SOS-KIWI)".

Targeted culturomic approach to select new cellulolytic bacteria using Hermetia illucens larvae as natural bioreactor

Ida Romano [1,*], Marisa Amato [1], Lucia Amoroso [1], Valeria Ventorino [1,2], Maria Letteriello [1], Morena Casartelli [3], Gianluca Tettamanti [4], Giuseppina Magaraci [1], Olimpia Pepe [1,2]

[1] Department of Agricultural Sciences, Division of Microbiology, University of Naples Federico II, Naples, Piazza Carlo di Borbone 1, Portici (NA), Italy
[2] Task Force on Microbiome Studies, University of Naples Federico II, Naples, Italy
[3] Department of Biosciences, University of Milan, Via Celoria 26. Milan (MI), Italy
[4] Department of Biotechnology and Life Sciences, University of Insubria, Via Jean Henry Dunant, 3, Varese (VA), Italy

* *Corresponding author: Ida Romano (ida.romano@unina.it)*

Abstract. The growing demand for sustainable resources led biotechnology research to use innovative approaches to transform lignocellulosic waste through bio-based technologies. *Hermetia illucens* larvae were employed to isolate cellulolytic strains from their gut for biomass bioconversion, following a Canapule-based diet and to evaluate its impact on midgut, hindgut, and larvae–substrate bacterial communities, using high-throughput sequencing and qPCR targeting the *bcs*Z gene (encoding endo-1,4-β-D-glucanase). Dietary changes caused notable shifts in hindgut bacteria compared to larvae fed an optimal (chicken feed) diet. Based on these results, a targeted culturomics approach was applied using rearing substrate and gut samples from Canapule-fed larvae. Two enrichment media (A1: CMC-based; A2: *Arundo donax*-based; both supplemented with soil, larval extract, and hemp powder) were sampled at inoculation, and after 7 and 14 days at 30°C. Metagenomic analysis revealed that sampling time affected bacterial composition, and substrates inoculated with gut showed higher *bcs*Z gene abundance. To isolate cellulolytic microorganisms, enrichment samples were plated on solid media with CMC, Avicel, *A. donax*, or Canapule powder. After five days at 30°C, plates were stained with 1% Congo red to detect cellulose-degrading bacteria. 417 bacterial isolates were grouped into 58 phenotypes by MALDI-TOF, ~32% of which showed cellulolytic activity. Among producers, 28 strains (halos ≥15 mm) were further screened: 86% showed exo-cellulase, 36% xylanase, 43% β-glucosidase, and 29% pectinase activity. All strains were tested for quantitative enzyme production, and so far, *Pseudomonas phenolilytica* AV144.1 has been tested in MiniBio bioreactors, yielding up to 0.27 U/mL endo-1,4-β-D-glucanase within 11 hours at 37°C. These findings confirm the enrichment strategy and position *H. illucens* as a promising source of cellulose-degrading bacteria for biomass bioconversion.

Keywords: Endo-1,4-β-D-glucanase; *Hermetia illucens*; Lignocellulosic waste; Enzyme production; *Targeted culturomics*.

Acknowledgements. This study was supported by Agritech National Research Center and funded by the European Union Next-GenerationEU (PNRR – Missione 4 Componente 2, Investimento 1.4 – D.D. 1032 17/06/22, CN00000022).

When a standard is uncertain. Implications of Penman-Monteith model uncertainty for agricultural water dynamics estimates

Edoardo Ronco *, Samuele De Petris, Enrico Borgogno-Mondino

Department of Agricultural, Forest and Food Sciences (DiSAFA) - University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy

* *Corresponding author: Edoardo Ronco (edoardo.ronco@unito.it)*

Abstract. Reference evapotranspiration (ET_0) is a key variable in hydrology, agriculture, and climate studies; its estimation is affected by significant uncertainties arising from meteorological inputs and model structure. Despite its widespread use, the uncertainty associated with ET_0 estimates is often poorly quantified. In fact, neglecting ET_0 uncertainty may lead to an unbalanced modelling effort, where increased precision in secondary parameters (crop/stress coefficients) does not result in proportional improvements in model reliability. In this study, we develop a variance propagation model to explicitly estimate the uncertainty of ET_0 calculated using the FAO56 Penman-Monteith formulation. The proposed approach analytically propagates the variance of the main meteorological drivers i.e., air temperature, net radiation, wind speed, and relative humidity, through the Penman-Monteith equation, allowing the contribution of each variable to the total ET_0 uncertainty to be assessed. The methodology is implemented within the Google Earth Engine platform and applied globally using the ERA5 reanalysis dataset. Gridded meteorological inputs are used to compute both ET_0 and its associated uncertainty under different scenarios at the global scale, producing spatially explicit maps of ET_0 variance. This enables the identification of regions/periods where ET_0 estimates are particularly sensitive to input data uncertainty. Results highlight substantial spatial heterogeneity in ET_0 uncertainty, emphasizing that uncertainty is not uniform and should be explicitly considered in hydrological and climate impact studies. The proposed framework provides a computationally efficient and scalable tool for local to global ET_0 uncertainty assessment and can be readily extended to other evapotranspiration models and datasets. This work contributes to a more robust interpretation of ET_0 estimates and supports improved decision-making in water resources management and climate change applications.

Keywords: Potential evapotranspiration uncertainty; FAO56 Penman-Monteith; Variance propagation law; Agricultural water management.

From spruce decline to mountain fruit systems: establishment and eco-physiological monitoring of sweet chestnut in post-disturbance areas

Lorenzo Rosso [1,*], Giovanni Gamba [1], Matteo Maver [2], Luca Poggetti [2], Sandra Mariangela [2], Michele Fabro [2], Gabriele Loris Beccaro [1]

[1] Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy
[2] Chestnut R&D Center – Regione Gambarello, 23, 12013 Chiusa di Pesio (CN), Italy
[3] Agenzia Regionale per lo Sviluppo Rurale del Friuli Venezia Giulia (ERSA), Pozzuolo del Friuli (UD), Italy

* *Corresponding author: Lorenzo Rosso (lorenzo.rosso@unito.it)*

Abstract. Climate change is increasing the frequency and severity of biotic disturbances in European forests, forcing managers and researchers to rethink long-term land-use strategies. In Friuli Venezia Giulia (Northeastern Italy), the combined effects of the Vaia storm (2018), which caused extensive windthrow, and the subsequent outbreaks of the European spruce bark beetle (*Ips typographus*) have severely affected Norway spruce (*Picea abies*) stands. In this framework, a pilot project was established in Cercivento (Udine) to evaluate the conversion of affected forest areas into sweet chestnut (*Castanea sativa* Mill.) orchards as a resilient and economically viable land-use alternative. The project combines traditional germplasm valorisation with advanced eco-physiological monitoring. Traditional Friulian cultivars, together with selected varieties from other Italian growing areas, were introduced using a dual establishment strategy: in situ grafting onto existing wild rootstocks and planting of trees grafted in nursery. This design allows the comparison of propagation techniques and genotype performance under the same pedoclimatic conditions. Plant performance was evaluated through a combination of dendrometric surveys, phenological observations, and continuous eco-physiological monitoring. Among the tools adopted, TreeTalker® sensors are used to record real-time stem radial growth and sap flow dynamics, providing high-resolution data on plant water use and growth patterns. These measurements are integrated with climatic variables to evaluate genotype-specific responses and management effects. The main objectives are: (i) to assess the adaptability of sweet chestnut in post-bark beetle environments; (ii) to identify suitable cultivars and management strategies; and (iii) to develop guidelines for forest-to-orchard conversion in disturbed mountain areas. Preliminary observations suggest that this approach may offer a promising framework for post-disturbance land-use transition, integrating restoration objectives, precision monitoring tools, and the valorisation of local genetic resources, with potential relevance for other European regions affected by conifer decline.

Keywords: *Castanea sativa*; Grafting; Cultivar performance; Field establishment; Local germplasm.

Peat substitution with chestnut wood fiber: species-specific responses in forest nursery seedlings under biostimulant application

Lorenzo Rosso *, Giovanni Gamba, Davide Salvino, Dario Donno, Gabriele Loris Beccaro

Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy

* *Corresponding author: Lorenzo Rosso (lorenzo.rosso@unito.it)*

Abstract. Peat replacement is a key strategy to enhance sustainability in nursery plant production. This study evaluated chestnut wood fiber, a by-product of tannin extraction, as a partial peat substitute and its interaction with an oak tannin-based biostimulant in *Acer campestre* and *Crataegus monogyna*. Pure peat served as the control, while peat was partially replaced with chestnut wood fiber at 30%, 50%, and 80% (v/v) in the other treatments. Moreover, two levels of the biostimulant (presence/absence) were tested. The experimental design included sixteen seedlings per substrate × biostimulant combination, which were grown under greenhouse conditions for one growing season. Preliminary dry biomass results showed species-specific responses. In *A. campestre*, aboveground biomass was unaffected by treatments, whereas root biomass was highest in the control (5.77 ± 2.88 g) and decreased markedly already at 30% wood fiber (3.38 ± 2.08 g). In *C. monogyna*, leaf biomass was influenced by the substrate × biostimulant interaction. The control without biostimulant was among the lowest-performing treatments (1.81 ± 0.67 g), while control + biostimulant and 30% fiber + biostimulant showed comparable values (3.03 ± 0.68 and 2.86 ± 0.96 g, respectively). The highest leaf biomass was observed at 30% fiber without biostimulant (3.63 ± 1.28 g). Conversely, root biomass decreased progressively with increasing fiber proportion. Overall, moderate peat substitution (30%) shows potential as a sustainable strategy for reducing peat use, though its suitability is strongly species dependent. The differential response to the oak tannin-based biostimulant further highlights the importance of evaluating substrate × biostimulant interactions.

Keywords: Nursery production; *Acer campestre*; *Crataegus monogyna*; Low-peat substrates; Tannin biostimulant.

Regional influence on consumer knowledge and awareness of wine quality labels and sustainability certifications in Italy

Sofiia Samarets [3], Mingze Rui [1,*], Filippo Brun [1], Stefano Massaglia [1,2]

[1] Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy
[2] Centro Interdipartimentale Viticoltura e Vino (CONViVi), University of Turin, 12051 Alba, Italy
[3] Independent researcher

* *Corresponding author: Mingze Rui (mingze.rui@unito.it)*

Abstract. Wine quality labels and sustainability certifications play an increasingly important role in the European wine market, acting as both information tools for consumers and differentiation instruments for producers. However, consumers do not interpret or value these certifications uniformly. This study investigates how regional and sociodemographic factors influence consumer knowledge and perceived importance of wine quality and sustainability certifications in Italy. The analysis focuses on three certification categories: PDO/PGI, organic, and sustainable wine certifications. The research examines whether consumer knowledge and perceived importance differ across Italian macro-regions, how knowledge relates to the importance attributed to certifications, and how sociodemographic characteristics interact with knowledge in shaping perceptions. The study is based on an online survey of Italian wine consumers. Respondents provided information on their sociodemographic, knowledge of certifications, and the importance they attribute to these cerfitications when purchasing wine. Italian regions were grouped into four macro-areas: North, Center, South, and Islands. Kruskal–Wallis tests were employed to assess regional differences, Spearman correlations to examine the relationship between knowledge and importance, and ordinal logistic regression models to predict consumer perceptions on different certifications. Results show significant regional disparities in both knowledge and perceived importance, with higher levels in Northern and Central Italy compared to the South and Islands. PDO/PGI certifications are the most recognized, while sustainable certifications display the lowest awareness. Knowledge emerges as a strong predictor of perceived importance across all models, particularly for organic and sustainable certifications. These findings highlight the need for regionally tailored communication strategies and suggest that improving consumer knowledge can enhance the economic and environmental effectiveness of wine certification schemes in Italy.

Keywords: Wine certifications; Consumer wine knowledge; Consumer behavior; Sustainability.

Comparison of different combinations of remote and proximal sensors (LiDAR, RGB camera) and point cloud analysis for canopy volume in a steep-slope Mediterranean vineyard

Celine Russo *, Carolina Perna, Andrea Pagliai, Niccolò Rimbotti, Riccardo Lisci, Daniele Sarri, Marco Vieri

Department of Agricultural, Food, Environmental and Forestry Sciences and Technologies (DAGRI) – University of Florence, Piazzale delle Cascine 18, 50144 Firenze (FI), Italy

* *Corresponding author: Celine Russo (celine.russo@unifi.it)*

Abstract. Volumetric analysis of tree canopies is of growing importance for farmers 4.0, as it enables the adoption of targeted, efficient agricultural practices, such as variable-rate fertilizers or phytosanitary treatments. Furthermore, the recent EPPO guideline PP 1/239 (3) introduced a new labelling system for plant protection products based on the LWA (Leaf Wall Area) or TRV (Tree Row Volume) index for the expression of the dose, making it essential for the farmer to obtain this information in a fast, precise, and sustainable way. Currently, the most used methods for acquiring such data are real-time sensors mounted on tractors or manual measurements, both of which require a long acquisition time. This study aimed to compare canopy volumes obtained using different combinations of monitoring technologies (UAV and terrestrial) and analytical methods applied to the point cloud of vines canopy in a Mediterranean environment characterized by steep terrain. The technologies used for UAV monitoring included high and low-cost RGB cameras, and LiDAR, while terrestrial monitoring was carried out with the Geoslam LiDAR. Regarding the analytical methods for processing the point cloud, the following were used: alphashape (a = 0.1-0.5), convex hull, voxelization (l = 0.05-0.10 m), and manual reference measurements. The results showed that, for surveys conducted with LiDAR, high-precision RGB cameras, and low-precision RGB cameras, the convex hull was the most appropriate analytical method (RMSE: 0.10, 0.13, and 0.30 m^3, respectively). With Geoslam LiDAR, the most appropriate analytical method was alphashape with a = 0.5 (RMSE: 0.11 m^3). In conclusion, for the practical needs of a farmer, it is possible to obtain volumetric data representative of reality using low-cost technologies and rapid surveys, provided the most suitable analytical method is adopted. However, further studies are needed to validate these results under different growing conditions and on a larger data sample.

Keywords: UAV; Low-cost; Alphashape; Convex hull; Voxelization.

Multi-environment analysis of yield and quality traits to boost the European common bean varietal portfolio

Rocco Sabato [1,2,*], Stefania Marzario [1], Giuseppina Logozzo [1], Valeria Morante [1], Carmen Verrastro [1], Gerardo Pio Placido [1], Juan Jose Ferreira [1], Evelin Adam [1], Ana Campa [1], Valerio Di Vittori [1], David Gaikpa [1], Lars-Gernot Otto [1], Patrice Jeanson [1], Otto Klaus Oldach [1], Roberto Papa [1], Ivo Rieu [1], Gerthon van de Bunt [1], Donal Murphy-Bokern [1], Tania Gioia [1]

[1] The Legume Generation Consortium coordinated by the IPK Gatersleben in Germany
[2] PhD School in Agricultural, Forest and Food Sciences, University of Basilicata, Via dell'Ateneo Lucano 10, 85100 Potenza, Italy

* *Corresponding author: Rocco Sabato (rocco.sabato@unibas.it)*

Abstract. Within the context of sustainable agriculture, common bean (*Phaseolus vulgaris* L.) represents an essential legume crop due to its modest agronomic requirements and its contribution to soil fertility and crop diversification. However, the European varietal portfolio for both fresh pod and dry seed types has undergone limited renewal, resulting in continued dependence on imports in order to satisfy demand. Strengthening breeding activities is therefore critical and aligns with EU priorities on agrobiodiversity and sustainability. As part of this effort, the Legume Generation project aims to reinforce the European breeding base of common bean. In 2025, two breeding panels, BBS1 (dry bean) and BBS2 (snap bean), each comprising ~ 200 entries, were evaluated in Southern Italy (Paterno; 40°16'20.352" N, 15° 54' 37.905"E) within a multi-location field trial framework (MLFT). Both panels were simultaneously cultivated across three European environments characterized by contrasting agroclimatic conditions and farming systems. The trials followed a Randomized Complete Block Design with repeated checks; BBS1 with three replicates and BBS2 with two replicates, each plot consisting of a single row of 14 seeds. A total of 35 traits were recorded, including 19 qualitative and 16 quantitative traits covering phenology, morphology, and yield components, with priority given to key yield traits (Number of seeds per pod, Total dry seed mass per plot, 100 seed mass). The MLFT results will provide insights into genotype adaptation and yield stability across contrasting environments, supporting the identification of the most promising lines in terms of adaptation and yield stability. Moreover those data will give insight about the performance under ongoing climatic changes of both BBS.

Keywords: Genetic resources; Legume crops; Common bean; Phenotyping; Multi-location field trial.

Evaluation of the effect of spectral composition on the response to UV-B stress in Micro-Tom

Elige Salamé *, Giacomo Cocetta, Carla Colombani, Roberta Bulgari

University of Milan, Department of Agricultural and Environmental Sciences – Production, Landscape, Agroenergy (DiSAA), Via Celoria 2, 20133 Milan, Italy

* *Corresponding author: Elige Salamé (elige.salame@unimi.it)*

Abstract. To evaluate how light spectral quality influences plant responses to environmental stressors, Micro-Tom plants were grown in a controlled growth chamber using the Micro Experimental Growing (MEG®) system under two LED light spectra: green-enriched (MEG 1) and red-enriched (MEG 2), with an average PPFD of 210 µmol m^{-2} s^{-1}. Plants were exposed to UV-B radiation (4 W m^{-2}) twice weekly for two weeks, with 1 hour exposures every 2 hours during the photoperiod. Leaf tissues were collected and analyzed to evaluate physiological and metabolic responses. Results showed that under MEG 1, UV-B exposure led to a significant reduction in total sugars, whereas chlorophyll *a*+*b* and malondialdehyde (MDA) concentrations remained unchanged, while phenolic compounds increased markedly. This response indicates a metabolic reallocation toward UV-screening and antioxidant secondary metabolites, supporting redox homeostasis and preserving photosystem II efficiency. The green-enriched light environment likely contributes to these effects by promoting more uniform excitation within mesophyll tissues, thereby stabilizing PSII and facilitating carbon allocation toward protective metabolic pathways. In contrast, plants grown under red-enriched MEG 2 showed reduced F_v/F_m and performance index values, increased MDA accumulation, and a limited induction of phenolic compounds following UV-B exposure, reflecting enhanced lipid peroxidation, photoinhibition, and a compromised antioxidant response. The predominance of red light likely promotes surface-biased excitation, increasing excitation pressure and sensitivity to UV-B induced oxidative stress. Collectively, these preliminary findings demonstrate that green-enriched light enhances UV-B tolerance in Micro-Tom plants by supporting photochemical stability, redox balance, and adaptive metabolic reprogramming, highlighting the role of light penetration and chloroplast excitation dynamics in stress acclimation and the potential of spectral optimization to improve crop resilience in controlled environments.
Future studies could explore whether similar spectral strategies confer tolerance to other abiotic stresses, such as drought or heat.

Keywords: Indoor farming; Micro-Tom; LED lighting; UV-B stress.

The role of LuxR/LuxI-quorum sensing based system in *P. gessardii* in the regulation of proteolytic activity: Insights into QS inhibition as a strategy for control of spoilage activity

Mohammed Salman [1], Irene Giordano [1], Giuseppina Tommonaro [2], Adele Cutignano [2], Iris Bertani [3], Cristina Bez [3], Sérgio F. Sousa [4], Anabela Borges [4], Vittorio Venturi [3], Gianluigi Mauriello [1,*], Roberto Abbamondi [2,*]

[1] Department of Agricultural Sciences, University of Naples Federico II, 80055 Portici, Italy.
[2] National Research Council (CNR), Institute of Biomolecular Chemistry (ICB), Via Campi Flegrei, 34, 80078 Pozzuoli, Italy.
[3] Department of Biomedicine, Faculty of Medicine, University of Porto, Rua Alameda Prof. Hernâni Monteiro, Porto 4200-319, Portugal.
[4] Department of Chemical and Biological Engineering, Faculty of Engineering, University of Porto, Rua Dr. Roberto Frias, s/n, Porto 4200-465, Portugal.

* *Corresponding author: Gianluigi Mauriello (giamauri@unina.it);*
Roberto Abbamondi (gennaroroberto.abbamondi@cnr.it)

Abstract. Quorum-sensing is a bacterial signaling pathway and involved in the regulation of genes expression. Yet, its role in food spoilage is not well explored. *Pseudomonas* are a main spoilage species in dairy products. During storage of raw milk under cold conditions before thermal processing, there will be production of spoilage thermostable protease enzymes by *Pseudomonas* spp. In this project, *Pseudomonas* with high spoilage activity at 4°C and 25°C were isolated from raw milk and identified at species level. After that, they were analyzed to determine the type of acyl homoserine lactones-QS system by whole genomic sequencing, biosensor assays, and liquid chromatography-mass spectrometry analysis. The AHL-degrading enzyme lactonase was heterologously expressed in the strains to investigate the contribution of AHL signals to proteolytic activity in comparison with wild-type strains. QS inhibition could be as a strategy to control spoilage activity, for this purpose, 50 polyphenols and postbiotics were virtually screened by molecular docking analysis for their ability to interact with the LuxR receptor of *P. gessardii.* The promising compounds were tested for their inhibitory effect on proteolytic activity at 4 °C and 25 °C in skim milk. Six highly proteolytic isolates were identified as *P. gessardii* and found to produce short chain AHL, mainly C4-HSL. Whole genomic sequencing revealed for the first time presence of diverse LuxI and LuxR solo genes in *P. gessardii*. Conjugated *P. gessardii* strains with lactonase confirmed the regulatory role of AHLs in proteolytic activity. Cinnamaldehyde and salicylic acid were found to compete with C4-HSL to bind with the LuxR and showed significant inhibition of proteolytic activity without antibacterial effects. Furthermore, postbiotic compounds from *Lactobacillus acidophillus* LA-5 were also shown to exert anti-proteolytic activity without antimicrobial effect. This work provides new insights into the potential of polyphenols and postbiotics to stabilize raw milk by QS inhibition.

Keywords: Food spoilage; Pseudomonas; Polyphenols; Proteolytic activity; Quorum sensing.

Actions to encourage climate and health friendly food choices among consumers: a systematic literature review

Sara Sansoni [1,*], Roberta Pietrangeli [2], Clara Cicatiello [2]

[1] Department of Economics, Engineering, Society, and Business (DEIM), University of Tuscia, Via del Paradiso, 47, 01100 Viterbo, Italy
[2] Department for Innovation in Biological, Agro-food and Forest Systems (DIBAF), University of Tuscia, via San Camillo de Lellis snc, 01100 Viterbo, Italy

* *Corresponding author: Sara Sansoni (sara.sansoni@unitus.it)*

Abstract. Current food systems rely on diets rich in meat and ultra-processed foods, making them unsustainable for both the environment and human health. They contribute to high greenhouse gas emissions and increased risk of chronic diseases. But which actions can effectively promote more sustainable dietary patterns? To answer this question, we develop a systematic literature review to examine studies that empirically test actions pushing climate and health friendly food choices among consumers. The systematic review is conducted following the PRISMA methodology. Relevant publications are identified in the Scopus database via a search string with the main keywords, between 2000-2025, resulting in 2063 records. An initial title and keyword screening excludes 1,826 articles not addressing actions to influence consumer food behaviour. Abstracts are then assessed against 4 criteria: food behaviour change, climate change mitigation, health outcomes, and empirical testing of at least one action. The 35 articles reporting empirically tested actions targeting food behaviour change are included in the review. In these articles, 73 actions are identified and grouped into 6 categories: messages/recommendations (52%), nudges (18%), labels (12%), educational courses or programmes (10%), immersive interventions (5%), mixed actions (3%). For each action, we assess the methodology of testing, the measured and the direction of the observed change. Overall, 58% of actions trigger a positive food behaviour change (more healthy and/or more environmentally friendly). Despite being more common, only 53% of actions related to messages/recommendations lead to an improvement. In comparison, mixed actions and educational interventions are more effective, with 100% and 86% of actions resulting in positive outcomes, respectively. These results highlight that changing eating behaviours is possible, but interventions need to be multiple and more complex; despite being extensively studied, simple messages are frequently ineffective.

Keywords: Healthy food consumption; Food behaviour change; Systematic review; PRISMA; Food choices.

Cover crops as a climate change mitigation strategy: Effects on wheat quality

Thomas Croci [1,*], Davide Mazzitelli [2], Barbara Chicco [2], Claudia Sardella [3], Andrea Bresciani [1], Massimo Blandino [3], and Alessandra Marti [1]

[1] Department of Food, Environmental and Nutritional Sciences (DeFENS), Statale University of Milan, Via Celoria 2, 20133 Milan, Italy
[2] Soremartec Italia S.r.l, Ferrero Group, Piazzale P. Ferrero 1, 12051 Alba (CN), Italy
[3] Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy

* *Corresponding author: Thomas Croci (thomas.croci@unimi.it)*

Abstract. In a context of proposing agronomic strategies to limit the negative impact of climate change on agricultural production and safeguard the environment, regenerative agriculture practices can provide very interesting solutions. In this regard, an important role is played by cover crops, with the aim of safeguarding the soil, preventing erosion phenomena, ensuring carbon sequestration and maintaining biodiversity. On the other hand, limited studies focused on evaluating the impact of cover crops adoption on the quality of wheat kernels, flour and baked products obtained, which is the aim of this study. A high protein bread wheat variety (Giorgione, protein content 15%) was grown in two seasons, 2024 and 2025, under five soil cover treatments during the intercropping period (bare soil, sorghum, niger, cowpea, and infested soil) and three fertilization rates (0, 90, 150 kg N/ha). Agronomic (grain yield) and qualitative features of kernels (test weight and protein content) and flours (gluten aggregation properties, starch pasting properties, dough mixing and extensional properties) were investigated. Finally, small-scale baking tests were performed. Cover crops affected yield and protein content, while fertilization rate impacted yield, test weight, and protein content. Gluten aggregation properties were influenced by both fertilization rates and cover crops, with cover crops samples presenting better gluten aggregation properties at lower fertilization rates than the control; differences were attenuated at higher fertilization rates. On the other hand, the agronomic strategies adopted did not affect starch gelatinization profiles, but impacted dough mixing properties, with cover crops mainly affecting dough stability and fertilization rates impacting dough development time. Changes in extensional properties and bread-making performance were also observed.
In conclusion, cover crops is a promising strategy for climate change mitigation, but, within a correct re-design of cereal cropping systems, require optimal fertilization to ensure effective implementation and minimize potential negative effects on wheat quality.

Keywords: Regenerative agriculture; Cover crops; Wheat quality.

The environmental impact of different farming systems for Piemontese cattle

Roberto Senatore *, Simone Blanc, Paolo Cornale, Davide Biagini

Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy

* *Corresponding author: Roberto Senatore (r.senatore@unito.it)*

Abstract. The steady increase in consumption of animal products will worsen the environmental impact of the livestock sector. It is therefore essential to quantify the environmental impact of different farming systems to promote the most sustainable ones. The Piemontese is the main beef cattle breed raised in Italy under different rearing systems. This study aimed to compare the environmental impacts of grazing-based and confinement-based Piemontese fattening systems using Life Cycle Assessment (LCA). A cradle-to-farm-gate approach was adopted, which includes upstream feed production, on-farm energy use, herd management, enteric methane, and manure handling. The functional unit was 1 kg of live weight. Environmental impacts were assessed using the ReCiPe 2016 Midpoint (H) V1.08 / World (2010) H method. Grazing-based systems were associated with reduced impacts in several categories, including ionizing radiation, ozone formation affecting human health, and terrestrial ecosystems, as well as terrestrial, freshwater and marine ecotoxicity. In contrast, no statistically significant differences emerged between systems for global warming, stratospheric ozone depletion, fine particulate matter formation, terrestrial acidification, marine eutrophication, mineral resource scarcity or land use. Grazing systems nevertheless showed a tendency towards higher land use. These differences were mainly attributable to the lower reliance on fossil energy and synthetic inputs. It is also important to note that pastures are typically located in marginal areas unsuitable for other agricultural purposes, and grazing contributes to their maintenance through the provision of ecosystem services, which the LCA does not assess. Furthermore, when considering a carbon sequestration rate of 0.5 t C ha^{-1} yr^{-1}, the global warming potential of the grazing-based system became lower than that of the confinement system. In conclusion, this study characterises the environmental impact of Piemontese cattle farming, highlighting the environmental advantages of grazing systems over confined systems for specific impact categories that are often overlooked.

Keywords: Life Cycle Assessment; Extensive systems; Intensive systems; Grazing; Indoor housing.

Optimizing water management at fertilization enhances the mitigation efficiency of NBPT- treated urea on ammonia volatilization in temperate rice agrosystems

Alisea Seren Rosso [1,*], M. Friuli [1], P. Bianchet [2], E. Dinuccio [1], D. Said-Pullicino [1], E. Miniotti [3], D. Tenni [3], M. Romani [3], L. Celi [1]

[1] Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy
[2] Instituto Federal de Educação, Ciência e Tecnologia do Rio Grande do Sul – Campus Bento Gonçalves
[3] Ente Nazionale Risi, Castello d'Agogna (PV), Italy

* *Corresponding author: Alisea Seren Rosso (alisea.serenrosso@unito.it)*

Abstract. Ammonia (NH_3) emissions from soil significantly contribute to nitrogen (N) losses in rice agrosystems. The use of urease inhibitors as additives to urea-based fertilizers has been widely adopted to mitigate NH_3 emissions; however, their effectiveness is highly dependent on water management practices. In this study, we evaluated the effect water management at fertilization (WMF) on NH_3 emissions from rice paddies in northern Italy. Specifically, we compared three N fertilizers (urea, urea + urease inhibitor (NBPT) and ammonium sulphate) and two water management regimes at fertilization events (drained vs flooded soil). Ammonia measurements were carried out immediately after fertilization and during the two following weeks using semi-open static chambers and acid traps. Urea, exchangeable NH_4^+ and nitrate at two soil depths were monitored as well as rice yield and quality. Results show that the highest emission occurred shortly after fertilization in all cases. The presence of the urease inhibitor NBPT significantly reduced NH_3 volatilization by about 72% with respect to urea, but only in drained soils. In flooded plots, NBPT did not mitigate NH_3 emissions, likely due to failure of inhibitor activation. The use of ammonium sulfate did not result in significant NH_3 losses, although it may pose economic and environmental concerns due to its high cost and sulfur accumulation in soil. In the topsoil, urea was more abundant in the plots treated with urea and NBPT, but it was rapidly converted to ammonium with limited movement along the soil profile. Nitrate levels remained minimal, even in the drained plots, suggesting that the potential loss of N through denitrification following soil flooding was limited. In conclusion, the use of urea combined with NBPT can effectively mitigate NH_3 emissions when applied to well-drained soils, hereby improving air quality and N use efficiency compared to applications on flooded soils.

Keywords: Rice; Nitrogen; Fertilizers; Ammonia emission; Water management.

Molecular traceability of pistachio products

Natalia Sgaramella [1,*], Valentina Fanelli [1], Angela Casadibari [1], Monica Marilena Miazzi [1], Cinzia Montemurro [1,2]

[1] Department of Soil, Plant and Food Sciences (DISSPA), University of Bari, Bari, Italy.
[2] Sinagri spin-off, University of Bari Aldo Moro, Bari, Italy

* *Corresponding author: Natalia Sgaramella (natalia.sgaramella@uniba.it)*

Abstract. Pistachio (*Pistacia vera* L.) is a crop of high economic and commercial value due to its excellent sensory and nutritional properties. The increasing demand for pistachio, in both its whole and processed forms, has led to a growing necessity to ensure the authenticity and traceability of the product throughout its entire production chain. Traceability is particularly relevant in relation to food fraud, including the use of peanut (*Arachis hypogaea* L.) as a substitute or adulterant for pistachio, despite peanut is one of the most common and dangerous food allergens, and its economic value is much lower and cannot be compared to pistachio. The identification based on morphological or sensory traits is ineffective, especially in processed foods, due to the use of additive and colorants. For this reason, molecular traceability techniques based on DNA analysis provide an effective tool to verify the conformity of products marketed as pistachio and to distinguish deceptive activities from cross-contamination. Molecular markers can discriminate the presence of pistachio from fraudulent presence of peanut, even in complex mixtures and regardless of the degree of product processing. In the present study, an effective simple sequence repeats-based method was used to specifically identify pistachios and peanuts. Firstly, a method based on qualitative PCR was developed and tested on controlled mixtures of the two species in order to evaluate its ability to detect peanut. The quantification of the peanut at different contamination levels will be assessed through digital PCR (dPCR) allowing the set up of a quantitative approach. Subsequently, the proposed method will be applied to commercial pistachio paste samples to detect any undeclared fraudulent additions of peanut, thereby protecting consumers and food safety. So far, our study demonstrated the feasibility of the proposed method and its effectiveness in detecting fraudulent presence of peanut, even in complex mixtures.

Keywords: Molecular traceability; *Pistacia vera* L.; *Arachis hypogaea* L; Digital PCR; SSR markers.

Technological innovation in the management of dissolved gases in the winemaking process

Agnese Spadi *, Ferdinando Corti, Giulia Angeloni, Lorenzo Bruchi, Cristiano Vizzo, Piernicola Masella, Alessandro Parenti

Dipartimento di Scienze e Tecnologie Agrarie, Alimentari, Ambientali e Forestali (DAGRI), Piazzale delle Cascine, 18 - 50144 Firenze (FI)

* *Corresponding author: Agnese Spadi (agnese.spadi@unifi.it)*

Abstract. Wine can contain various dissolved gases that significantly influence its physicochemical evolution and sensory profile. Commonly present gases include oxygen (O_2), carbon dioxide (CO_2), nitrogen (N_2), and, in trace amounts, other gases such as hydrogen sulfide (H_2S). Some of these, particularly oxygen and carbon dioxide, play a key role in wine quality management, both during the aging process and in the pre-bottling phase. The objective of this study was to investigate and evaluate the Smart MMR Plus, a machine developed by JU.CLA.S., assessing its potential applications in the management of dissolved gases during winemaking. The system is based on a selective membrane that, through the application of negative relative pressure, enables the controlled removal of dissolved gases from wine. The experiment was conducted on three types of wine: a white wine, a young red wine, and a red wine aged for 10 months in barrique. Three levels of negative relative pressure (-0.3, -0.6, and -0.9 bar) were tested, with three replicates for each treatment (n = 3). Samples were analyzed for dissolved oxygen and carbon dioxide content, volatile organic compounds, and subjected to sensory evaluation. Data were processed using two-way ANOVA in R software (v. 4.5.1) to evaluate the effectiveness of the treatment and the potential contribution of the technology. The results demonstrated that the use of the equipment significantly influenced the wine at both the physicochemical and sensory levels. A general reduction in dissolved oxygen and carbon dioxide levels was observed, with more pronounced decreases at specific levels of negative pressure. Regarding the aromatic profile, no statistically significant differences were detected; however, a decreasing trend in some volatile compounds was observed.

Keywords: Dissolved gases; Wine quality; Volatile organic compound; Process technology.

Why berries? Exploring Italian and German consumer choices

Antonina Sparacino *, Lorenzo Brunetti, Danielle Borra, Cristiana Peano

Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy

* *Corresponding author: Antonina Sparacino (antonina.sparacino@unito.it)*

Abstract. In recent years, berries, including strawberries, raspberries, blueberries, blackberries, and currants, have emerged not only as healthy foods but also as symbols of a healthy and sustainable lifestyle. Consumption is rapidly growing in Europe, driven by interest in health, naturalness, and convenience of consumption especially with targeted marketing. Italy and Germany, both consumers country, offer distinct cultural contexts, providing a unique opportunity to examine how values, habits, and consumption patterns shape perceptions of berries. While previous studies have explored nutritional benefits and consumer attitudes, the rapidly evolving European market calls for updated insights into cross-cultural differences in berry perception. The survey, collected with CAWI method (Computer-Assisted Web Interviewing), counted 904 respondents (503 Italians, 401 Germans), of whom 859 were berry consumers. It assessed perceptions of health, naturalness, sustainability, traceability, and convenience, alongside frequency and mode of consumption. ANOVA analyses and radar graphs visualized perception profiles and identified significant cross-country differences. Results show that Italians associate berries with health, naturalness, and traceability, with differentiated evaluations across each fruit, whereas Germans prioritize convenience and safety, showing more uniform perceptions among them. Frequency and consumption style amplify these cultural differences: Italian regular consumers predominantly use berries both fresh and processed (e.g., 63% for strawberries; over 50% for raspberries and blueberries), reinforcing health- and quality-oriented perceptions, while occasional consumers favor fresh berries only, reflecting seasonal or situational use. In Germany, regular consumers distribute choices between “fresh only” and “processed only” (e.g., 35% vs 20% for blueberries respectively), consistent with a practical, functional approach. These findings suggest that understanding cultural values, consumption frequency, and modes of consumption, along with generational differences, is crucial for targeted marketing and communication strategies, guiding innovation and growth in the European berry market.

Keywords: Cross-country; Consumer behavior; New trends; Berries perception.

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Do demand and supply speak the same language? Evidence from apple markets

Antonina Sparacino *, Giulia Mastromonaco, Simone Blanc, Filippo Brun, Stefano Massaglia

Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy

* *Corresponding author: Antonina Sparacino (antonina.sparacino@unito.it)*

Abstract. Traceability and food certification represent an important source of added value as a potential bridge between demand and supply within agri-food markets. Despite the economic relevance of the Italian apple sector, empirical studies together examining consumer preferences and supply communication strategies remain scarce. To address this gap, this study adopts an integrated approach by analysing both demand and supply within the same geographical context in Italy. From the supply side, producers' communication approaches were explored through a Reinert method and Content Analysis of the websites of companies. The analysis, revealed three main themes: i) relate to certification and quality assurance; ii) to storytelling of cultivation practices and natural resources; and ii) to the role of producer networks and consortia. Overall, sustainability communication places greater emphasis on environmental issues, while social and economic dimensions receive less visibility. Product certifications emerge as a central component of corporate websites, whereas traceability tends to be addressed in a more implicit way. From the demand side, consumer preferences were examined using a Conjoint Analysis involving 1,763 respondents. Findings indicate that price continues to play a dominant role in purchasing decisions; however, sustainability attributes significantly affect preferences, with positive preference for certifications and integrated farming methods. In contrast, traceability shows a weaker influence on choice, which may be explained by consumers' limited awareness and low perception of related risks. Certifications, particularly organic, emerge as a point of convergence, functioning as trust signals for consumers and representing a central element of company communication. Traceability appears under-communicated by producers and insufficiently understood by consumers, limiting its potential as a competitive and informational tool. Finally, the social and economic dimensions of sustainability remain largely invisible. More coherent and explicit communication strategies could better align demand and supply, strengthen trust, and support informed and sustainable purchasing decisions.

Keywords: Apple market; Certification; Consumer behaviour; Communication strategies; Traceability.

How yellow colour and ethical certification shape banana choice

Antonina Sparacino *, Giulia Mastromonaco, Raffaele Zanchini, Selene Ollani, Nicole Roberta Giuggioli

Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy

* *Corresponding author: Antonina Sparacino (antonina.sparacino@unito.it)*

Abstract. Bananas are among the most widely consumed fruits in Italy and represent one of the tropical products most deeply integrated into daily dietary habits. In the context of climate change, the progressive warming of Mediterranean areas may open new perspectives for banana cultivation, potentially enabling shorter supply chains and fruit characteristics more closely aligned with consumer quality expectations. At the same time, consumers are increasingly attentive to product attributes that signal quality, ethical sustainability, including certifications such as organic and fair trade. To identify the key drivers of purchasing decisions, a face-to-face survey was conducted with 360 consumers. Preferences were analyzed using a Conjoint Analysis based on a ranking approach, estimating part-worth utilities and the relative importance of selected attributes: price, certification, brand, and fruit color. Results indicate that fruit color is the most influential attribute, followed by price, certification, and brand. The strong preference for yellow bananas highlights the importance of visual cues as signals of perceived quality, taste, and ripeness stage. Price remains crucial, confirming the price-sensitive nature of banana consumption. Certification, particularly Fair-Trade labels, also plays a relevant role, suggesting that ethical and social attributes can enhance product differentiation when combined with intrinsic quality characteristics. These findings have important implications for producers and market operators in the Italian context, indicating that strategies focused on quality signaling, ripeness management, certification and efficient supply chains may improve market positioning and consumer acceptance in emerging production contexts.

Keywords: Banana; Food choice; Conjoint Analysis; Fair Trade; Certifications.

Effects of management abandonment on tree-related microhabitats: from recently abandoned forests to old-growth forests

Pierdomenico Spina [1,*], Christopher Leifsson [1], Roberta Berretti [1], Giovanni Santopuoli [2], Davide Ascoli [1], Alma Piermattei [1], Giorgio Alberti [3]; Renzo Motta [1]

[1] Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy
[2] Department of Agricultural, Environmental and Food Sciences (DiAAA) – University of Molise, Via F. De Sanctis, 86100, Campobasso, Italy
[3] Department of Agricultural, Food, Environmental and Animal Sciences (Di4A) – University of Udine, Via delle Scienze, 206, 33100, Udine, Italy

* *Corresponding author: Pierdomenico Spina (pierdomenico.spina@unito.it)*

Abstract. Rewilding is defined as the process of natural restoration of ecosystems in the absence of direct human activities. Despite the several positive effects of this phenomenon, such as the restoration of natural processes and benefits for wildlife, in some cases, the effect can be controversial. In fact, the abandonment of agricultural practices and the increase in abandoned land are leading to the closure of several mountain grasslands with a consequent loss of biodiversity. This study assesses the effect of rewilding on forest biodiversity by analysing alpha, beta and gamma diversity of tree-related microhabitats (TreMs) in different forest ecosystems across Europe. In detail, seven European forest types and different time since abandonment (TSA), defined as the time since the last silvicultural intervention, were considered for the analyses. The results show that there are no statistically significant differences in the TreM diversity among EU forest types. In comparison, beta diversity differs between forests that had not been managed for 30 to 60 years compared to old-growth forests. A linear regression model was used to understand how TSA, forest structure, and topography affected TreMs diversity. The results showed that TSA and diameter are the main drivers for alpha and beta diversity. Specifically, a lower TSA and a larger diameter lead to increased alpha diversity. Conversely, a greater TSA and a smaller diameter result in higher beta diversity. In addition, TreMs beta diversity is positively influenced by the slope. No significant fixed-effect influences on gamma diversity were found. These findings highlight the effect of rewilding on biodiversity, confirming the importance of tree dimensions on biodiversity. In addition, the study demonstrates the effect of management abandonment on the average number of TreM types per tree and on the degree to which TreM composition changes from tree to tree within a given plot.

Keywords: Forest Biodiversity; Tree-related Microhabitats; Old-Growth Forests; Silviculture; Abandonment.

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Wild edible plants in the western Italian Alps: Ethnobotanical heritage, phytochemical properties, safety, and postharvest quality

Stefania Stelluti [1,*], Nicole Mélanie Falla [1], Sonia Demasi [1,2], Simone Ravetto Enri [1], Daniela Manila Bianchi [3], Giampiero Lombardi [1], Valentina Scariot [1]

[1] Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy
[2] Department of Life Sciences and Systems Biology (DBIOS) – University of Torino, Via Accademia Albertina 13, 10123 Torino, Italy
[3] Experimental Zooprophylactic Institute of Piedmont, Liguria, and the Aosta Valley, Via Bologna 148, 10154 Torino, Italy

* *Corresponding author: Stefania Stelluti (stefania.stelluti@unito.it)*

Abstract. Foraging has always accompanied human life, assuming different forms and importance depending on places and times. Nowadays, foraging is increasingly popular throughout Europe as both a provisioning and recreational practice, and wild edible plants (WEPs) are acquiring growing commercial interest. Their rediscovery for food purposes responds to the increasing attention toward balanced and healthy diets rich in bioactive compounds, and renewed interest in local food traditions connected to terroir and intangible cultural heritage. In this framework, the Italian Alps represent an important repository of knowledge on WEPs, particularly in less explored peripheral valleys. An in-depth literature review of Piedmont ethnobotanical heritage recorded 527 species across 78 families, of which approximately 69% have their leaves collected and consumed. Among these wild leafy vegetables (WLVs), we selected eight, namely: *Achillea millefolium* L., *Alchemilla xanthochlora* Rothm., *Bistorta officinalis* Delarbre, *Blitum bonus-henricus* (L.) Rchb., *Phyteuma betonicifolium* Vill., *Plantago lanceolata* L., *Silene vulgaris* (Moench) Garcke, and *Taraxacum* F.H.Wigg. sect. Taraxacum. Analyses of mineral and phytochemical composition showed high phenolic content and antioxidant activity, while potential toxic elements (trace elements and nitrates) below legal limits. Microbial analyses confirmed the absence of key pathogens (e.g., *Salmonella* spp. and *Listeria monocytogenes*), and minimal processing (washing with water or 1% acetic acid solution) was useful to reduce mould and yeast. A panel test evaluation revealed generally mild flavours suitable for food mixtures. During postharvest storage most species retained their quality over extended periods, although interspecific differences in quality traits and dynamics were observed, with the most pronounced biochemical changes occurring ten days after harvest. Taking together, these results support a potential broader inclusion of these WLVs in sustainable food systems.

Keywords: Wild leafy vegetables (WLVs); Minerals; Nitrates; Microbiological safety; Shelf life.

Spatial planning and supply sizing of residual forest biomass for energy applications

Alice Carlotta Tani *, Raoul Romano

Council for Agricultural Research and Economics - CREA (Department of Policies and Bioeconomy)

* *Corresponding author: Alice Carlotta Tani (alicecarlotta.tani@crea.gov.it)*

Abstract. The transition toward sustainable energy systems requires analytical tools capable of effectively sizing energy plants according to real supply potential, integrating the quantitative assessment of available resources with the needs of territorial, forest, and industrial planning. Understanding the available potential of residual biomass derived from forest harvesting processes represents an essential preliminary step, in line with the principle of cascading wood use. However, such estimates must be translated into information that is useful for regional decision-making and planning processes. This contribution proposes a spatial prioritization approach aimed at supporting the planning of energy valorization of forest residues from the perspective of environmental sustainability and operational feasibility. Starting from the high-resolution mapping of the net annual potential of residual biomass—obtained using polygons from the Italian Forest Map (CFI) and dendrometric parameters derived from the National Forest and Forest Carbon Sink Inventory (INFC)—a multicriteria analysis was developed within a GIS environment (QGIS). In addition to resource availability, the analysis integrates territorial criteria related to slope and the presence of environmental constraints, in order to classify forest areas into priority classes (high, medium, and low) for the potential activation of the bioenergy supply chain. The outcome is represented by a choropleth map showing the spatial distribution of the different priority classes, serving as a synthetic and immediately interpretable decision-support tool. The application to the case study of the Calabria Region makes it possible to identify territorial areas where the combination of biomass availability, morphological conditions, and limited environmental constraints makes the implementation of valorization strategies more coherent and sustainable. The proposed approach does not replace existing forest and energy planning instruments but aims to provide a replicable and updatable knowledge support tool, useful for defining territorially targeted interventions within regional policies for energy transition and the forest bioeconomy.

Keywords: Residual biomass; Supply; Forest harvesting; Energy plants; GIS.

Sustainable bioplastic production from agrifood waste using *Cupriavidus necator*

Andrea Torreggiani [1,*], Angela Longo [2], Gaia Salvatori [3], Marianna Villano [3], Vito Carofiglio [4], Michela Verni [5], Carlo Giuseppe Rizzello [2]

[1] Department of Soil, Plant and Food Sciences, University of Bari, Via G. Amendola, 165/a, 70126 Bari, Italy
[2] Department of Environmental Biology, Sapienza University of Rome, P.le Aldo Moro, 5, 00185 Rome, Italy
[3] Department of Chemistry, Sapienza University of Rome, Piazzale Aldo Moro, 5, 00185 Rome, Italy
[4] EggPlant Srl, Polignano a Mare, Italy
[5] Department of Human Science and Quality of Life Promotion, San Raffaele University, Rome, 00166, Italy

* *Corresponding author: Andrea Torreggiani (andrea.torreggiani@uniba.it)*

Abstract. The accumulation of conventional plastic waste has intensified the search for sustainable alternatives, such as polyhydroxyalkanoates (PHAs). In this study, the potential of *Cupriavidus necator* DSM 428, a well-known intracellular producer, to synthesize polyhydroxybutyrate (PHB) using various agro-industrial by-products as low-cost carbon sources, was investigated. Specifically, the research focused on the valorization of bread and potato processing waste, artichoke residues and coffee oil extract (COE) recovered from industrial coffee waste. To release fermentable sugars, specific pre-treatments were optimized: bread waste underwent enzymatic hydrolysis with amyloglucosidase, while potato and artichoke residues were treated via acid hydrolysis using hydrochloric and sulfuric acid, respectively. Coffee waste powder was subjected to Soxhlet extraction to obtain the lipid fraction. Initial batch fermentations using only sugar-rich hydrolysates yielded PHB accumulations between 25.6% and 40.2% of cell dry weight (CDW). However, a significant increase in productivity was observed when these substrates were supplemented with COE. The results demonstrated that combining low concentrations of fermentable sugars (approx. 5 g/L) with 1.5% COE markedly enhanced microbial growth and biopolymer accumulation. The most promising outcome was achieved with potato waste hydrolysate supplemented with 1.5% COE, reaching an exceptional PHB content of 91.3% PHB/CDW in flask trials. Artichoke waste also showed high potential, yielding 76.6% PHB/CDW under similar conditions. Scale-up experiments in a 3-liter bioreactor confirmed the viability of the process, with artichoke-based formulations achieving 63.6% PHB/CDW. Chemical characterization via GC and TGA confirmed high polymer purity, with several samples reaching 100% HB monomer content, and favorable thermal stability. These findings highlight a circular economy approach, transforming diverse food wastes into high-value biodegradable plastics through optimized microbial fermentation.

Keywords: Bioplastic; *Cupriavidus necator*; Agrifood waste; Oil coffee; Food by-products.

Physiological indicators for drought resilience and irrigation management in cotton

Noemi Tortorici [1,*], Nicolò Iacuzzi [1], Thiago F. Duarte [3], Uzair Ahmad [2], Teresa Tuttolomondo [1], Xuejun Dong [2]

[1] Department of Agricultural, Food and Forest Sciences (SAAF), University of Palermo, Viale delle Scienze 4, 90128 Palermo, Italy.
[2] Texas A&M AgriLife Research, Garner Field Rd 1619, 78801 Uvalde, Texas, USA.
[3] Federal University of Rondonópolis, Avenida dos Estudantes 5055, Cidade Universitária, 78736-900 Rondonópolis, Mato Grosso, Brazil.

* *Corresponding author: Noemi Tortorici (noemi.tortorici@unipa.it)*

Abstract. The selection of drought-resistant cotton genotypes with high productivity and improved water-use efficiency is an increasingly pressing challenge, especially in major cotton-producing regions of arid and semi-arid climates, where the growing water crisis is being accelerated by climate change. We investigated physiological differences between two cotton varieties under well-watered and water-stressed conditions in southwest Texas. The varieties NG 4190 B3XF and ST 4990 B3XF were selected based on their contrasting responses to water stress in previous studies. Our objective was to evaluate these varieties in terms of water-use efficiency under different irrigation regimes. Under field conditions, we measured several physiological traits, including relative water content (RWC), leaf water potential (LWP), leaf chlorophyll fluorescence, instantaneous leaf gas exchange, and canopy temperature at different times of day across five clear days during the 2025 growing season. Additional measurements included rapid light- and CO_2-response curves and leaf carbon isotope ratios ($\delta^{13}C$). A unified stomatal optimization model was applied to identify potential differences in leaf stomatal strategies between the varieties. While photosynthetic parameters such as maximum carboxylation rate of Rubisco (Vcmax), maximum electron transport rate (Jmax), and photochemcial efficiency of PS II (Fv/Fm) did not differ significantly between treatments, maximum photosynthesis (Pm) under high light and photosynthetic efficiency (α) under low light were significantly reduced under water stress in ST 4990, whereas NG 4190 showed no significant changes. The reduction in cotton yield under water stress in ST 4990 was associated with midday RWC, the stomatal optimization parameter b1, and the seasonal maximum leaf area index (LAI). Our findings highlight key physiological traits underlying genotypic differences in water stress responses and may contribute to optimizing cotton production by improving water-use efficiency and reducing irrigation requirements.

Keywords: *Gossypium hirsutum*; Drought-tolerant; Water limitation; Crop selection; Stomatal conductance.

Water and carbon costs: A footprint-based evaluation of sustainability and competitive edge in organic cotton in Mediterranean environmental

Teresa Totaro *, Noemi Tortorici, Teresa Tuttolomondo, Nicolò Iacuzzi

Department of Agricultural, Forest and Food Sciences (SAAF) - University of Palermo, Viale delle Scienze, Building 4, 90128 - Palermo (PA), Italy.

* *Corresponding author: Teresa Totaro (teresa.totaro@unipa.it)*

Abstract. The analysis of water and emission efficiency in cropping systems has become a key part of sustainable agriculture in the Mediterranean region, which is facing increasing water scarcity. This study provides a site-specific evaluation of the Water Footprint (WFP) and Carbon Footprint (CFP) of organic cotton under Mediterranean conditions, combining the assessment of mass-based environmental indicators with the economic valuation of greenhouse gas (GHG) emissions through the EU Emissions Trading System (ETS) and the Social Cost of Carbon (SCC). The experiments were conducted at three locations with different soil and climate conditions, testing two cultivars (Armonia and ST-318) under three irrigation levels: severe water deficit (I30), moderate water deficit (I70), and full irrigation (I100). The results clearly show differences between sites, with distinct site-specific variations. The average WFP_lint increases from about 1,440 m^3 t^{-1} at the most productive site to over 4,100 m^3 t^{-1} at the least productive site. Similarly, the average C0FP_lint is lower under high productivity conditions, confirming the strongly yield-driven nature of mass-based indicators. At the Carboj and Primo Sole sites, moving from water stress (I30) to I100 results in roughly a 50% reduction in emissions, while at the Buonfornello site, increased irrigation does not produce a consistent decrease in emissions, as the rise in emissions per unit area is not fully offset by a corresponding increase in production. The response of different varieties is key to understanding these patterns: Armonia shows greater resilience to water stress, leading to better environmental performance during water shortages, whereas ST-318 performs best under full irrigation, boosting mass-yield indicators. Overall, the findings demonstrate that the environmental and economic sustainability of Mediterranean cotton systems depends on the interaction of yield, site, and cultivar, and that strategies focused only on increasing water volumes often fail to achieve effective results.

Keywords: Site-specific management; Irrigation efficiency; Cultivar response; Yield-environment trade-off; Carbon pricing.

Who seems local, who seems global? Exploring differences among consumer identity types in food neophobia, locavorism and food certification awareness

Fabio Tuscano [1], Irene Sandi [2,*], Pericle Raverta [2], Paola Toschi [1], Barbara Loera [2], Jatziri Mota Gutierrez [1], Claudio Forte [1]

[1] Department of Veterinary Sciences – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy
[2] Department of Psychology – University of Turin, Via Verdi 10, 10124 Torino (TO), Italy

* *Corresponding author: Irene Sandi (irene.sandi@unito.it)*

Abstract. Understanding consumers behaviour is essential for shaping the future of agri-food systems. Social identity theory suggests that individuals' self-concepts are tied to group memberships, which in turn influence preferences and consumption behaviour. Identity orientations such as nationality have been shown to systematically affect consumers purchase behaviour. Exploring how multiple consumers identities influence food preferences, neophobia, and awareness of certified products can guide strategies to promote sustainable, safe, and healthy foods, addressing challenges and opportunities for the next generation of agri-food professionals. This study investigated how consumer identity types (local, national and local, local and national, cosmopolitan, national and global and glocal) are related to food neophobia, adherence to and promotion of local foods and local production (locavorism) and food certification awareness through an online survey administered in December 2024 (n=1237). Consumer identity was assessed via territorial identity, based on respondents' primary and secondary spheres of belonging. Food neophobia was assessed using a 10-item scale with 5-point Likert-type responses, locavorism using a 7-item scale with 5-point Likert-type responses, and food certification awareness through a composite score derived from dichotomous variable (know/don't know). One-way ANOVA was conducted to test differences in food neophobia, locavorism, and food certification awareness scores across consumer identities. Our findings revealed differences ($p<0.05$) across identities for locavorism, food neophobia, and food certification awareness, with small-to-moderate effect sizes. Trends were consistent with theoretical expectations. Local identities were associated with higher preference for local products, lower consumers' openness to novel foods and lower attention to certifications. These results support the validity of the consumer identity type and demonstrate a link between territorial identities and psychological dispositions toward food choices. Tailoring food communication, labelling, and marketing strategies to identity profiles may enhance engagement with local and certified foods, providing insights for agrifood researchers and stakeholders.

Keywords: Territorial identity; National identity; Cosmopolitan identity; Food awareness; Food preferences.

Application of physical light elicitors to improve color uniformity in sweet cherry

Alice Varaldo *, Giovanna Giacalone

[1] Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy

* *Corresponding author: Alice Varaldo (alice.varaldo@unito.it)*

Abstract. Sweet cherry (*Prunus avium*) production is gaining interest in Piedmont (Italy), due to its high economic profitability and the strong market demand. However, sweet cherries face several challenges during harvest and postharvest phases. One of the main issues is non-homogeneous skin coloration within the same batch, which negatively impacts marketability and consumer acceptance. Achieving standardized coloration would require multiple harvest rounds, which would significantly increase production costs. Moreover, variable and adverse climatic conditions, ranging from extremely dry to excessively rainy seasons, often limit harvesting at the optimal maturity, further increasing variability in fruit quality and skin coloration. To enhance fruit coloration without raising harvesting costs, postharvest treatments using LED light as physical elicitors may represent a promising chemical-free approach. By inducing mild abiotic stress, these treatments activate enzymatic pathways involved in the synthesis of secondary metabolites responsible for skin pigmentation. In the present study, sweet cherries, cv. 'Sweet Saretta', were treated immediately after harvest, before cold storage, with UV-B radiation and white LED light to evaluate their effects on fruit quality. Fruits were exposed to three irradiation durations (2, 5, and 10 minutes) for both UV-B and white LED treatments and subsequently stored at 2 °C for 12 days. Fruit quality was evaluated at 0, 2, 5, and 12 days of storage by assessing weight loss, color, mechanical properties, and nutraceutical attributes. Results showed that increasing irradiation doses improved skin pigmentation and significantly enhanced nutraceutical compounds, particularly in UV-B–treated fruits without negatively affecting mechanical properties or transpiration rate. In conclusion, LED and UV-B light treatments as postharvest physical elicitors represent a valuable and sustainable technology to enhance sweet cherry quality and shelf life, reducing postharvest losses without the use of chemical inputs.

Keywords: Sweet cherry; Postharvest; Fruit quality; Physical elicitor; LED.

Postharvest management of A. arguta: How harvesting stage affects fruit quality

Alice Varaldo *, Selene Ollani, Nicole Roberta Giuggioli, Cristiana Peano, Giovanna Giacalone

Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy

* *Corresponding author: Alice Varaldo (alice.varaldo@unito.it)*

Abstract. *Actinidia* spp. has played a significant role in fruit cultivation in the Piedmont region, contributing heavily to the local economy. Over the past 25 years, major pathological issues, including *Pseudomonas syringae* infections and kiwifruit decline, have severely impacted the sector, leading to the removal of many hectares. In the last 10 years, a new species, *Actinidia arguta*—also known as baby kiwi or kiwiberry—has taken over, with the commercial name Nergi®. It can be grown under the same pedoclimatic conditions and orchard setup, but demonstrates greater resistance to diseases. However, *A. arguta* faces postharvest challenges, where it is managed as a berry with storage of up to 3 months in a controlled atmosphere (CA). As a relatively new crop, harvesting and management practices have been developed based on knowledge from kiwifruit, but specific studies and techniques are lacking, sometimes resulting in brown spots that decrease its commercial value. Therefore, this study aimed to establish a potential CA protocol on a laboratory scale. Nergi® cv. Tahi® was collected at premature (PH) and late harvest (LH), 8 days apart. The fruits were stored at 1°C for 35 days under 3.5% CO2 and 3% O2. Measurements of weight loss, firmness, polyphenols, and antioxidant capacity were taken at T0 and T35. At the end of storage, Nergi® respiration was monitored after 1, 3, and 8 days. Significant variability was observed in columella firmness, with ES samples softening more quickly than LS. This parameter should be considered when selecting berries for extended storage. Regarding ethylene production at day 8 post-storage, the LS samples showed higher levels.

Keywords: *Actinidia arguta*; Harvest; Post-harvest management; Controlled atmosphere; Respiration.

Regional-scale mapping of direct protection forests through sediment connectivity analysis

Irene Vercellino [1,*], Gaia Mascetti [1], Arianna Casarini [1], Giorgio Vacchiano [1], Matteo Vizzarri [1], Alessio Cislaghi [1,2]

[1] Department of Agricultural and Environmental Sciences (DiSAA), University of Milan, Via Celoria 2, 20133 Milan, Italy

[2] Centre of Applied Studies for the Sustainable Management and Protection of Mountain Areas (Ge.S.Di.Mont), University of Milan, Via Morino 8, Edolo, 25048 Brescia, Italy

* *Corresponding author: Irene Vercellino (irene.vercellino@unimi.it)*

Abstract. Direct Protection Forests (DPFs) play a crucial role in mitigating natural hazards, acting as natural shields for exposed elements such as buildings, infrastructures, and transportation networks. DPFs are part of Nature-based Solutions (NBS), as they integrate risk reduction, biodiversity conservation, and sustainable management, contributing to the maintenance of ecosystem functions. Their protective capacity is strongly influenced by plant–soil–environment interactions, including root reinforcement of soils, hydrological regulation, and sediment flux control. However, DPF delineation at the regional scale remains challenging due to the variability of natural hazards, limited and heterogeneous data. This study proposes an integrated and spatially explicit methodology for identifying DPFs, based on the overlay of: (i) natural hazards maps (shallow landslides, rockfalls, debris flows, and snow avalanches); (ii) a forest cover map; (iii) elements at risk; and (iv) a sediment connectivity map used to identify linkage areas between potential hazard source zones and exposed elements. The innovative aspect of this study is in the use of the Index of Connectivity (IC), which defines potential water, snow, or sediment downslope pathways towards the valley and allows the identification of forest patches with a direct protective function for the selected elements at risk. The methodology was applied to the entire Lombardy Region (23,860 km²), characterized by predominantly alpine and pre-alpine forest cover of approximately 6,758 km² (28% of the regional area). The results indicate that DPFs cover 974 km², accounting for around 14% of the regional forest area. From the mapping results, spatially distributed indicators were developed to assess the protective predisposition of forest stands and to identify priority areas for silvicultural interventions. Overall, the proposed approach represents an effective decision-support tool for territorial and forest planning, improving map consistency and guiding sustainable management strategies to enhance forest resilience under increasing natural hazard pressure.

Keywords: Protection forest; Natural hazards; Sediment connectivity; forest management.

From genomes to defense: Key alleles driving pepper resistance to *Leveillula taurica*

Edoardo Vergnano [1,2], Flavie Cussonneau [1,3], Anne Massire [1], Christophe Gros [1], Sonia Elbelt [1], Jacques Lagnel [1], Luciana Gaccione [2], Roland Schaftleitner [4], Arnaud Bovy [5], Pasquale Tripodi [6], Lorenzo Barchi [2,*], Véronique Lefebvre [1]

[1] INRAE, GAFL, 84140 Montfavet, France
[2] DiSAFA, Plant Genetics, University of Turin, Grugliasco, TO 10095, Italy
[3] Sakata Vegetables Europe SAS, 30620 Uchaud, France
[4] World Vegetable Center, Shanhua, Taiwan
[5] WUR, Plant Breeding, 6700AJ Wageningen, The Netherlands
[6] CREA, 84098 Pontecagnano Faiano, Italy

* *Corresponding author: Lorenzo Barchi (lorenzo.barchi@unito.it)*

Abstract. The identification of previously undescribed genes conferring resistance to plant pathogens is becoming a key strategic asset to strengthen marker-assisted selection and improve resistance diagnostics within plant genebanks. By enabling the deployment of resistant materials, this approach can reduce the need for agricultural inputs and limit the environmental contamination associated with synthetic compounds commonly applied for disease management. Here, we investigated the Capsicum core collection assembled in the framework of the G2P-SOL project, which includes 345 C. annuum accessions subjected to whole-genome resequencing and described by almost 18 million genetic variants. Genomic information was integrated with phenotypic scores from field trials carried out in Morocco and Jordan, then used in a genome-wide association study (GWAS) to pinpoint genomic regions associated with resistance to *Leveillula taurica*, the causal agent of powdery mildew and one of the most severe constraints to pepper production globally. The GWAS detected significant SNP–trait associations distributed across the entire set of 12 chromosomes, with the most prominent signals mapping to terminal regions of chromosomes P4 and P6. Collectively, these two loci accounted for over 70% of the phenotypic variance observed for resistance.

Keywords: *Capsicum annuum*; Marker-assisted breeding; Powdery mildew resistance; Whole-genome re-sequencing.

The use of wheat distiller to replace soybeans in rations for high-producing dairy cows

Daniele Vezzolla [1,*], Ernesto Tabacco [1], Giorgio Borreani [1], Luciano Comino [2]

[1] Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy
[2] Regional Breeder Association of Piedmont (ARAP) – Via Torre Roa 13, 12020 Madonna dell'Olmo (CN), Italy

* *Corresponding author: Daniele Vezzolla (daniele.vezzolla@unito.it)*

Abstract: By 2050, global population growth will lead to an increase in demand for animal products, pushing animal husbandry towards more efficient and sustainable systems. Despite the nutritional value of meat and milk, the intensive use of edible crops such as soybeans in animal feed raises environmental and ethical concerns related to greenhouse gas emissions and feed-food competition. The increase in cereal costs has encouraged the use of by-products such as wheat distillers, which are rich in protein and offer economic and environmental advantages. However, their use requires caution to avoid negative effects such as milk fat depression, linked to their high lipid content. The study was conducted over a 4-month period on a commercial farm in Piedmont, involving 210 Holstein dairy cows. The aim was to evaluate the impact of partially replacing soybean meal with wheat distillers dried grains (DDG) and methionine-lysine addiction. The two diets were evaluated by dividing cows into two groups, using a crossover design scheme. Dry matter intake, milk production and quality, rumination, and feed, energy, and nitrogen efficiency parameters were evaluated. The "Distiller" diet increased digestible fiber and non-degradable protein, promoting ruminal stability without negative effects on lipid synthesis. Crude protein intake was slightly higher with the distiller diet, while starch intake decreased. NDF, ADF, and lignin in the diet increased, promoting rumination. There were no changes in dry matter or net energy intake. The introduction of distillers led to an increase in milk production of approximately 1 kg/cow/day, with no effect in fat content. Milk protein concentration remained stable, while the lipid profile improved, with an increase in unsaturated fats. Production efficiency (kg milk/kg dry matter) increased (1.74 vs. 1.70), while energy and nitrogen efficiency remained stable. The distiller diet reduced the use of edible protein and energy for humans, improving Net Food Production.

Keywords: Wheat distiller dried grains; Reducing food-feed competition; By-product in dairy cow diet; Sustainable protein source.

Implementation of the SWAT+ model in a Mediterranean basin with small dams: a case study from Southern Italy

Alissar Yassin [1,*], Anna Maria De Girolamo [2], Francesco Gentile [1], Giovanni Francesco Ricci [1]

[1] Department of Soil, Plants and Food Sciences, University of Bari Aldo Moro, Bari, Italy
[2] CNR-IRSA, National Research Council, Water Research Institute, Bari, Italy

* *Corresponding author: Alissar Yassin (a.yassin@phd.uniba.it; alessarryasseen@gmail.com)*

Abstract. Mediterranean rivers are characterized by intermittent flow regimes due to seasonal differences in climate, lithological and geological properties, and land cover types. In the last years the effect of climate change and the increasing water needs has made water scarcity an even more pressing concern. One of the possible solutions to counteract this issue is to realize small dams (<15 m high), decentralized water storage that can replace or supplement the larger infrastructure for several purposes, such as irrigation, rural and urban water supply, and groundwater recharge. Though these structures are categorized as systems with low impact, their total hydrological effects, especially on the basin scale, are still largely unexplored. This work aims to implement a SWAT+ modeling framework for a Mediterranean basin in order to analyze hydrological behavior and to explore the role of small dams under current conditions, providing a basis for scenario analyses. The SWAT+ was applied in the Canale La Pescara basin (Puglia, southern Italy). The river has intermittent flow, and there are four small dams built in the past but not-operational. The model implementation requires several inputs such as, climate, land use, soil, drainage patterns, and the location and the characteristics of the small dam. The basin is approximately 15,976 ha and is further divided into sub-basins and hydrologic response units. The simulation period is from the year 2001 to 2024 and uses measured climate data of three weather stations. Once implemented, satellite evapotranspiration data will be used to calibrate the model. This work will allow the development of a structured modeling framework to support the analysis of hydrological processes in regulated Mediterranean drainage basins and to improve the understanding of the role of small dams under current conditions.

Keywords: Mediterranean; Small dams; SWAT+ model; Hydrological modelling.

Economic valuation of tourist and recreational services in Gran Paradiso National Park: a choice experiment

Silvia Novelli [1], Raffaele Zanchini [1,*], Giovanna Sacchi [1], Lorenzo Baima [1], Azzura Orlando [1], Filippo Brun [1]

Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy

* *Corresponding author: Raffaele Zanchini (raffaele.zanchini@unito.it)*

Abstract. Protected natural areas and National Parks are vital reservoirs of biodiversity, cultural heritage, and ecosystem services. In Italy, the Gran Paradiso National Park has a longstanding tradition of integrating conservation objectives with local development and the promotion of cultural heritage. As part of their management responsibilities, National Parks are often required to assess the economic value of ecosystem services. Such assessments pose significant methodological challenges, as these values include both use and non-use components and largely depend on the valuation method adopted. Using stated preferences, it is possible to estimate both; however, particular attention must be paid to hypothetical bias, which may lead to overestimation. This study aims to assess visitors' valuation of selected tourist and recreational services, to evaluate the feasibility of their provision by the Park. To this end, a multi-section questionnaire incorporating a choice experiment was developed. Six attributes related to the service provision were used to develop the model: price, naturalistic observation points, QR code-based multimedia content, number of vehicle entries, road management and dissemination activities. The experiment was designed using a D-efficient design with a total of 12 choice tasks, each with three alternative profiles plus the *status quo*, divided into two blocks of six tasks. This structure improved both response efficiency and model performance. The estimation of parameters and willingness to pay was derived using a conditional logit model.
The results indicate that tourists show interest in the implementation of specific services by the Park. A positive willingness to pay was identified for all attributes except dissemination activities. The analysis made it possible to quantify the value of different services, suggesting that tourists are willing to pay for improvements in the quality of their experience within the Park.

Keywords: Cultural ecosystem services; Willingness to pay; Choice experiments; Conditional logit; Tourist behaviour.

Local certification as a tool for the valorisation of protected natural areas: the role of ecosystem services in the Gran Paradiso National Park

Raffaele Zanchini *, Giovanna Sacchi, Simone Blanc, Silvia Novelli, Filippo Brun

Department of Agricultural, Forest and Food Sciences (DiSAFA) – University of Turin, Largo P. Braccini 2, 10095 Grugliasco (TO), Italy

* *Corresponding author: Raffaele Zanchini (raffaele.zanchini@unito.it)*

Abstract. The Gran Paradiso National Park is Italy's oldest national park, attracting more than 200,000 visitors per year. Considering the ecosystem services, it provides various intangible benefits, namely cultural ecosystem services (CES) or artistic, educational, cultural, recreational, and sporting activities. Among the tangible benefits, local products represent an important source of income for local communities. These products can be promoted using certification systems which, if recognised, can lead to greater acceptance and higher willingness to pay. As a valorisation tool, the Park's own certification, "Qualità Gran Paradiso", provides a case study for analysing the role of quality labels in promoting local products linked to the conservation of the area's cultural and environmental heritage. The aim was to understand the relationship between cultural ecosystem services and provisioning services, using the Park's certification as a proxy. In particular, the study sought to identify which CES influence consumers' decisions to purchase certified products. The framework was further extended to include drivers related to visiting habits and sociodemographics. Therefore, a study was developed based on face-to-face interviews and a multi-section questionnaire. After data cleaning, 405 observations were used for data analysis. Tourist behaviour was assessed using a dummy variable to capture the purchase of certified products. A logit model was applied, using CES, sociodemographic characteristics, and visiting habits as covariates combined with a stepwise procedure. The quantitative assessment was performed using average marginal effects to estimate the probability of purchasing certified products.

The results show that CES act as significant drivers of the purchase of local products. Participation in artistic activities and attendance at cultural events significantly increase the likelihood of purchasing certified products. These findings suggest that tourists who develop a connection with the Park through cultural experiences may exhibit a greater affinity for local products, also as a means of supporting local communities.

Keywords: Local certification; Consumer behaviour; Cultural ecosystem services; Gran Paradiso National Park; Sustainable tourism.