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2026

Conference

International Conference on Agricultural Sciences

Agroecology and Sustainable Systems

21–23 October 2026, Bologna, Italy



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2026 International Conference on Agricultural Sciences

Agroecology and Sustainable Systems

21–23 October 2026 | Bologna, Italy

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Notice

Delegates will receive a name-badge at the Information Desk upon registration. The badge must be worn prominently in order to gain access to the conference lecture halls and meals during the event. Admission will be refused to anyone not in possession of an appropriate badge.

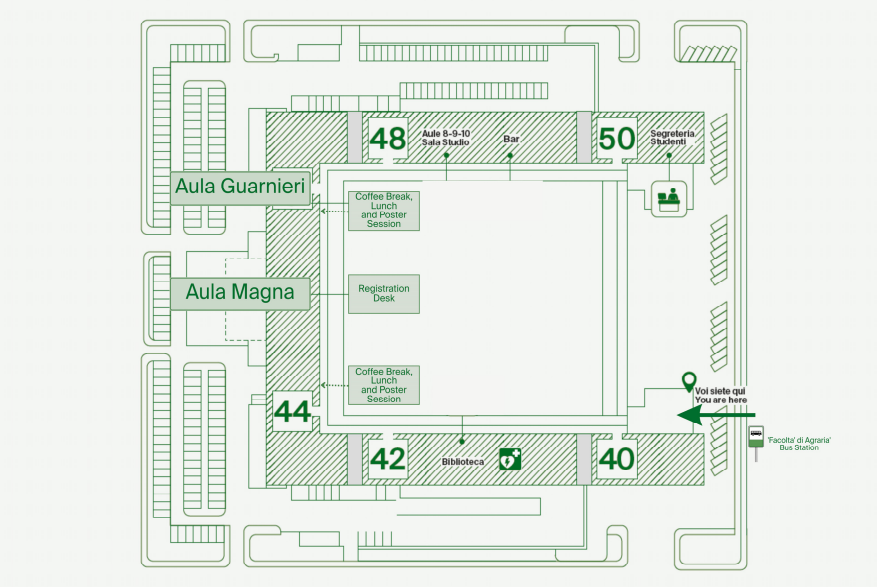
Wifi Information

Wi-Fi Network (SSID): ALMAWIFI

Each participant will receive temporary credentials (a username and password) to access the University of Bologna's Wi-Fi network, **ALMAWIFI**.

The credentials will be sent a few days before the event to the email address provided during registration. Participants can use these credentials to connect to the ALMAWIFI network and access the internet.

Venue Floor Plan



Reaching the Conference Venue

By bus: Line 35 runs directly from Ospedale Maggiore and Bologna Centrale (the main train station) to the conference venue. Standard urban bus tickets in Bologna cost €2.30 when bought before boarding or with a contactless card/app and are valid for about 75 minutes across multiple bus lines. You can also buy a ticket onboard for €2.50 if paying with cash. Please find more information here.

By taxi: Taxis offer a convenient door-to-door option from the city center to the conference venue. The journey typically takes 20–35 minutes, depending on traffic, and fares are approximately €20–€30 for a standard taxi. Please find more information here.

Conference Dinner

Following the conclusion of the scientific program on Day 1, the Conference Dinner will take place **from 7:00 to 9:00 PM** at **Trattoria Bolognese**, an authentic Italian restaurant nestled within Grand Tour Italia, conveniently located just a short walking distance from the conference venue. **Please note that registration for the Conference Dinner is now closed.**

Latest Program

Please scan the QR code below to access the latest version of the conference program and stay up to date with the schedule.

Organizers

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Agronomy (ISSN 2073-4395) is an international and cross-disciplinary scholarly journal on agronomy and agroecology. It publishes reviews, regular research papers, communications and short notes, and there is no restriction on the maximum length of the papers. Our aim is to encourage scientists to publish their experimental and theoretical research in as much detail as possible. Full experimental and/or methodical details must be provided for research articles. There are, in addition, unique features of this journal:

- Manuscripts regarding research proposals and research ideas will be particularly welcomed;
- Computed data or files regarding the full details of the experimental procedure, if unable to be published in a normal way, can be deposited as supplementary material;
- We also accept manuscripts communicating to a broader audience with regard to research projects financed with public funds.

Journal Website: https://www.mdpi.com/journal/agronomy

agriculture
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Agriculture (ISSN 2077-0472) is an international, scholarly and scientific open access journal publishing peer-reviewed research papers, review articles, communications and short notes that reflect the breadth and interdisciplinarity of agriculture.

The aim of *Agriculture* is to publish research on the science and technology of crop and animal production, biosecurity, and postharvest handling of produce, agricultural technology, management of the natural resource base for agricultural production (land, soil and water), rural management and agricultural development, and agriculture in changing environments.

Journal Website: https://www.mdpi.com/journal/agriculture

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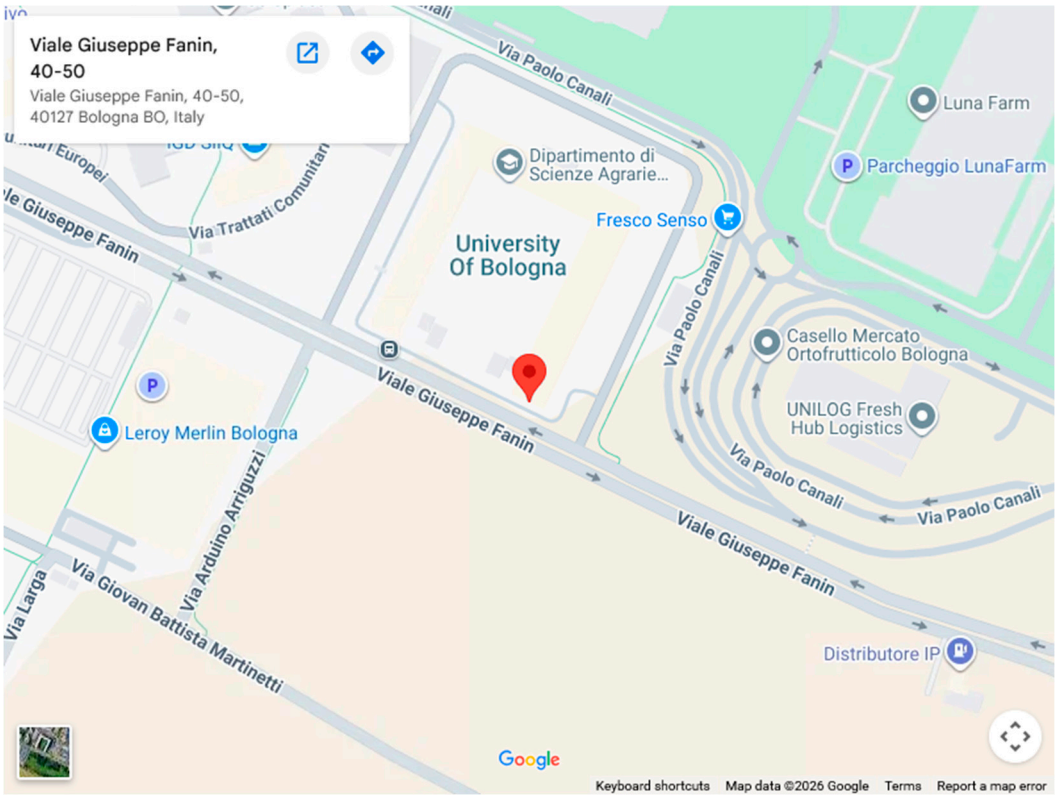
The Department of Agricultural and Food Sciences (DISTAL) at the University of Bologna encompasses all teaching and research activities in the agri-food sector, providing a unified framework for education, innovation, and scientific advancement in agriculture and food sciences.

Conference Venue

DISTAL, University of Bologna

The Department of Agricultural and Food Sciences (DISTAL) at the University of Bologna traces its origins to the reorganization of the University following the Gelmini Reform. From the original five departments, two were initially created and later merged into a single, integrated department. Today's DISTAL encompasses all teaching and research activities in the agri-food sector, providing a unified framework for education, innovation, and scientific advancement in agriculture and food sciences.

Address: Viale Giuseppe Fanin, 40-50, 40127 Bologna, Italy



(Click on the map to view the location in Google Maps)

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Organizing Committee

Conference Chairs

Prof. Dr. Anna Andolfi

Prof. Dr. Leslie Weston

Conference Co-Chairs

Prof. Giovanni Dinelli

Prof. Ilaria Marotti

Committee Members

Prof. Dr. Agnieszka Kuźniar
Prof. Alessio Cimmino
Prof. Dr. Carlo Leifert
Dr. Elisa Pellegrino
Prof. Emmanouil Roditakis
Prof. Dr. Enrico Porceddu
Prof. Dr. Francesco Caracciolo
Prof. Dr. Francesco Marinello
Prof. Giovanni Burgio
Prof. Dr. Imre J. Holb
Assoc. Prof. Kaiguang Zhao
Assoc. Prof. Koffi Djaman
Prof. Dr. Kui Cheng
Prof. Dr. Longsheng Fu
Prof. Dr. Manuel Ângelo Rosa Rodrigues
Dr. Marco Valerio Rossi Stacconi
Prof. Dr. Mumtaz Akhtar Cheema
Prof. Dr. Othmane Merah
Prof. Dr. Rafał Łopucki
Prof. Dr. Ryusuke Hatano
Dr. Sanzidur Rahman
Prof. Dr. Stanislav Trdan
Prof. Dr. Zina Flagella

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Conference Secretariat

Email: icas@mdpi.com

Welcome from the Chairs

Dear Colleagues,

We are delighted to announce that the 2026 International Conference on Agriculture Sciences: Agroecology and Sustainable Systems (ICAS 2026) will be held in person in Europe in 2026. The event is organized by MDPI's open-access journals Agriculture and Agronomy and will take place in Bologna, Italy, from 21 to 23 October 2026.

Agricultural activities, in their complexity, represent the physiological and social relationships between rural society and the land that nourishes it. Agricultural practices serve not only a productive purpose but also play a crucial role in protecting the environment. Unfortunately, the exponential increase in the impact of agricultural practices has frequently shifted the balance toward productivity at the expense of environmental, social, and economic sustainability.

In this complex web of interactions that characterizes agro-ecosystems and the growing demand for resources, the 2026 International Conference on Agriculture Sciences: Agroecology and Sustainable Systems aims to bring together a group of diverse stakeholders involved in the sector. Given these complex interactions, it is increasingly important to move forward with the common goal of making agriculture more sustainable. Therefore, we will foster multidisciplinary interaction between scholars working in different scientific fields.

We welcome scholars, engineers, students, and non-academic colleagues to join Agriculture 2026, and we kindly ask you to save these dates. Our aim is to make this event a forum for discussion, knowledge exchange, and fruitful interactions among stakeholders working in different agriculture-related fields: agronomy, chemistry, ecology, economy, engineering, entomology, genetics, informatics, plant pathology, toxicology, and others. Both oral and poster contributions are welcome for higher degree students and researchers.

We are very enthusiastic about the 2026 International Conference on Agriculture Sciences (ICAS 2026) and are relying on your attendance to make it a successful event. We look forward to meeting you in Bologna in 2026!



Prof. Dr. Anna Andolfi
Conference Chair
University of Naples Federico II, Naples, Italy



Prof. Dr. Leslie Weston
Conference Chair
Charles Sturt University, Bathurst, Australia

Plenary Speaker



Professor Diego Rubiales

Institute for Sustainable Agriculture, CSIC, Córdoba, Spain

Prof. Diego Rubiales performed a PhD in Plant Breeding at the University of Cordoba, Spain (1989-1991). Then was Marie Curie Postdoc at Wageningen Agricultural University Holland and then at INIA, Cordoba. In 1993 got a permanent position as scientist at CSIC, being promoted to principal researcher in 2003 and to full professor in 2006. During this period has worked in various aspects of disease resistance in cereals and legumes.

He has extensive experience in participation and coordination of research both at national and international level. He has been coordinator of a FP5 EU project (EUFABA), of a FP7-ARIMNet (MEDILEG), of COST action (COST849) and of a FP7-PEOPLE-2009-IOF. He has also been WP leader or PI in a FP6 EU Integrated Project (GLIP), in a FP6-ERANet (LEGRESIST), in two FP7 projects (ABSTRESS and LEGATO), in two H2020 projects (DIVERSify and RADIANT), three EU Horizon projects (BELIS, COUSIN and IPMorama), two PRIMA project (DiVicia and NUSTALGIC) and in a GRDC Australian project. In addition to this, he has lead 22 Spanish research projects and 13 projects for bilateral cooperation, mainly with North African countries, including two projects with Canada.

He is President of the Spanish Legume Society (AEL) and Coordinator of the Spanish Legume Network (RELEG). He has been President of International Legume Society (ILS. 2013-2017, current Secretary and Treasurer) and of the European Association of Grain Legumes Research (2008-2013) and member of the Executive Committee of the Int. Parasitic Plant Society (2005-2011).

Keynote Speakers



Prof. Alessio Cimmino

Department of Chemical Sciences, University of Naples Federico II, Naples, Italy



Prof. Dr. Andreas Meyer Aurich

Leibniz Institute for Agricultural Engineering and Bioeconomy (ATB)



Prof. Dr. Carlo Leifert

SCU Plant Science, Southern Cross University, Lismore, NSW, Australia



Assoc. Prof. Federica Zanetti

Department of Agricultural and Food Sciences (DISTAL), Alma Mater Studiorum—University of Bologna, Bologna, Italy



Assoc. Prof. Francesco Vinale

Department of Veterinary Medicine and Animal Production, University of Naples Federico II, Naples, Italy



Prof. Dr. Gianfranco Romanazzi

Department of Agricultural, Food and Environmental Sciences, Marche Polytechnic University, Ancona, Italy



Prof. Giovanni Dinelli

Department of Agricultural and Food Sciences, University of Bologna, Bologna, Italy



Prof. Joshua D. Klein

Volcani Center, Rishon LeZion, Israel



Prof. Dr. Leslie Weston

Charles Sturt University, Wagga Wagga, Australia



Prof. Dr. Mumtaz Akhtar Cheema

School of Science and the Environment Grenfell Campus Memorial University, NL Canada



Prof. Per Kudsk

Department of Agroecology, Aarhus University, Slagelse, Denmark



Dr. Timothy Crews

The Land Institute, Salina, Kansas, USA

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Prof. Dr. Carlo Leifert
SCU Plant Science, Southern Cross University, Lismore, NSW, Australia



Dr. Elisa Pellegrino
Institute of Crop Science, Scuola Superiore Sant'Anna, Pisa, Italy



Prof. Emmanouil Roditakis
Department of Agriculture, School of Agricultural Sciences, Hellenic Mediterranean University, Estavromenos, Heraklion, Greece, Institute of Agri-Food and Life Sciences, Hellenic Mediterranean University Research Centre, Heraklion, Greece



Prof. Dr. Enrico Porceddu
Department of Cultural Heritage Sciences, Tuscia University, Viterbo, Italy



Prof. Dr. Francesco Caracciolo
Department of Agricultural Sciences, Università degli Studi di Napoli Federico II, Napoli, Italy



Prof. Dr. Francesco Marinello
Department of Land, Environment, Agriculture and Forestry, University of Padova, Legnaro, Italy



Prof. Giovanni Burgio
Department of Agricultural and Food Sciences, University of Bologna, Bologna, Italy



Prof. Dr. Imre J. Holb
Institute of Horticulture, Faculty of Agricultural and Food Sciences and Environmental Management, University of Debrecen, Debrecen, Hungary, Plant Protection Institute, HUN-REN Centre for Agricultural Sciences, Budapest, Hungary



Assoc. Prof. Kaiguang Zhao
Ohio Agricultural Research and Development Center, School of Environment and Natural Resources, The Ohio State University, Ohio, USA



Assoc. Prof. Koffi Djaman
Department of Plant and Environmental Sciences, Agricultural Science Center at Farmington, New Mexico State University, Farmington, NM, USA



Prof. Dr. Kui Cheng
College of Engineering, Northeast Agricultural University, Harbin, China



Prof. Dr. Longsheng Fu
College of Mechanical and Electronic Engineering, Northwest A&F University, Yangling, China, Key Laboratory of Agricultural Internet of Things, Ministry of Agriculture and Rural Affairs, Yangling, China, Shaanxi Key Laboratory of Agricultural Information Perception and Intelligent Service, Yangling, China, Northwest A&F University Shenzhen Research Institute, Shenzhen, China



Prof. Dr. Manuel Ângelo Rosa Rodrigues
Centro de Investigação de Montanha (CIMO), Instituto Politécnico de Bragança, Campus de Santa Apolónia, Bragança, Portugal, Laboratório para a Sustentabilidade e Tecnologia em Regiões de Montanha, Instituto Politécnico de Bragança, Campus de Santa Apolónia, Bragança, Portugal



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Research and Innovation Centre, Fondazione Edmund Mach, San Michele all'Adige, Italy



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Prof. Dr. Othmane Merah

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Prof. Dr. Ryusuke Hatano
Research Faculty of Agriculture, Hokkaido University, Sapporo, Japan



Dr. Sanzidur Rahman
Applied Economics and Marketing Department, School of Agriculture, Policy and Development (SAPD), University of Reading, Whiteknights Campus, Reading, UK

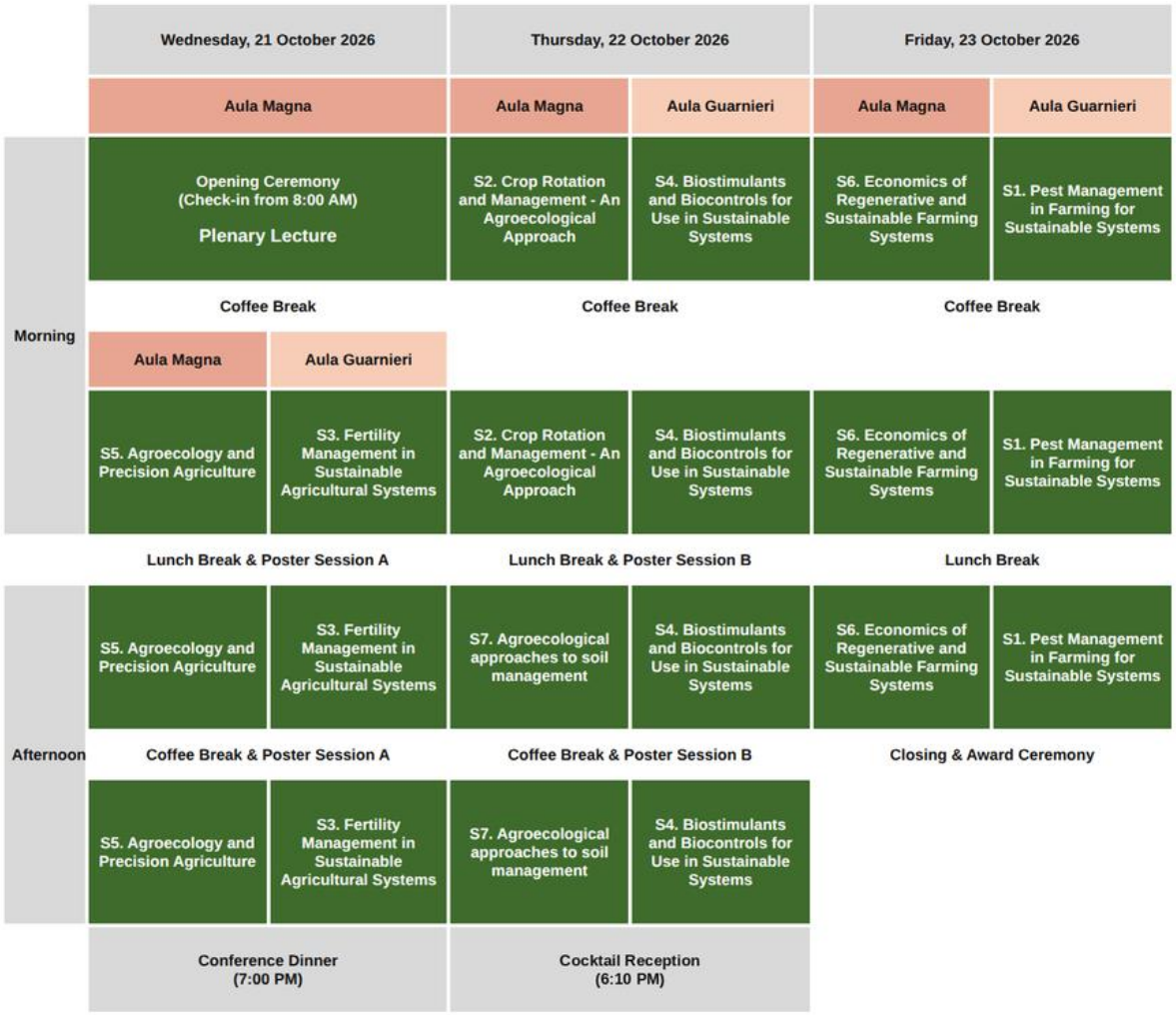


Prof. Dr. Stanislav Trdan
Department of Agronomy, Biotechnical Faculty, University of Ljubljana, Ljubljana, Slovenia



Prof. Dr. Zina Flagella
Department of Agriculture, Food, Natural Resources and Engineering (DAFNE), University of Foggia, Foggia, Italy

Program Overview



ICAS 2026 Detailed Program

Please note that all times indicated in the detailed program are in CEST (Central European Summer Time), corresponding to the local time in Bologna, Italy.

Day 1—Wednesday, 21 October 2026		
08:00–09:00	Registration & Check-in	
Aula Magna		
09:00-9:20	**Opening Ceremony & Welcome Remarks**	
09:20–10:00	**Prof. Diego Rubiales** Plenary Speaker	Plant breeding is required to meet agroecological demands: Legumes as a case study
10:00–10:30	**Coffee Break**	
Following the coffee break, participants proceed to their respective rooms for the parallel sessions:		
		Aula Magna *Session 5: Agroecology and Precision Agriculture* Chaired by Prof. Giovanni Dinelli
10:30–10:35	**Session Introduction**	
10:35–11:05	**Prof. Giovanni Dinelli** Keynote Speaker	The Agroecology Revolution: Redesigning Food Systems for Sustainability, Resilience and Social Justice
11:05–11:20	**Gessica Altieri** Oral Presenter	Estimation of Hazelnut (Corylus avellana L.) Canopy Volume Using SLAM and UAV Point Clouds
11:20–11:35	**Fernanda Nunes Maciel** Oral Presenter	When Technology Makes Sense: Personal Values and Digital Adoption by Small Dairy Farmers
11:35–11:50	**Jean Franck Galliano** Oral Presenter	Computational Agroecological Identity: A Multidimensional Data Framework Linking Precision Assessment and Product Valorization
11:50–12:05	**Maria (Marietta) Papakonstantinou** Oral Presenter	IoT-Assisted Organic Compost Production in Open Piles
12:05–12:20	**Pasqualina Sacco** Oral Presenter	The potential contribution of artificial intelligence to the selection and use of farm machinery
12:20–13:20	**Lunch Break & Poster Session A**	
		Aula Magna *Session 5: Agroecology and Precision Agriculture* *Chaired by Prof. Dr. Francesco Marinello*
13:20–13:35	**Paulo Henrique Montagnana Vicente Leme** Oral Presenter	What Drives Digital Agriculture Adoption? Evidence from the Brazilian Coffee Sector
13:35–13:50	**Francisco Tugores** Oral Presenter	Predictor selection for ordinal classification of physiological fruit drop in persimmon: a comparison across rootstocks
13:50–14:05	**Muhamet Zogaj** Oral Presenter	UAV-Based NDVI Assessment on Open-Field Pepper Production:ACase Study in Kosovo
14:05–14:20	**Simona Pitardi** Oral Presenter	Physiological, Productive and Biodiversity Responses of Vitis vinifera L. cv. Primitivo under Agrivoltaic Conditions in a Mediterranean Vineyard

14:20–14:35	**Devanakonda Venkata Sai Chakradhar Reddy** Oral Presenter	Retrieval of Wheat Nitrogen using Radiative Transfer Models and Machine Learning
14:35–14:50	**Ivan Zyrianoff** Oral Presenter	TRACE: LoRaWAN-Based IoT Monitoring and Data Analytics for Medicinal and Aromatic Plant Cultivation in Emilia-Romagna
14:50–15:05	**Roberto A. Braga** Oral Presenter	The Seed Dataset Library for Dynamic Laser Speckle Raw Images
15:05–15:45	**Coffee Break & Poster Session A**	
		Aula Magna *Session 5: Agroecology and Precision Agriculture* *Chaired by Prof. Dr. Francesco Marinello*
15:45–16:00	**Emilia Pafumi** Oral Presenter	Mapping crop diversity with open remote sensing data: a regional application in NE Italy
16:00–16:15	**Ayesha Khan** Oral Presenter	Growth performance of Amaranthus tricolor in response to varying light intensities in Controlled Environment Agriculture
16:15–16:30	**Józef Tyburski** Oral Presenter	Effectiveness of mechanical precision weed control in organically grown soybean
16:30–16:45	**Melissa Tamisari** Oral Presenter	Monitoring of Tomato Phenological Phases through MOX Gas Sensors and Machine Learning
16:45–17:00	**Hafiza Komal Komal Naeem** Oral Presenter	Acoustic Vibration Priming Enhances Drought Resilience in Olive (Olea europaea) through Physiological and Biochemical Responses
17:00–17:15	**Uladzimir Bury** Oral Presenter	Assessing floristic diversity in Latvian apple orchards: the role of landuse history and orchard management
19:00–21:00	**Conference Dinner at Trattoria Bolognese, Grand Tour Italia**	

		Aula Guarnieri *Session 3: Fertility Management in Sustainable Agricultural Systems* *Chaired by Prof. Dr. Leslie Weston*
10:30–10:35	**Session Introduction**	
10:35–11:05	**Prof. Dr. Leslie Weston** Keynote Speaker	Methylobacterium symbioticum SB0023 biostimulant results in enhanced growth and yield in dryland winter wheat
11:05–11:20	**Oli Ahmed Fakir** Oral Presenter	Fertilizer-N supply modulates growth, yield, and N remobilization responses of dryland wheat to Methylobacterium symbioticum SB23
11:20–11:35	**Martha Elena Domínguez-Hernández** Oral Presenter	Assessing Agroecological Functions of the Milpa Intercropped with Fruit Trees (MIAF) System in Central Mexico
11:35–11:50	**Elisa Dominguez Hernandez** Oral Presenter	Environmental impact of manure reallocation as a circular fertility management strategy in a small-scale mixed farm
11:50–12:05	**Tanzila Rafique** Oral Presenter	Rootstock-Mediated Growth and Photosynthetic Responses of Grafted Tomato Seedlings under Drought Stress
12:05–12:20	**John Vincent Abenoja Nate** Oral Presenter	Valorising Indigenous Irish Feedstock using the Framework of GROUND UP: Growth-media Reengineering using Organic Upcycled Nutrient Diversification for Upstream Production

12:20–13:20	**Lunch Break & Poster Session A**	
		Aula Guarnieri *Session 3: Fertility Management in Sustainable Agricultural Systems* *Chaired by Prof. Dr. Leslie Weston*
13:20–13:35	**Wathsala Dissanayake** Oral Presenter	Development and Evaluation of a Waste-Derived Biodegradable SlowRelease Fertiliser for Improving Nitrogen Use Efficiency
13:35–13:50	**Lorenzo Negri** Oral Presenter	Long-Term Sustainability of Wheat Production under Diversified Crop Rotations and Manure Supply in the Mediterranean Environment
13:50–14:20	**Dr. Timothy Crews** Keynote Speaker	Managing living roots to manage fertility
14:20–14:35	**Brenda Antonella Medina Privatt** Oral Presenter	Development and Assessment of a Soy-Based Slow-Release Granular Fertilizer for Home Lawn Use
14:35–14:50	**Artur Matevosyan** Oral Presenter	Optimization of a Hydroponic Nutrient Solution and Evaluation of Foliar Silicon Dioxide Nanoparticles under Salinity Stress in Cyamopsis tetragonoloba L.
14:50–15:05	**Susana Ferreira** Oral Presenter	Microbial Biofertilizers Sustain Apple Tree Performance under Reduced Mineral Fertilization
15:05–15:45	**Coffee Break & Poster Session A**	
		Aula Guarnieri *Session 3: Fertility Management in Sustainable Agricultural Systems* *Chaired by Prof. Dr. Leslie Weston*
15:45–16:00	**Roshni Vijayan** Oral Presenter	Harnessing rice reproductive traits for fertility management in sustainable systems
16:00–16:15	**Nicola Cinosi** Oral Presenter	Olive Harvest Timing Affects Fruit Oil Accumulation and Carbohydrate Reserves in Trees
19:00–21:00	**Conference Dinner at Trattoria Bolognese, Grand Tour Italia**	

Day 2—Thursday, 22 October 2026		
08:30–09:00	**Registration & Check-in**	
	Aula Magna *Session 2: Crop Rotation and Management - An Agroecological Approach* *Chaired by Assoc. Prof. Federica Zanetti*	
09:00–09:05	**Session Introduction**	
09:05–09:35	**Assoc. Prof. Federica Zanetti** Keynote Speaker	Improving Agriculture Resilience by Adopting Brassica-based Intercropping Systems
09:35–09:50	**Lauren Tribbeck** Oral Presenter	Impacts of vining peas on soil carbon and nitrogen in a crop rotation
09:50–10:05	**Maria Krtikashyan** Oral Presenter	Comparative Performance of Two Indigenous Armenian Grape Varieties, 'Black Kharji' and 'Yeghegnadzor Black', under the Conditions of the Armavir Region, Armenia
10:05-10:20	**Sumita Sen** Oral Presenter	Effect of crop management practices on rainfed winter wheat (Triticum aestivum L.) growth, physiology and yield components in corn-soybeanwheat rotation system
10:20–10:50	**Coffee Break**	
	Aula Magna *Session 2: Crop Rotation and Management - An Agroecological Approach* *Chaired by Assoc. Prof. Federica Zanetti*	
10:50–11:05	**Sunday Ebonka Nwajei** Oral Presenter	Effect of intercropping on the growth and grain yield of sorghum in the Czech Republic
11:05–11:20	**Michele D'Angiolo** Oral Presenter	Dye Plants as Flower Strips forSustainableAgroecosystems: a Comprehensive Analysis of Agronomic Performance, Pollinator Dynamics, Biological Potential
11:20–11:50	**Prof. Per Kudsk** Keynote Speaker	Pesticide Load Indicators: Tools with multiple applications
11:50–12:05	**Jesmin Aktar** Oral Presenter	Digging Deeper: Dry Matter Allocation, Root Growth and Grain Production in Perennial Wheat derivatives
12:05–12:20	**Roshni Vijayan** Oral Presenter	Mitigation of water stress and enhancing productivity of cowpea in summer rice fallows
12:20–13:35	**Lunch Break & Poster Session B**	
	Aula Magna *Session 7: Agroecological approaches to soil management* *Chaired by Prof. Dr. Mumtaz Akhtar Cheema*	
13:35–13:40	*Session Introduction*	
13:40–14:10	**Prof. Dr. Mumtaz Akhtar Cheema** Keynote Speaker	Industrial Waste Valorization for Sustainable Agricultures
14:10–14:40	**Prof. Joshua D. Klein** Keynote Speaker	Willow (Salix acmophylla Boiss.) irrigated with saline or treated waste water provides sustainable healthy feed supplements for goats, sheep and calves
14:40–14:55	**Anna Lilian Gardossi** Oral Presenter	Satellite-based monitoring of crop residues: assessing NDTI reliability at the regional scale in Friuli Venezia Giulia
14:55–15:10	**Glenn-Horland Pango** Oral Presenter	Influence of hedgerows on soil quality and macrofauna in three agricultural systems in the chalky Champagne region (France)

15:10–15:50	**Coffee Break & Poster Session B**	
		Aula Magna *Session 7: Agroecological approaches to soil management* *Chaired by Prof. Dr. Mumtaz Akhtar Cheema*
15:50-16:05	**John Vincent Abenoja Nate** Oral Presenter	Qualitative Systems Model for Compost-Based Growing Media: Oxygen Demand, Salinity, and Nitrogen Immobilisation Risk
16:05–16:20	**Alex Lindsey** Oral Presenter	Compost-Based Soil Management Improves Soil Health and Turfgrass Performance in Construction-Disturbed Sandy Soils
16:20–16:35	**Janine Maree Joyce** Oral Presenter	Country, Collaboration, and Soil: Integrating Indigenous Knowledge in Transdisciplinary Agroecology
16:35–16:50	**Julián Guzmán-Zavala** Oral Presenter	Characterization of Microbial Communities Dynamics in a Manure SolidLiquid Separation System: A Shotgun Metagenomics Approach
16:50–17:05	**Veronica Zuffi** Oral Presenter	Surface-Enhanced Raman Spectroscopy (SERS) of Deep Soil as a Tool for Cropping System Sustainability Evaluation
17:05–17:20	**Adrija Dorbe** Oral Presenter	Nitrogen accumulation in field peas (Pisum sativum L.) under different tillage systems
17:20–17:50	**Prof. Dr. Carlo Leifert** Keynote Speaker	Regenerative soil and crop management in organic agriculture; a strategy to maintain fertile soils, healthy crops, food quality and human health
18:10–20:00	**Cocktail Reception**	

		Aula Guarnieri *Session 4: Biostimulants and Biocontrols for Use in Sustainable Systems* *Chaired by Assoc. Prof. Francesco Vinale*
09:00–09:05	**Session Introduction**	
09:05–09:35	**Assoc. Prof. Francesco Vinale** Keynote Speaker	From Biodiversity to Bioproducts: Exploring Nature's Microbial and Chemical Resources for Sustainable Agricultural Innovation
09:35–09:50	**Daniele Alberoni** Oral Presenter	Soil microbiota influence floral signals and pollinator attraction in sunflowers
09:50–10:05	**Piper Sloan** Oral Presenter	Effects of Ascophyllum nodosum extracts on physiological and morphological function of drought-stressed canola
10:05–10:20	**Marie Hielscher** Oral Presenter	Field Evaluation of Oregano (*Origanum vulgare*) Elicitation with Salicylic Acid and Methyl Jasmonate for Improved Crop Resilience and Quality
10:20–10:50	**Coffee Break**	
		Aula Guarnieri *Session 4: Biostimulants and Biocontrols for Use in Sustainable Systems* *Chaired by Assoc. Prof. Francesco Vinale*
10:50–11:05	**Sadia Tabassum Tanni** Oral Presenter	Integrated physiological, biochemical and metabolomics elucidate stage and treatment-specific response in tomato under waterlogging, salt, and combined stress conditions during the flower and fruit initiation
11:05–11:20	**Orsolya Papp** Oral Presenter	From Laboratory Screening to On-Farm Validation: Rhizobial Inoculation of Cowpea (Vigna unguiculata ssp. unguiculata) in Hungarian Organic Horticulture
11:20–11:35	**Alberto Cavallito** Oral Presenter	Life cycle assessment of microbial biostimulant integration in legume cover crop systems: a comparative environmental

		modelling study for rain-fed wheat production in the Po Valley (Italy).
11:35–11:50	**Shamsul Haque** Oral Presenter	Biostimulants and Biochar: Unlocking Phosphorus Uptake in wheat
11:50–12:05	**Elisa Pellegrino** Oral Presenter	Differential effects of microbial consortia and single arbuscular mycorrhizal inoculation on durum wheat performance and root microbiome across Mediterranean environments
12:05–12:20	**Victor Hugo Abarca** Oral Presenter	Reducing Synthetic and Irrigation Inputs in Zoysiagrass Lawns through Microbial Nitrogen Fixation
12:20–13:35	**Lunch Break & Poster Session B**	
		Aula Guarnieri ***Session 4: Biostimulants and Biocontrols for Use in Sustainable Systems*** ***Chaired by Prof. Alessio Cimmino***
13:35–13:40	***Session Introduction***	
13:40–14:10	**Prof. Alessio Cimmino** Keynote Speaker	Beyond Strigolactones: Plant and Fungal Specialized Metabolites Interfering with Parasitic Weed Development
14:10–14:25	**Ali Elnaeim Elbasheir Ali** Oral Presenter	Metabolomic insights into salt tolerance-promoting rhizobacteria-mediated salinity tolerance in wheat seedlings
14:25–14:40	**Ilaria Marotti** Oral Presenter	Biostimulant-based elicitation to improve bioactive compound accumulation in medicinal and aromatic plants under open-field conditions
14:40–14:55	**Katya Valeria Pérez Ramos** Oral Presenter	Actinobacteria: biofungicides and biorremediators of agricultural soils
14:55–15:10	**Zarqa Hassan** Oral Presenter	Green Synthesis of ZnO Nanoparticles from Cucurbita maxima Peels for Developing 3D Hybrid Structures and Agricultural Applications
15:10–15:50	**Coffee Break & Poster Session B**	
		Aula Guarnieri ***Session 4: Biostimulants and Biocontrols for Use in Sustainable Systems*** ***Chaired by Prof. Alessio Cimmino***
15:50–16:05	**Koffi Vincent Messanh** Oral Presenter	Dual effect of Rugulosin A: Inhibition of Botrytis cinerea and Alternaria alternata growth and protection against mold disease in grapevine plantlets and berries.
16:05-16:20	**Simona Errico** Oral Presenter	From Waste to Biostimulant: Insect Frass Extracts as Emerging Agents for Seed Chemo-Priming
16:20-16:35	**Lénia Rodrigues** Oral Presenter	Seed-Applied PGPB-Based Biostimulants Influence Early Plant Establishment: Contrasting Responses Across Crop Species
18:10–20:00	**Cocktail Reception**	

Day 3—Friday, 23 October 2026		
08:30–09:00	Registration & Check-in	
		Aula Magna *Session 6: Economics of Regenerative and Sustainable Farming Systems* *Chaired by Prof. Dr. Andreas Meyer Aurich*
09:00–09:05	**Session Introduction**	
09:05–09:20	**Melkamu Girma Koricho** Oral Presenter	The Influence of Nitrate Derogation on Land Rental Market Participation: Evidence from Ireland
09:20–09:35	**Pramod Gautam** Oral Presenter	Farmer Readiness for Net-Zero Agriculture: Motivations, Barriers, and Digital Decision Support Systems
09:35–09:50	**Dirk Osada** Oral Presenter	The Biological Nutrient Cycle as an Economic Determinant: Soil – Food/Feed – Animal – Human and the Cost of Micronutrient Deficiency
09:50–10:05	**Bhola Paudel** Oral Presenter	Smart farming, data use and sustainability pathways in Australian agriculture: Evidence from farmers' survey
10:05–10:20	**Sutthathip Kamthornphiphatthan-akul** Oral Presenter	Economic Viability of Sustainable Livestock Production: A Financial Analysis of AIoT-Driven Precision Management Systems
10:20–10:35	**Ekamjot Dhillon** Oral Presenter	Productivity, Agricultural Development, and the Governance of Sustainability: From the Green Revolution to AGRA
10:35–10:50	**Andrea Fantini** Oral Presenter	Resilience of Agroecological and Organic Markets: A Comparative Analysis of six case studies from Italy, Bolivia, Brazil, Spain and Colombia
10:50–11:25	**Coffee Break**	
		Aula Magna *Session 6: Economics of Regenerative and Sustainable Farming Systems* *Chaired by Prof. Dr. Andreas Meyer Aurich*
11:25–11:55	**Prof. Dr. Andreas Meyer Aurich** Keynote Speaker	Digitalization as Enabler for Agroecology
11:55–12:10	**James Hennessy** Oral Presenter	What Drives Forage Adoption Intensity Among Smallholder Dairy Farmers? Evidence from Kenya
12:25–13:25	**Lunch Break**	
14:25–14:45	**Awards & Closing Ceremony**	

		Aula Guarnieri *Session 1: Pest Management in Farming for Sustainable Systems* *Chaired by Prof. Dr. Anna Andolfi*
09:00–09:05	**Session Introduction**	
09:05–09:20	**Saleem Jaffar** Oral Presenter	Understand the Methyl Eugenol Application: Chemosensory and Detoxification Mechanisms in Male Oriental Fruit Fly, Bactrocera dorsalis
09:20–09:35	**Thilo Schmidt** Oral Presenter	Laser weeding—does wavelength matter?
09:35–09:50	**Jessica Schäckermann**	Farming with Nature in the Desert: Wildflower Plots for Biodiversity and Pest Control

	Oral Presenter	
09:50–10:05	**Diletta Missere** Oral Presenter	Cultivation of Monarda spp. for the Production of Essential Oils and Hydrolates for the Control of Insects and Nematodes in Organic Farming: The MOEIDIN Project
10:05–10:20	**Michał Prusiński** Oral Presenter	Metal nanoparticles as a potential alternative to conventional bactericidal treatments
10:20–10:35	**Michael Desens** Oral Presenter	Precision Agriculture Approach for European Corn Borer Control Using AI-Based Detection and Laser Application
10:35–10:50	**Lorenzo Negri** Oral Presenter	Evaluation of agroecological weed management practices to reduce chemical herbicides applications
10:50–11:25	**Coffee Break**	
		Aula Guarnieri ***Session 1: Pest Management in Farming for Sustainable Systems*** ***Chaired by Prof. Dr. Anna Andolfi***
11:25–11:55	**Prof. Dr. Gianfranco Romanazzi** Keynote Speaker	Basic substances as a tool for sustainable plant protection from pre and postharvest diseases
11:55–12:10	**Pumeza Cingo** Oral Presenter	Evaluating the resilience of agricultural systems to the impacts of invasive plants and climate change in the Eastern Cape, South Africa
12:10–12:25	**Annamaria Massafra** Oral Presenter	Multi-Omics insights into advanced solarization effects on soil and tomato development
12:25–13:25	Lunch Break	
		Aula Guarnieri ***Session 1: Pest Management in Farming for Sustainable Systems*** ***Chaired by Prof. Dr. Anna Andolfi***
13:25–13:40	**Hugh Smith** Oral Presenter	Invasive Thysanoptera: a global challenge to sustainable pest management
13:40–13:55	**Luka Čotić** Oral Presenter	Identifying volatile attractants for the olive fruit fly (Bactrocera oleae Rossi) from modified brewer's spent yeast: A chemometric study
13:55–14:10	**Davide Savy** Oral Presenter	From trash to treasure: synthesis and characterisation of dsRNA nanocarriers from waste-derived humic substances
14:25–14:45	**Awards & Closing Ceremony**	

Poster List

Poster Session A (S2, S3, S5) Day 1 – Wednesday, 21 October 2026 Lunch Break 12:20–13:20 & Coffee Break 15:05–15:45		
1.	**Yanina Arnaoudova**	Investigation of the possibilities for the application of fluorescence spectroscopy in comparative analysis with the male gametophyte of pepper subjected to drought
2.	**Zita Bednar-Konski**	Enhancing the Resilience of Organic Farming through Agroforestry: A Practice-Research Network across Germany
3.	**Elisa Masi**	Acoustic vibrations modulate grapevine phenology and physiology: first evidence from vineyard and controlled environment experiments
4.	**Rafał Łopucki**	Balancing crop production and biodiversity: Wheat and maize as contrasting habitats for the European hamster
5.	**Rafał Łopucki**	Renewable energy in agroecosystems: Physiological effects of wind farms on a terrestrial farmland mammal
6.	**Claudia Sánchez**	Non-destructive assessment of quality attributes across various apple varieties
7.	**Jonathan Castaño Serna**	Sentinel-2 NDVI as a tool to monitor potato crop development across planting calendars
8.	**Francisco Tugores**	Effect of Temporal Aggregation on the Performance of Reference Evapotranspiration Estimates along the Spanish Mediterranean Coast
9.	**Federico Frontali**	IMMAGO: Automated In-Field Classification of Tomato Phenological Stages Using Promptable Zero-Shot Detection
10.	**Momchil Paunov**	From Laboratory Exposure to Smart Agriculture: Radiofrequency Electromagnetic Field Effects on Wheat and Maize
11.	**Miguel Leão de Sousa**	OHVeNet: AI-Enabled Smart Monitoring Network for Agricultural Pests and Disease Vectors
12.	**Miquel Llompart**	Performance of Turbulent-Flow Drip Emitters under Thermal Variability
13.	**Deqing Zhuoga**	Impact of future climate change on the development period of spring highland barley in Shigatse, Xizang
14.	**Wahiba Aous**	Activities of Aromatic Plant Hydrosols as Larvicides and Repellents against Culex pipiens: A Sustainable Bio-Based Approach
15.	**Wahiba Aous**	Evaluation of the Insecticidal Activity of Mandarin Essential Oil on Stored Tribolium Populations
16.	**Ping An**	Mitigating salinity stress in spinach (Spinacia oleracea L.): The role of extended photoperiods on growth, physiology, and metabolic profiles
17.	**Filiz Vardar**	Comparative Analysis of Antioxidant Capacity and Photosynthetic Pigments in Bulgarian Pepper (Capsicum annuum L.) Cultivars under Water Deficit Conditions
18.	**Miguel Leão de Sousa**	FruitPV: Agrivoltaic Solutions for Climate-Resilient High-Density Mediterranean Apple Orchards
19.	**Catalina Calin**	Innovative Controlled-Release Fertilizers for Enhancing Nutrient Availability in Sustainable Agricultural Systems
20.	**Inês do Carmo Luís**	Foliar zinc sulfate application in Triticum aestivum L. (cvs. Roxo and Paiva): Impacts on thousand kernel weight, yield, test weight, and zinc concentration
21.	**Cláudia Pessoa**	Foliar zinc biofortification of bread wheat under irrigated and rainfed Mediterranean conditions
22.	**Stefan Shilev**	Soil Eukaryome of Sweet Maize in Response to Organic and Mineral Fertiliser Application

23.	**Teodora Tomova**	Soil Biological Indicators and Rhizosphere CO2 Emission Dynamics under Different Fertilization Regimes in a Field Experiment with Squash (Cucurbita Moschata)
24.	**Susana Ferreira**	Partial Replacement of Mineral Fertilizers with Organic Amendments Sustains Apple Tree Performance under Mediterranean Conditions
25.	**Giulia Mozzo**	Developing a short hop supply chain in Tuscany: cultivation, on-farm drying and cone preservation
26.	**Anna Lehmann-Skoczylas**	The effect of crop rotation and catch crops on selected properties of light soil
27.	**Anna Caccavo**	Effect of Compost Soil Incorporation and Turfgrass Cultivar Selection on Turf Performance Under Non-Irrigated Conditions
28.	**Maria Magdalena Turek Rahoveanu**	Precision Agriculture in a Bibliometric Approach
29	**Du Jun**	Effects of climate change on yield of highland barley in Xizang

Poster Session B (S1, S4, S6, S7) Day 2 – Thursday, 22 October 2026 Lunch Break 12:20–13:35 & Coffee Break 15:10–15:50		
1.	**Paulo Legoinha**	Particle size influence in water absorption capacity of a commercial biochar for agricultural applications
2.	**Arkadiusz Matuszewski**	Kokogel: A novel microbially enriched hydrogel-containing fertilizer derived from poultry manure for improving soil quality and supporting wheat productivity
3.	**Claudia Sánchez**	Soil organic matter and its impact on apple postharvest quality
4.	**Vera Thoss**	Temperate agroforestry systems increase abundance and functional diversity of earthworm communities
5.	**Olha Kachalova**	Machine Learning Reveals Soil-Type-Specific Drivers of Soil Health Change in Czechia
6.	**Vesna Mrvić**	Bacterial inoculation effect on nickel concentrations in Medicago sativa: Bioaccumulation potential
7.	**Agnieszka Kuźniar**	Ecological Indicators of Earthworm Effects on Soil Microbial Biodiversity
8.	**Wahiba Aous**	Evaluation of the insecticidal and repellent activities of essential oils from thyme (Thymus vulgaris L.) and rosemary (Rosmarinus officinalis L.) against the black thistle aphid (Brachycaudus cardui)
9.	**Thanunchanok Chairin**	Formulation Optimization and Immune Priming Effects of Trichoderma virens for Sustainable Oil Palm Basal Stem Rot Management
10.	**Maria Luisa Dindo**	Effects of a Sweet Orange Essential Oil-Based Biopesticide on Exorista larvarum, a Tachinid Parasitoid with Dual Ecological Functions
11.	**Kristijan Franin**	Biostimulatory and Allelopathic Effects of Selected Plant Extracts on Germination of Vegetable Seeds
12.	**Agnieszka Kuźniar**	Bacterial Biopreparations as Modulators of Soil Algal Growth during Biocrust Formation
13.	**Fernando Lidon**	Effects of biostimulant application on durum wheat grain quality
14.	**Maria Manuela Silva**	Biostimulant-mediated modulation of nutrient dynamics in durum wheat
15.	**Pongrawee Nimnoi**	Synergistic Effects of Pseudomonas and Bacillus Inoculants on Plant Productivity, Soil Bacterial Succession, and Functional Metabolic Pathways
16.	**Srinivasan Sivakumar**	Degradation of methyl orange dye employing an endophytic Streptomyces sp. and its application in agriculture
17.	**Stefano Benvenuti**	Ecosystem service provided by sown wildflower strips
18.	**Stefania Galletti**	Enhancing tomato (Solanum lycopersicum L.) tolerance to biotic stress through seed biopriming with algal extracts and derivatives
19.	**Jolanta Kowalska**	Improving the use of biological pesticides and natural biostimulants to protect winter rapeseed in organic farming system
20.	**Hope Namara**	Application of Regenerative Agriculture Practices across Central Europe: A bibliometric review
21.	**Milan Stevanovic**	Farm Competitiveness and Climate-Smart Investment Portfolios: Post-Investment Evidence from the Serbia Competitive Agriculture Project
22.	**Paulo Henrique Montagnana Vicente Leme**	Between perception and adoption: innovation attributes in the use of digital technologies in coffee farming
23.	**Renata Przygodzka**	Agricultural Payments and the Transition Towards Sustainable Farming Systems in Poland: A Regional Perspective

24.	**Gessica Altieri**	A two-year field study on the susceptibility of hazelnut cultivars to the filbert big bud mite Phytoptus avellanae Nalepa
25.	**Erica Errico**	Soil health–based sustainable strategies for managing soilborne pathogens in strawberry production
26.	**Renata Biziene**	Association of SNP9–9224292 with Virus-Specific Susceptibility and Coinfection Frequency in Honey Bees (Apis mellifera)
27.	**Justina Dambrauskaite**	Antimicrobial Peptide Gene Expression in Virus-Infected Honey Bees: Implications for Pollinator Health
28.	**Vongai Paradza**	Pest status of Phthorimaea spp. in South African potato production and the potential of entomopathogenic fungi for integrated pest managemen
29.	**Nijolė Pečiulaitienė**	Detection of Antibiotic Resistance Genes in Bee Microbiota
30.	**Stanislav Trdan**	Trapping of European june beetle (Amphimallon solstitiale [L.]) and Common cockchafer (Melolontha melolontha [L.]) adults using light traps and various pheromone traps in Slovenia
31.	**Qaiser Javed**	Modified Brewer's Spent Yeast as a Sustainable Attractant for Mediterranean Fruit Fly Management: Evidence from Laboratory and Field Studies
32.	**Loukas Orfeas Loukakis**	Biostimulant Effects of Ascophyllum nodosum and Ecklonia maxima Extracts on Yield and Malting Quality Traits of Winter Barley under Mediterranean Conditions
33	**Mwafaq Ibdah**	The Good Neighbor Effect: Resistant Pear Volatiles Prime Defense and Reduce Psylla in a Susceptible Cultivar

Session 1. Pest Management in Farming for Sustainable Systems

Sciforum-189354: The Good Neighbor Effect: Resistant Pear Volatiles Prime Defense and Reduce Psylla in a Susceptible Cultivar

Mwafaq Ibdah [1,*], Liora Shaltiel-Harpaz [2,3], Yuval Cohen [2,4], Bharadwaj Revuru [1], Sureshkumar Mesara [1] and Prasada Rao Konagala [1]

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Plants emit volatile organic compounds (VOCs) that function as airborne signals in ecological communication. These compounds are involved in plant defense regulation and inter-plant interactions. However, field evidence showing that constitutive VOCs from resistant genotypes can modify the physiology of nearby susceptible plants is still limited. The link between such exposure and pest pressure reduction also remains insufficiently resolved.

This study examined VOC-mediated interactions between two pear genotypes differing in resistance to pear psylla (Cacopsylla bidens): the resistant genotype Py-701 and the susceptible cultivar Spadona. Two field experiments were conducted. In the first experiment, potted Spadona plants were placed either next to mature Py-701 trees or in a separate control plot without Py-701 influence. Volatile emissions were collected and analyzed using solid-phase microextraction coupled with gas chromatography–mass spectrometry (SPME–GC–MS). Pest incidence was quantified through standardized field sampling. In the second experiment, Spadona trees were established near Py-701 stands or in isolated plots, and psylla infestation was monitored under natural conditions.

Exposure of Spadona plants to the vicinity of Py-701 induced measurable changes in volatile profiles. Several compounds associated with defense-related pathways increased in abundance, even in the absence of direct herbivore attack. These metabolic shifts suggest activation of a primed defensive state triggered by airborne cues. In parallel, Spadona trees growing near Py-701 showed a significant reduction in pear psylla infestation compared with control trees grown in isolation.

The results provide field-based evidence that constitutive VOC emissions from resistant pear genotypes can influence neighboring susceptible plants. These interactions are associated with altered volatile metabolism and reduced pest pressure. The findings support the concept of VOC-mediated priming-like effects under natural orchard conditions. They also indicate a potential ecological mechanism that could be integrated into sustainable pest management strategies based on plant–plant communication.



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Sciforum-189692: The use of companion cropping for cowpea aphid (*Aphis craccivora)* management in smallholder farming systems

Mutondwa Masindi Phophi [1,*], Paramu Mafongoya [2] and Bonginkosi Vilakazi [3]

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[2] Crop Science, School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, Pietermaritzburg, South Africa
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Agricultural production is highly affected by insect pests and diseases, which are mostly exacerbated by climatic changes. This often results in management challenges, therefore contributing to food insecurity. Due to limited knowledge and awareness, most smallholder farmers in South Africa rely heavily on synthetic pesticides to manage major insect pests and plant diseases. The use of synthetic pesticides has negative impacts, including human health implications; they affect soil organisms and accelerate the development of insect and disease resistance. Due to climate change, insect pests remain challenging to manage effectively, leading to yield losses and socio-economic impacts on farmers. This study highlights the importance of incorporating companion cropping and plant extracts in Integrated Pest Management under smallholder farming systems. Six companion crops (Basil, Marigold, Nasturtium, Garlic, Chives, and Lavender) were tested for cowpea aphid insect control in cowpea production for two seasons of 2023/2024. The same crops were also applied as a pesticidal plant extract. Aphid abundance, leaf damage, and cowpea pod yield were collected over different sampling times. Analysis of Variance (ANOVA) for the collected data was done using Genstat 23.1. Results showed that Basil and Marigold were effective in reducing cowpea aphid abundance and leaf damage, and in improving cowpea yield ($P<0.05$). The use of these crops is recommended for managing aphid infestations in smallholder farming systems, given the high costs of synthetic pesticides. The study also highlights that these crops did not harm the natural enemies of cowpea aphids. Therefore, this practice is suitable for incorporation in the IPM programme.



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Sciforum-194908: From trash to treasure: synthesis and characterisation of dsRNA nanocarriers from waste-derived humic substances

Davide Savy [1,*], Gennaro Volpe [2], Sara Nastasi [3], Bianca Maria Orlando Marchesano [3], Ilaria Di Lelio [1], Maria Cristina Bonza [3], Maria Antonietta Rao [1] and Francesco Pennacchio [1]

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[3] Department of Biosciences, University of Milan, Milan, Italy

Introduction

Humic Substances (HS) are well known for their plant biostimulant properties, as already widely reported [1]. However, owing to their high molecular heterogeneity, these complex materials may find novel applications, including the production of nanocarriers (NCs).

Methods

The electron-donating capacity of HS was exploited to crosslink chitosan chains and synthesise spherical nanoparticles via ionotropic gelation [2]. The resulting NCs were used to encapsulate and deliver double-stranded RNA (dsRNA) targeting a specific gene in *Spodoptera littoralis*. The efficacy of this biopesticide relies on RNA interference-mediated gene silencing following dsRNA delivery [3].

Results

The NCs achieved a dsRNA encapsulation efficiency exceeding 90%, owing to strong non-covalent interactions with HS alkyl and aromatic moieties and chitosan amino groups. They also protected dsRNA from pH-mediated degradation. Upon ingestion by insects, the NCs released biologically active dsRNA, resulting in efficient silencing of the target gene.

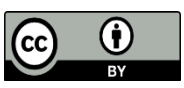
To investigate NC fate in plants, fluorescein isothiocyanate (FITC) was encapsulated and the resulting nanosuspension was sprayed onto tomato leaves. The NCs penetrated the plant cuticle and localised within the epidermal apoplast, where they remained stable for at least 96 h.

Conclusions

These findings demonstrate that HS derived from bio-waste can be exploited as substrates for the synthesis of advanced, value-added nanocarriers with potential applications in crop protection. The versatility of these nanomaterials enables the encapsulation of diverse bioactive compounds, including proteins, peptides, and metallic ions. Further research is needed to explore their full application potential and support the valorisation of agro-industrial bio-waste.

References

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Sciforum-195184: Antimicrobial Peptide Gene Expression in Virus-Infected Honey Bees: Implications for Pollinator Health

Justina Dambrauskaite *, Renata Bižienė, Kristina Morkūnienė, Nijolė Pečiulaitienė, Ramutė Mišeikienė and Laimutis Kučinskas

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Honey bees are key pollinators supporting crop production, biodiversity, and ecosystem stability. However, honey bee populations are increasingly challenged by pathogens, parasites, and other environmental stressors. Viral infections, particularly those associated with Deformed Wing Virus (DWV), represent a major threat to colony health and are frequently linked to the parasitic mite *Varroa destructor*. Understanding honey bee immune responses to viral infection is important for developing sustainable management strategies that support pollinator resilience and agroecosystem stability. Antimicrobial peptides (AMPs) constitute an important component of the honey bee innate immune response and are rapidly induced following pathogen challenge.

Individual worker bees collected from colonies located in six Lithuanian apiaries were screened for common honey bee viruses using polymerase chain reaction (PCR). Based on viral screening results, individuals were classified as infected or non-infected, with DWV identified as the most frequently detected virus. The expression of three AMP genes, *defensin*, *hymenoptaecin*, and *apidaecin*, was evaluated using quantitative real-time PCR.

Virus-infected bees exhibited significantly higher expression of all three AMP genes compared to non-infected individuals. *Defensin* showed the strongest response, with approximately 5–6-fold increased expression, while *hymenoptaecin* and *apidaecin* exhibited approximately 4-fold and 3–4-fold increases, respectively. These findings indicate activation of important antimicrobial defense mechanisms in response to viral infection.

The observed upregulation of AMP genes demonstrates a strong immune response in honey bees exposed to viral pathogens. These findings contribute to a better understanding of molecular mechanisms associated with honey bee health and disease resistance. Improved knowledge of honey bee immune responses may support sustainable beekeeping and integrated pest management strategies aimed at reducing the impacts of Varroa-associated viral infections, strengthening colony resilience, and safeguarding pollination services essential for productive and sustainable agricultural systems.



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Sciforum-195517: Association of SNP9–9224292 with Virus-Specific Susceptibility and Coinfection Frequency in Honey Bees (*Apis mellifera*)

Renata Biziene [1,*], Justina Dambrauskaitė [1], Kristina Morkūnienė [1], Nijolė Pečiulaitienė [1], Ramutė Mišeikienė [1], Giedrius Palubinskas [2] and Laimutis Kučinskas [1]

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Honey bee (*Apis mellifera*) populations are threatened by numerous viral pathogens that contribute to colony losses worldwide. Host genetic variation may influence susceptibility to infection and the occurrence of viral coinfections. This study investigated the association between SNP9–9224292 genotypes and the prevalence of three honey bee viruses in Lithuanian honey bees.

A total of 140 adult worker bees collected from four regions of Lithuania were genotyped at SNP9–9224292 (AA, AG, GG). Viral infections were assessed using PCR targeting Black queen cell virus (BQCV), Chronic bee paralysis virus (CBPV), and Deformed wing virus (DWV). Associations between genotype and virus prevalence were evaluated using chi-square tests. Coinfection was defined as the presence of two or more viruses in a single individual.

Significant genotype-dependent differences were observed for all three viruses. BQCV prevalence varied from 77.5% in AA bees and 66.7% in AG bees to 26.5% in GG bees ($p < 0.001$). CBPV was detected in 22.5% of AA bees and 7.6% of AG bees but was absent in GG individuals ($p = 0.004$). The strongest association was observed for DWV, which was detected in 82.5% of AA bees and 80.3% of AG bees compared with only 8.8% of GG bees ($p < 0.001$). Coinfections were common among AA (67.5%) and AG (63.6%) bees but rare in GG bees (2.9%) ($p < 0.001$).

These findings demonstrate a strong association between SNP9–9224292 and susceptibility to multiple viral infections. The markedly reduced prevalence of individual viruses and viral coinfections in GG bees suggests a potential protective effect of the G allele and highlights this locus as a promising candidate for future studies of disease resistance in honey bees.



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Sciforum-195760: Evaluation of the Insecticidal Activity of Mandarin Essential Oil on Stored Tribolium Populations

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Mandarin essential oil (*Citrus reticulata*), belonging to the Rutaceae family, is widely known for its richness in bioactive secondary metabolites, particularly limonene, flavonoids, and phenolic acids. These compounds are associated with several biological properties, including insecticidal and repellent activities. The present study aimed to evaluate the insecticidal potential of mandarin essential oil against adults of *Tribolium castaneum*, a major pest of stored products responsible for considerable quantitative and qualitative losses in stored grains and food commodities.

The evaluation was conducted using three biological assays: contact toxicity, inhalation toxicity, and repellency tests. The contact test was performed at different concentrations and exposure times of 24, 48, and 72 hours in order to determine the effect of direct exposure to the essential oil. The inhalation assay was used to assess the toxic effect of volatile compounds under confined conditions, while the repellency test was carried out after 2 and 4 hours of exposure to determine the behavioral response of insects toward treated areas.

The results showed that the contact assay produced the highest insecticidal activity, with mortality increasing progressively according to both concentration and exposure duration. This dose- and time-dependent effect confirms the real toxicity of mandarin essential oil through direct contact. In contrast, the inhalation test showed lower mortality rates, even at the highest concentration of 10%, suggesting a limited fumigant effect. The repellency assay demonstrated that adults of *T. castaneum* systematically avoided treated areas, indicating a strong repellent effect.

Overall, mandarin essential oil showed promising insecticidal and repellent properties, especially by direct contact, and may represent a natural alternative to conventional chemical insecticides for stored-product pest management.



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Sciforum-196490: Detection of Antibiotic Resistance Genes in Bee Microbiota

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Antimicrobial resistance is one of the most important public health and environmental challenges of modern society. Antibiotic resistance genes may spread not only in clinical environments but also in natural ecosystems; therefore, their monitoring in environmental microbiota is increasingly important. Honey bees (Apis mellifera), due to their close contact with plants, soil, water, and the surrounding environment, may serve as bioindicators of antibiotic resistance gene prevalence in ecosystems. This study aimed to identify antibiotic resistance genes in the microbiota of bees collected from different regions of Lithuania and to evaluate their prevalence.

A total of 105 bee samples from four Lithuanian regions, Kupiškis, Kaišiadorys, Lazdijai, and Klaipėda districts, were analyzed. The bee microbiota was tested for genes associated with resistance to aminoglycosides (*aph*), beta-lactam antibiotics (*blaZ*), tetracycline (*tetM*), and sulfonamides (*sul1, sul2*). DNA was extracted using the GeneJET Genomic DNA Purification Kit. Target gene fragments were amplified by nested polymerase chain reaction, and PCR products were analyzed by agarose gel electrophoresis. Data were processed using Microsoft Excel.

The results showed that 52 of 105 samples (49.5%) were positive for at least one antibiotic resistance gene. The most frequently detected gene was *sul2*, found in 52 samples. The *tetM* gene was detected in 3 samples, and *sul1* in 1 sample, while aph and *blaZ* were not detected. Four samples contained more than one resistance gene. The highest frequency of positive samples was recorded in Kupiškis district (86%), followed by Kaišiadorys district (33%), whereas no target resistance genes were detected in Lazdijai or Klaipėda districts.

These findings indicate that *sul2* is the most prevalent antibiotic resistance gene in Lithuanian bee microbiota and that resistance gene distribution varies by region. The study supports the use of bees as environmental bioindicators for monitoring antibiotic resistance genes.



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Sciforum-197038: Modified Brewer's Spent Yeast as a Sustainable Attractant for Mediterranean Fruit Fly Management: Evidence from Laboratory and Field Studies

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Tephritid fruit flies are significant invasive pests that cause major economic losses in agriculture and negatively impact local ecosystems worldwide. Current management strategies rely heavily on chemical insecticides, which may conflict with the principles of sustainable agriculture. Brewer's spent yeast (BSY), a by-product of the brewing industry, offers a promising environmentally friendly alternative as an attractant for pest monitoring and control. This study evaluated the attractiveness of two modified BSY formulations, derived from ale- and lager-type yeasts, to the Mediterranean fruit fly, *Ceratitis capitata*. Formulations were prepared at concentrations of 5%, 10%, and 15% and tested through laboratory multiple-choice bioassays and field experiments. Adult flies were grouped by age and mating status to assess potential differences in behavioral responses. Laboratory assays showed that both ale- and lager-based BSY formulations attracted significantly more flies than the control, with responses varying by sex and physiological condition. The 10% lager formulation produced the highest attraction in unmated males aged 4–10 days, while the 15% lager formulation consistently attracted males across all tested groups. Female flies generally exhibited more stable attraction patterns, whereas responses among 4–10-day-old unmated males varied depending on the formulation and concentration. Field trials confirmed the laboratory findings, with all modified BSY treatments capturing significantly more flies than the control. Among the treatments, the 15% lager formulation recorded the highest captures of both male and female flies. Overall, the results demonstrate that modified BSY, particularly lager-type formulations, has strong potential as an effective and sustainable attractant for *C. capitata*. Its effectiveness under field conditions highlights its suitability for integrated pest management programs, providing a low-cost and environmentally responsible alternative to conventional insecticide-based control strategies.



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Sciforum-197061: Identifying volatile attractants for the olive fruit fly (*Bactrocera oleae* Rossi) from modified brewer's spent yeast: A chemometric study

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The olive fruit fly (*Bactrocera oleae* Rossi) is the primary threat to olive production, causing severe economic losses worldwide. Traditional pest control relies mainly on synthetic chemical insecticides, but their widespread use leads to environmental degradation, public health risks, and the development of resistant insect populations. In line with the European Green Deal's goal to reduce chemical pesticide use by 50% by 2030, there is an urgent need to adopt sustainable, biotechnical control methods. This case study examines the chemometric identification of volatile organic compounds (VOCs) from two types of modified brewer's spent yeast (BSY), derived from Ale and Lager beer production, and their role in attracting *B. oleae*. To optimize the raw materials, both BSY types underwent a modification process involving boiling to increase dry matter and reduce alcohol content, followed by enzymatic protein hydrolysis with papain. A preservative was then added, and the substrates were stored at 4 °C until use. To assess efficacy, these modified BSYs were tested in field trials in two olive groves. Chemical characterization of the modified BSY profiles was conducted using HS-SPME/GC-MS analysis, which identified 47 distinct volatile compounds. Multivariate statistical methods, including Principal Component Analysis (PCA) and Redundancy Analysis (RDA), were used to analyze complex chemical signals and correlate them with field attractiveness. Results show that the modified lager profile, characterized by high relative abundances of ethanol, 3-methyl-1-butanol, and specific pheromonal esters such as ethyl decanoate, exhibited significantly higher attraction rates (p = 0.005). In contrast, the modified ale profile had higher levels of β-myrcene and α-humulene, which correlated with reduced field catches. These findings support the development of selective and efficient baits for the olive fruit fly within integrated pest management (IPM) frameworks.



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Sciforum-198834: Multi-Omics insights into advanced solarization effects on soil and tomato development

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Introduction

Intensive agriculture practices often cause the degradation of soil health and the accumulation of soil-borne pathogens, among the most important factors limiting tomato yield. The increasing regulatory restrictions on chemical fumigants accelerated research for sustainable, non-chemical alternatives to protect and improve both soil ecology and crop development. In the present study we compared four soil treatments under high tunnel: unsolarised control, Polyethylene sheet, Polysolar® film and Solin® (Polyeur, Benevento, Italy), a new solarization method. We aimed to study the influence of these solarization methods on soil microbiome, evaluate effects on tomato yield and fruit quality parameters, and investigate the transcriptomic response to such treatments of tomato fruits at the commercial ripening stage.

Methods

we employed a multi-omics and multidisciplinary approach. We performed DNA metabarcoding to evaluate how solarization affected soil microbiome; RNA-Seq and biochemical analysis to evaluate how changes in soil microbiome influenced tomato fruit quality and maturation.

Results

Soil evaluation showed that the higher temperatures achieved by Solin and Polysolar distinctly separated the control groups from the treatments, highlighting a higher effect on fungi than on bacteria. Agronomically, Solin and Polysolar achieved the highest total yields and promoted fruit ripening earlier. RNA-Seq data showed that ripe fruits from Solin treatment guided molecular reprogramming, characterized by the upregulation of key ethylene biosynthetic and signaling genes, alongside core phenylpropanoid and pathogenesis-related pathways. Finally, biochemical analysis confirmed fruit quality preservation, with Solin® treatment showing the highest ascorbic acid content, and PE polyphenols and flavonoids content, respectively.

Conclusions

Overall, this multi-disciplinary approach showed that soil solarization is not only effective for the suppression of soil-borne pathogens, but has other agronomic implications reshaping soil microbiomes, affecting tomato performance, fruit ripening, and antioxidant quality. Solin® system emerged as the most effective system, particularly for its capacity to rise and maintain soil temperature above 40°C.



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Sciforum-198845: Trapping of European june beetle (*Amphimallon solstitiale* [L.]) and Common cockchafer (*Melolontha melolontha* [L.]) adults using light traps and various pheromone traps in Slovenia

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We investigated the effectiveness of different methods for attracting adults of European june beetle (2025) and Common cockchafer (2026) in Slovenia in order to determine the most suitable method for their mass trapping. The experimental sites were permanent grasslands, divided into three blocks along the forest edge, within which seven treatments (traps) were randomly arranged. Six of the tested traps (five with pheromone dispensers, and one without dispenser), differed in shape and color, while the seventh treatment consisted of a light trap. Six traps (all except the light traps) were placed on tree trunks (2025) or on wooden stakes (2026) at a height of 1.5 m in each block. The light traps consisted of an UV LED lamp emitting electromagnetic radiation with peaks at 368 nm (ultraviolet), 450 nm (blue), 530 nm (green), and 550 nm (cool white), with an irradiance of 1.43 W m^{-2}. In Dolnja Briga, 180 beetles were captured between 15 May and 28 July 2025, with only one individual not caught in the light trap. The highest capture rate (app. 5 adults/trap/day) was recorded between 24 June and 2 July 2025. In Stari Breg, 47 beetles were captured in the light trap between 5 May and 21 July 2025, with the highest capture rate (one adult/trap/day) recorded between 2 July and 8 July 2025. In Jereka, we caught 266 adults in light traps from 20 April to 3 June 2026, all other traps were empty. The largest catch was found in the period from 20 April to 28 April 2026, when we recorded 161 beetles in light traps, or an average of 6 beetles/trap/day. We can conclude that light traps are effective for attracting and potentially mass trapping of studied adults, while pheromone traps, when used simultaneously with light traps, do not show any attraction.



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Sciforum-198881: Laser weeding—does wavelength matter?

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Weed control is a critical factor in maintaining high yields in horticultural and agricultural production systems. However, the increasing prevalence of herbicide-resistant weed species, coupled with rising labor costs, necessitates alternative, environmentally friendly, and autonomous weed management strategies. Laser-based weeding represents a promising approach, utilizing thermal energy to damage plant tissues. Its effectiveness depends strongly on the absorption characteristics of the plant components, including the photosynthetic system and water content.

Current commercial laser weeding systems employ different laser types operating at various wavelengths, yet most scientific studies focus on a single wavelength, limiting comparability. In this study, we systematically evaluate commonly used wavelengths in commercial applications (450, 980, 1470, and 1940 nm) through standardized dose–response analyses. The objective is to compare their efficacy in weed control under consistent experimental conditions and identify wavelength-dependent differences in plant response.

Creeping thistle (*Cirsium arvense*) was used as a model species and treated at growth stage BBCH 12. Laser systems were operated with output powers of up to 100 W. The applied dose was controlled via exposure time, while the laser spot diameter was fixed at 5 mm. Following treatment, plants were cultivated under controlled greenhouse conditions, and dose–response curves were assessed three weeks after treatment to determine LD90 values.

All investigated wavelengths induced lethal damage; however, clear wavelength-dependent differences in efficacy were observed. These differences were primarily attributed to variations in tissue absorption, particularly related to water content and photosynthetically active structures. Wavelengths with higher absorption achieved lethal effects at lower energy inputs, indicating more efficient conversion of laser energy into thermal damage. In contrast, lower absorption required higher energy doses, partially compensated by increased exposure time. Overall, these findings demonstrate that wavelength selection is a key factor for optimizing laser-based weed control systems and provide a comparative basis for future development in precision agriculture.



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Sciforum-199217: Farming with Nature in the Desert: Wildflower Plots for Biodiversity and Pest Control

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The overreliance on chemical pesticides and fertilizers in intensive agriculture poses significant environmental challenges, including ecosystem degradation, biodiversity loss, and pest resistance. This highlights the need for sustainable pest management alternatives, particularly in vulnerable and understudied hyper-arid regions such as the Arava Valley.

Within an interdisciplinary living lab framework, we evaluate desert wildflower plots in date plantations as a nature-based solution to enhance biodiversity and support biological pest control. Eighteen wildflower plots (~12 m^2 each), seeded with annual and perennial desert species, were established across two plantations (organic and conventional). An additional 18 plots with spontaneous natural vegetation served as controls. Biodiversity monitoring includes weekly insect sampling, lesser date moth (LDM; *Batrachedra amydraula*) monitoring during pest season, biweekly plant phenology surveys, and assessments of bird communities. Differences in arthropod abundance, community composition, and flowering dynamics were analyzed using appropriate statistical models. The study spans two monitoring years (September 2024-August 2025 and September 2025-August 2026).

First-year findings showed 2.15-fold higher arthropod abundance in wildflower plots than in control plots ($z = 7.71$, $p < 0.001$), including a 1.98-fold increase in parasitoid wasp abundance ($z = 5.37$, $p < 0.001$). Insect community composition also differed significantly between treatments (PERMANOVA: $F = 23.03$, $R^2 = 0.06$, $p = 0.001$). Flowering abundance varied among seeded species, with *Diplotaxis acris* and *Rumex cyprius* exhibiting the highest values. Flowering phenologies were complementary across species, providing floral resources throughout the growing season. Additional analyses examining soil biological quality and evaluating relationships among flowering dynamics, beneficial arthropods, and bird communities in relation to wildflower plots are currently underway.

These findings suggest that native desert wildflower plots can enhance arthropod abundance and alter community composition, highlighting their potential to support natural enemies and contribute to more sustainable integrated pest management strategies in hyper-arid agriculture.



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Sciforum-199374: Invasive Thysanoptera: a global challenge to sustainable pest management

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Introduction

Over the past four decades, several species of thrips (Thysanoptera) have dispersed from their areas of origin and become major pests of agriculture globally. Their small size, cryptic behavior, high reproductive potential and tendency to develop resistance to conventional insecticides present regulatory, diagnostic and management challenges. Management presently relies primarily on conventional insecticides, however competition from endemic thrips, conservation biological control and biopesticides may contribute to thrips suppression.

Methods

On-farm and experiment station field trials, as well as regional screenings for insecticide susceptibility, have been conducted in Guatemala and Florida, USA, to develop management programs for thrips impacting snow pea (*Pisum sativum*), strawberry (*Fragaria* x *ananassa*) and common bean (*Phaseolus vulgaris*). Impacts of essential oils and other biopesticides on thrips survival and egg-laying have been evaluated in cage and greenhouse studies. Since 2022, in person and virtual trainings have been conducted with agronomists across Central America to strengthen responses to *Megalurothrips usitatus*, *Thrips parvispinus* and other invasive pests.

Results

Because of the potential for non-pest thrips to outcompete invasive thrips, resources to assist the non-specialist in distinguishing pest from non-pest thrips are essential. On-farm and experiment station trials have demonstrated that intensive insecticide use can select for invasive thrips while reduced sprays enhance abundance of endemic, non-pest thrips. Field trials in Guatemala identified an abundance of predators in corn (*Zea mays*) but found limited dispersal into adjacent snow pea even with reduced sprays. Kaolin clay has shown promise for reducing some thrips species whereas some essential oil-based biopesticides increased thrips numbers.

Conclusions

Additional research is needed to enhance establishment of natural enemies in horticultural crops and to refine the role of distinct biopesticides in suppressing thrips numbers. Across Central America, there is need for increased capacity building in sustainable pest management.



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Sciforum-199510: Cultivation of *Monarda* spp. for the Production of Essential Oils and Hydrolates for the Control of Insects and Nematodes in Organic Farming: The MOEIDIN Project

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The growing demand for sustainable crop protection strategies, together with European policies aimed at reducing the use of synthetic pesticides, has increased interest in sustainable alternatives for pest management. Aromatic and medicinal plants are recognized as valuable sources of bioactive compounds for agricultural applications. Among these, species of the genus *Monarda* produce essential oils and hydrolates rich in secondary metabolites with promising biological activities. Within this framework, the MOEIDIN project, funded by the Italian Ministry of Agriculture, Food Sovereignty and Forests (MASAF), aims to assess the potential of these natural products for the biological control of insect pests and plant-parasitic nematodes in organic farming. The consortium includes universities, research institutions, an agricultural technical institute, and an organic farm, covering the entire chain from cultivation to biological evaluation. Three *Monarda* species (*M. didyma, M. fistulosa,* and *M. citriodora*) are now cultivated at two sites in Emilia-Romagna (Northern Italy) and monitored throughout their growth. The vegetative biomass will be harvested and subjected to steam distillation to obtain essential oils and hydrolates, whose potential against economically important insect and nematode pests will be evaluated. Their biological activity will be assessed through laboratory and field experiments. The chemical composition of these products will be characterized using gas chromatography–mass spectrometry (GC–MS). The integration of chemical and biological data will enable the identification of promising products from *Monarda* species for pest management applications. The project also promotes knowledge transfer through seminars, field demonstrations, and training activities involving students, farmers, and other stakeholders, focusing on *Monarda* cultivation and the use of essential oils and hydrolates for sustainable crop protection. The outcomes of this research could support the use of natural bioactive compounds in crop protection and contribute to reducing reliance on synthetic pesticides.



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Sciforum-199579: Evaluation of native entomopathogenic fungal isolates for biological control of potato tuber moth, *Phthorimaea operculella* Zeller (Lepidoptera: Gelechiidae) in South Africa

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The potato tuber moth, *Phthorimaea operculella* Zeller (Lepidoptera: Gelechiidae) is an important potato pest that causes significant economic losses in the field and in storage. The primary management of *P. operculella* with chemical pesticides poses challenges on their long-term sustainability and warrants the adoption of an integrated pest management approach. The study objective was to bio-prospect for native entomopathogenic fungi (EPF) across potato growing regions in South Africa and evaluate their potential for the biological control of *P. operculella*. The efficacy of 20 *Metarhizium* (Metschnkoff) Sorokin isolates was tested under laboratory conditions against different developmental stages of *P. operculella* at 1×10^8 cfu/ml - eggs (spraying), first instars (leaf-dip) and prepupae (inoculated soil). Thereafter, six isolates were selected for further complementary assays to determine concentration-mortality responses (10^5 – 10^9 cfu/ml) and the influence of temperature (15 – 35°C) and humidity (60 – 90%) on germination, vegetative growth and sporulation. The results showed that *P. operculella* was susceptible to EPF infections and the level of pathogenicity varied significantly across isolates for the different developmental stages. Although the eggs were less susceptible to infection, the EPFs completely inhibited egg-hatching. The EPFs induced high mortality in both prepupae (67.5 – 100%) and first instars (26.2 – 92.2%). Probit analysis showed a concentration dependent mortality, with LC_{50} ranging from 7.2×10^5 – 3.1×10^7 cfu/ml for first instars. The LC_{50} for prepupae were lower and fell below the lowest tested concentration for three isolates, indicating high susceptibility. Distinct optimal performance profiles among isolates were observed for germination, growth and sporulation across temperature/humidity combinations. These results demonstrate how the insect's developmental stage and EPF temperature/humidity requirements can be applied for a targeted approach in pest management. Soil application of EPFs can potentially suppress *P. operculella* populations in the field through the combined effects of inhibited egg-hatching and pupation.



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Sciforum-199728: Precision Agriculture Approach for European Corn Borer Control Using AI-Based Detection and Laser Application

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The LuMoS project is developing an automated, field-deployable platform for the attraction, detection and control of economically important insect pests. The system combines a mobile light trap for selective attraction with AI-based insect recognition and position tracking. This enables selective application of a laser beam against individual insects. The primary objective is to reduce pest populations by either immediately immobilising or causing lethal damage to insects within 24 hours. This study initially focuses on the European corn borer to demonstrate the concept.

Laser treatments were carried out using a 450 nm laser with a maximum output of 18 W, a spot diameter of approximately 1 mm, and an exposure time of 250 ms. Four anatomical target regions were evaluated: the head, neck, waist and wing joint. Immobilisation was evaluated immediately after treatment using two functional tests: the ability to fly after being gently tossed and the ability to self-right after being placed on the dorsal side. Insects showing impaired performance in both tests were classified as immobilised. Mortality was determined 24 hours after exposure.

The neck region was identified as the most susceptible target site, resulting in the highest levels of immediate immobilisation and 24-hour mortality. In this region, 100% immobilisation was achieved at 1.18 J/mm^2, while the LD_{90} was reached at 2.4 J/mm^2. Notably, the immobilisation dose caused 50% mortality after 24 hours, suggesting that sublethal doses can substantially impair survival.

These results demonstrate the strong potential of precision laser treatment for pest suppression under controlled conditions. Even at comparatively low dose levels, the system achieved complete functional incapacitation; doubling the dose produced near-complete lethality. In practical applications, immobilisation alone may provide substantial control by reducing mating success and increasing vulnerability to natural predators.



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Sciforum-199815: Evaluation of agroecological weed management practices to reduce chemical herbicides applications

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Weeds represent a significant challenge to crop production. Currently, weed management is heavily dependent on the usage of chemical herbicides, for their high efficiency, high flexibility, and low cost. Due to several negative implications associated with the use of chemical herbicides, more sustainable alternatives are under evaluation. The purpose of this thesis was to explore the agronomical performances of three agroecological weed management (AWM) solutions: acetic acid (10%) as bio-based herbicide, cover crops (a mixture of *Sinapis alba*, *Vicia sativa*, and *Trifolium incarnatum*), and hot foam. These were compared to glyphosate and mechanical weeding in two farms located in Cadriano (BO) and Ozzano dell'Emilia (BO), on maize and chickpea cultivation. The evaluated parameters were effectiveness against weeds, ground canopy cover, crop yield, pathogen severity, and soil microbiome.

It was found that AWM practices generally showed lower weed control effectiveness, ranging between 20% and 50%, compared to control practices. Narrowleaf weeds were consistently more difficult to control than broadleaf species. AWM practices achieved moderate control of broadleaf weeds, with acetic acid ranging around 45-60%, in the two sites, hot foam ranging 50-60% and cover crops around 50% in Cadriano. These results, lower than the previous literature, may suggest the need for different acetic acid concentrations or formulates, the introduction of Gramineae species in the cover crop mixture, and the integration between different AWM practices in the same cultivation. Crop yield, pathogen severity, ground canopy cover and soil microbiome were not significantly affected by treatments, or minimally. In general, no negative effects related to the introduction of the AWM were detected, suggesting that the future application of these solutions may be sustainable and possible, if further studies will increase the overall performances of the AWM strategies.



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Sciforum-199894: Metal nanoparticles as a potential alternative to conventional bactericidal treatments

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The development of sustainable crop protection strategies requires novel antimicrobial approaches that combine high efficacy against phytopathogens with limited adverse effects on plants and agroecosystems. In this study, green-synthesized silver (AgNPs) and copper (CuNPs) nanoparticles, obtained using extracts from herbs rich in antimicrobial compounds, were evaluated as potential tools for controlling bacterial phytopathogens and reducing dependence on conventional bactericidal products.

The antibacterial activity of the nanoparticles was examined against six economically relevant bacterial pathogens, associated with severe crop losses: *Clavibacter sepedonicus*, *Ralstonia solanacearum*, *Erwinia amylovora*, *Xanthomonas campestris*, *Pectobacterium carotovorum* and *Dickeya solani*. AgNPs exhibited broad-spectrum antibacterial activity, with MBC values ranging from 1.3 to 5.7 ppm. CuNPs showed pathogen-dependent activity, demonstrating effective inhibition of growth of *C. sepedonicus*, *R. solanacearum*, *E. amylovora* and *X. campestris,* with MBC values ranging between 10 and 100 ppm. Although less effective than AgNPs, CuNPs showed up to fivefold better antibacterial performance, compared with a commercial copper oxychloride formulation.

To evaluate sustainability of the nanoparticle-based treatments, potential phytotoxic effects were assessed in seedlings and mature plants. AgNPs at 40 ppm did not negatively affect the growth of wheat, cabbage, beetroot, tomato, eggplant and pea seedlings in contrast to the water controls. Application of CuNPs on plant seeds reduced the seedlings growth, but did not significantly affect the well-being of mature plants.

These findings demonstrate the potential of green-synthesized AgNPs and CuNPs in integrated bacterial disease management. Further investigation of the influence on soil microbiota or other non-target organisms is warranted to get more data on the safety of the proposed approach. In summary, metal nanoparticles produced *via* green synthesis could form a potential alternative to conventional pathogen control approaches.



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Sciforum-207662: Can Farmers' Lack of Knowledge About the Origin of Bayoud Disease Contribute to Its Spread in the Tafilalet Palm Grove? A Field Survey

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Bayoud disease is caused by Fusarium oxysporum f. sp. albedinis and represents one of the most destructive diseases affecting date palm production in North Africa. Sustainable management of this disease depends not only on phytosanitary measures but also on farmers' level of knowledge and their agricultural practices. This study aimed to describe the knowledge, perceptions, and management practices of farmers in the Tafilalet palm grove (Morocco) regarding Bayoud disease, and to examine associations between this knowledge and certain at-risk agricultural practices.A descriptive cross-sectional survey was conducted between January and April 2023 among 1,000 farmers across 25 sites along both banks of the Ziz Valley. Each site was visited four times during the study period, with 10 farmers interviewed per visit (25 sites × 4 visits × 10 farmers = 1,000 respondents), selected on the basis of [availability / random selection — to specify]. Data were collected through a structured questionnaire, [pre-tested / validated with a pilot sample of X farmers], administered orally by a team of five trained investigators.Results showed that 98% of respondents were unable to identify F. oxysporum f. sp. albedinis as the causal agent of Bayoud disease, and 75% were unaware of its mode of transmission. Notably, 98% incorrectly attributed the disease to the white grub, a distinct pest whose presence is associated with the use of untreated or unsolarized sheep manure. Indiscriminate pesticide use was reported by 95% of farmers, and nitrogen fertilizers (ammonium nitrate, NPK, ammonium sulfate, urea) were applied once a year based on personal experience rather than technical recommendations. A [chi-square test / logistic regression — to be completed] revealed a significant association between [variable] and [variable] (p = ...).These findings, which represent, to our knowledge, the first large-scale assessment of farmers' knowledge on the origin of Bayoud disease in the Tafilalet region, do not establish a direct causal link between knowledge gaps and disease spread, but reveal an information deficit likely to undermine the effectiveness of prophylactic measures and to encourage at-risk agricultural practices. They support the development of targeted training programs focused on pathogen identification, transmission pathways (root contact, irrigation water, contaminated tools and offshoots), and sound fertilization practices, as part of an integrated Bayoud disease management strategy.

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Sciforum-207673: Effects of Bacterial Isolate, Temperature, Humidity, and Antibiotic Treatment on Soft Rot Development in Potato Tubers

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Potato soft rot and blackleg reduce tuber quality, storage life, and seed health. Latent infections allow bacteria to remain undetected in symptomless seed tubers, pass through certification, and spread to new production areas. Antibiotics can cure systemic bacterial infection in virus-free potato tubers during the early stages of propagation. Antibiotic response may vary with temperature, humidity, and bacterial isolate, yet these factors are seldom evaluated together in a single potato tuber assay. This study tested the effects of bacterial isolate, temperature, humidity, and antibiotic treatment on soft rot development in potato tubers (cv. Gala). We inoculated tubers with *Pectobacterium brasiliense* F152, *P. parmentieri* PB20, *P. carotovorum* F135, *Dickeya dianthicola* D9, *D. solani* D12, or *Pseudomonas cichorii* Pch12. Erythromycin (15 mcg), amikacin (10 mcg), kanamycin (30 mcg), and gentamicin (10 mcg) were used, with three replicates per treatment. Inoculated tissues were incubated for 72 h at 25, 30, or 35 °C. Separate assays were conducted at 25 °C under low- and high-humidity conditions. Tissue-weight change and lesion size were measured, and the data were analyzed using one-way ANOVA. Tissue loss was greater at 35 °C than at 30 °C, while responses at 25 °C varied more among isolate–antibiotic combinations. Under low humidity, most combinations showed measurable tissue loss. High humidity was associated with irregular weight changes, including apparent gains that probably reflected water uptake rather than reduced maceration. On average, D12 produced comparatively the largest lesions, whereas PB20 produced the smallest in the temperature assay. Gentamicin-treated D9 and PB20 developed smaller lesions than D12, while kanamycin responses differed widely among isolates. The results indicate that treatment response depended on isolate identity and incubation conditions. Future studies should include multiple potato cultivars before advancing any antibiotic–isolate combination in greenhouse or field testing.

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Author contributions: Conceptualization, Riad Saidu Koroma; Methodology, Riad Saidu Koroma; Formal analysis, Riad Saidu Koroma, Olga Slovareva and Francess Sia Saquee; Resources, Elena Pakina; Data curation, Riad Saidu Koroma; Writing - original draft, Riad Saidu Koroma, Dooshima Rita Dugeri and Francess Sia Saquee; Writing - review and editing, Dooshima Rita Dugeri, Olga Slovareva, Francess Sia Saquee and Elena Pakina; Funding acquisition, Elena Pakina;



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Sciforum-208271: Understand the Methyl Eugenol Application: Chemosensory and Detoxification Mechanisms in Male Oriental Fruit Fly, Bactrocera dorsalis

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Bactrocera dorsalis (Hendel), a destructive polyphagous fruit fly pest of horticulture, causes persistent and severe damage to horticultural crop production in global tropical and subtropical regions. Methyl eugenol (ME), a powerful male-specific phytochemical attractant and key pheromone precursor, has long been a core tool in lure-and-kill integrated pest management programs for this pest. After ingestion by male flies, ME is metabolized into (E)-coniferyl alcohol (E-CF) and 2-allyl-4,5-dimethoxyphenol (DMP), which are stored in male rectal glands and released during courtship behavior to effectively attract female mates. Although ME plays a critical role in the reproductive ecology of B. dorsalis, the underlying molecular mechanisms of ME perception and downstream regulatory pathways remain largely uncharacterized. In this study, we conducted comparative transcriptomic analysis of four key tissues (head, gut, midleg, and wing) from ME-responsive and ME-non-responsive male B. dorsalis. A total of 15,727 genes were successfully annotated, including 970 functional genes associated with chemosensation, detoxification, and stress response. Differentially expressed genes (DEGs) were identified across tissues: 7222 in the head, 7763 in the gut, and 6105 in wings and midlegs. Notably, core detoxification genes (CYPs, UGTs) and stress-related HSP genes were significantly downregulated in ME-responsive males. GO and KEGG enrichment analyses further verified that CYP genes were prominently enriched in metabolic detoxification pathways. Overall, these findings uncover sophisticated molecular crosstalk between olfactory perception and detoxification processes. ME modulates coordinated genetic networks that govern the survival, reproductive fitness, and environmental adaptability of B. dorsalis, providing a valuable molecular foundation for developing novel, eco-friendly pest control strategies.



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Sciforum-208536: A Comprehensive Review of Microbiome-Regulated Detoxification and Resistance Mechanisms in *Helicoverpa armigera*

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Helicoverpa armigera is one of the most injurious and economic important polyphagous insect pests in the world which cause significant yield losses in many agricultural crops. It is an example of one of the most ecologically plastic insects, with a wide range of hosts, and an ability to rapidly develop insecticide resistance, making its management more difficult. Although most studies have concentrated on the host-encoded detoxification mechanisms, recent studies have revealed that gut microbiome is playing an important role in adaptation, detoxification and evolution of resistance. The gut of insects is also home to a variety of microorganisms that are involved in nutrient acquisition, degradation of plant secondary metabolites, immune response modulation and xenobiotic compound transformation. A number of recent studies have shown that certain gut bacteria species are able to directly break down the insecticides or indirectly control the detoxification pathways of the host by metabolic signaling and transcription modulation. In addition, studies using multi-omics including metagenomics, transcriptomics, metabolomics and functional genomics have identified complex host–microbiome relationships associated with the insecticide susceptibility and resistance phenotypes. The composition of microbial communities and the trajectory of resistance is also influenced by environmental factors such as host plant diversity, pesticide exposure, and climate variability. This review aims to integrate existing knowledge on the architecture of the gut microbiome in H. armigera, the mechanism of detoxification by gut microorganisms, and the molecular mechanisms underlying the role of microbial symbionts in insecticide responses and ecological adaptation. Moreover, new approaches to pest management using the microbiome, such as microbiome engineering, symbiont mediated interventions and microbiome informed resistance monitoring, are assessed in a critical manner. The interplay between H. armigera, its gut microbiota, and environmental stressors presents novel opportunities for creating sustainable and environmentally conscious pest management strategies.

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Sciforum-208660: Evaluating the resilience of agricultural systems to the impacts of invasive plants and climate change in the Eastern Cape, South Africa

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Climate change poses a serious threat to agricultural systems worldwide and exacerbates the spread of alien invasive species (AIPs), creating dual stressors for farmers, particularly in developing countries with limited adaptive capacity. This study aims to investigate the dual impact of climate change and AIPs on smallholder farmers in the Amathole District of the Eastern Cape, where three dominant AIPs, *Lantana camara* L., *Acacia mearnsii* De Wild, and *Opuntia sp*., will be evaluated. A multistage purposive sampling technique will be used to select 100 and 150 livestock smallholder farms based on farm location, livestock ownership, presence of the selected AIPs, and willingness to participate in assessing the distribution of the selected AIPs. The preliminary distribution of AIPs will be sourced from the Global Biodiversity Information Facility and Landcare database and validated with field surveys. The ecological impact of the selected alien invasive plants will be assessed on up to 30 farms representing different ecological zones across the district during the flowering season from September 2026 to April 2027 to evaluate how these impacts vary across different environmental gradients. Finally, this study will model the potential influence of climate change on the spread of alien invasive plants to assess how climate change is projected to alter the distribution and invasion potential of the selected AIPs under different climate scenarios. Climate data will be collected from WorldClim v2 and supplemented by the South African Weather Service. This study uniquely addresses the combined effects of AIPs and climate change, offering localised adaptive management strategies tailored to small-scale farmers.

Author contributions: Investigation, Pumeza Cingo; Writing - original draft, Pumeza Cingo; Writing - review and editing, Pumeza Cingo; Visualization, Pumeza Cingo; Supervision, Khapayi Musa and Samalesu Mayonde;



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Sciforum-208668: Silicon Dioxide (SiO_2) Dose-Dependent Suppression of Bipolaris Leaf Blight in Wheat: Integrating Disease Dynamics, Antioxidant Defense, Seed-Borne Pathogen Transmission, and Economic Thresholds in a Sub-Tropical Rice-Wheat System

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Bipolaris leaf blight (BLB), caused by Bipolaris sorokiniana (Sacc.) Shoemaker remains a critical biotic constraint in wheat (Triticum aestivum L.) production across South Asian rice–wheat cropping systems, where seed-to-seed pathogen transmission perpetuates inoculum across seasons yet is rarely co-evaluated with foliar disease management. This factorial field study—conducted at the Bangladesh Wheat and Maize Research Institute (BWMRI) research field, Dinajpur, during the 2025–2026 growing season—is the first to integrate dose-response quantification of silicon dioxide (SiO_2), temporal disease dynamics (AUDPC), seed-borne pathogen burden, and grain quality in a single unified experiment using two contrasting Bangladeshi commercial varieties (BARI Gom-30 and BARI Gom-33). Six SiO_2 doses (0, 20, 40, 60, 80, and 100 kg ha^{-1}) were applied as split soil amendments at four intervals (land preparation, 25, 50, and 75 DAS) in an RCBD with three replications (36 plots). Silicon at 80 kg ha^{-1} reduced flag-leaf disease severity by 52–57% and flag-1-leaf severity by 22–25% relative to the untreated control, achieved the lowest seed-borne B. sorokiniana infection (7.41% in T5×BARI Gom-33), increased grain yield by 37% (3.85 vs. 2.68 t ha^{-1}), and increased thousand-grain weight by 18.5% (52.40 vs. 41.37 g). Critically, 100 kg ha^{-1} (T6) did not outperform T5 for any disease or yield metric, suggesting that 80 kg ha^{-1} is the economically preferable dose under the conditions of this study, supported by a benefit-cost ratio of 2.87:1. Regression analysis revealed that flag-1-leaf disease severity at 75–79 DAS predicted final grain yield (R^2 = 0.52), identifying a potentially important predictive indicator for early disease management in this pathosystem.

Author contributions: Conceptualization, Abdur Rahman Rahman Al Mamun; Methodology, Abdur Rahman Rahman Al Mamun; Validation, Abdur Rahman Rahman Al Mamun and Jakaria Hossain; Formal analysis, Abdur Rahman Rahman Al Mamun and Jakaria Hossain; Investigation, Jakaria Hossain; Data curation, Amit Hashan; Writing - original draft, Amit Hashan; Visualization, Amit Hashan;



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Sciforum-208696: Soil health–based sustainable strategies for managing soilborne pathogens in strawberry production

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Strawberry production in Campania region (Southern Italy), located in Caserta and Naples provinces, is increasingly threatened by soilborne pathogens, including *Phytophthora* spp., *Neopestalotiopsis* spp., and *Macrophomina phaseolina*. Among these, *M. phaseolina* has emerged as a major constraint in strawberry crops managed with both organic and integrated farming systems. This polyphagous fungus is responsible for charcoal rot, root and crown rot, and plant decline. It is favored by high temperatures, making its management particularly challenging under climate change and the progressive restriction of plant protection products. Since 2024, ongoing research has developed an agroecological strategy for pathogen containment based on the "soil health–plant health–agroecosystem health" (One Health approach). This study combines laboratory and field investigations to design non-chemical control methods, such as Solin® solarization, Biological Control Agents (BCAs), and agronomic practices like organic amendments and crop rotations. Laboratory assays focused on determining lethal temperature thresholds for *M. phaseolina* microsclerotia and evaluating the antagonistic activity of selected BCAs. Field trials carried out at two commercial farms showed that Solin® solarization significantly increases soil temperature (up to 47°C), thereby effectively reducing pathogen inoculum levels. Moreover, the combined method with applications of *Trichoderma* spp. reduced disease incidence and severity, highlighting the efficacy of integrated approaches for soilborne pathogen management. Preliminary results indicate that combining Solin® solarization with BCAs ensures effective pathogen control and improvement of plant vigor. The results demonstrate that optimized soil management practices can increase soil suppressiveness against soilborne pathogens while enhancing agroecosystem resilience. Ongoing research aims to refine the strategy through diversified amendments, novel microbial formulations, and alternative crop rotations. This transition toward agroecological soilborne pathogens management represents a necessary shift to ensure productivity, sustainability, and climate resilience in strawberry farming systems.

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Sciforum-208943: A two-year field study on the susceptibility of hazelnut cultivars to the filbert big bud mite *Phytoptus avellanae* Nalepa

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The aim of this study was to evaluate the susceptibility of different hazelnut cultivars to *Phytoptus avellanae* infestation in a multi-cultivar experimental orchard located at the University of Salerno (Fisciano, Italy). Field assessments were conducted during 2025 and 2026 on 18 hazelnut cultivars. The experimental design comprised 18 plants per cultivar (five years old in 2025), arranged in three spatially separated replicates of six plants each. In both years, assessments were performed on two sampling dates, 30 days apart (March-April). Data were collected by visually inspecting three randomly selected plants per replicate (nine plants per cultivar). On each plant, three branches were examined, and the number of pseudogalls and the total number of buds were recorded to calculate the infestation rate.

Infestation data were analysed using a factorial analysis of variance (ANOVA - General Linear Model), with year, sampling time, cultivar, and their interactions included as fixed effects, while replicate was treated as a blocking factor. Mean comparisons were performed using Tukey's test (HSD; α=0.05).

Statistically significant differences were observed across years ($F_{1,70} = 34.07$, $p < 0.001$) and among cultivars ($F_{17,70} = 19.01$, $p < 0.001$). Tonda Gentile delle Langhe MT4 (19.3%) and Tonda di Giffoni (11.9%) exhibited the highest infestation levels across both years of the study. Moderate infestation rates (5–10%) were recorded for the cultivars McDonald, Daria, Camponica, Volumnia II, and Mortarella. The remaining cultivars showed low infestation rates (<5%), including Nocchione, Volumnia I, Tonda Bianca, Tonda Pacifica, Tonda Francescana, Etrusca, Sacajawea, Pauetet, and Yamhill. Notably, no infestation was observed in the Webster and Unito 101 cultivars.



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Sciforum-208947: Pest status of *Phthorimaea* spp. in South African potato production and the potential of entomopathogenic fungi for integrated pest management

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The *Phthorimaea* spp. pest complex of solanaceous crops in South Africa consists of the Potato tuber moth (PTM), *Phthorimaea operculella* (Gelechiidae) and tomato leafminer (TLM), *Phthorimaea absoluta* (Gelechiidae). The production areas and pest complexes of tomato and potato overlap. The recent change observed in *Phthorimaea* spp. composition in potato fields is of concern to producers in regions where both crops are planted. The potato and tomato industries in South Africa are heavily reliant on insecticides for pest control. A control approach that considers both pest species, different crops, and control options is needed to manage TLM and PTM on solanaceous crops in South Africa. TLM and PTM larvae in potato fields in two cropping regions were monitored, as well as the distribution patterns of both moth species inside and in natural veld adjacent to potato fields. PTM and TLM pheromone traps, as well as a control trap, were placed at -5 m (inside), and 25, 50, 75 and 100 m (outside) a 50-ha field in each locality. Traps were replicated across four wind directions (N, S, W, E). Laboratory tests were conducted to evaluate the efficacy of 20 entomopathogenic fungi (EPF) isolates against final-instar PTM larvae. The prepupae larvae were exposed to sterile, EPF-inoculated soil at 1 x 10^7 cfu/g of soil. Field monitoring data showed that the above-ground larval infestation of TLM in potato can reach 100% depending on location, agricultural landscape (e.g., presence of crops), and time within the cropping season, whereas tuber infestation is exclusively PTM. About one-third of the moths of both species were captured within the fields, while two-thirds were caught up to 100 m away. Reinfestation and overlapping generations therefore occur throughout the cropping season, highlighting the limitations of relying solely on chemical control. Contact of prepupae with EPFs in the soil caused significant mortality. All isolates were pathogenic, but overall mortality varied between 60 - 100%, with infection confirmed through mycosis. Proper field monitoring data can guide the utilisation of entomopathogenic fungi against the subterranean PTM larvae and warrants consideration as an additional option in an integrated pest management approach to target the pest's multiple life stages.

Author contributions: Conceptualization, Hannalene du Plessis and Vongai M Paradza; Methodology, Hannalene du Plessis, Ronan Diedericks, Tayla Swanepoel and Vongai M Paradza; Validation, Vongai M Paradza; Formal analysis, Hannalene du Plessis, Ronan Diedericks, Tayla Swanepoel and Vongai M Paradza; Investigation, Hannalene du Plessis, Ronan Diedericks and Tayla Swanepoel; Resources, Hannalene du Plessis; Data curation, Ronan Diedericks, Tayla Swanepoel and Vongai M Paradza; Writing - original draft, Ronan Diedericks and Tayla Swanepoel; Writing - review and editing, Hannalene du Plessis and Vongai M Paradza; Visualization, Ronan Diedericks, Tayla Swanepoel and Vongai M Paradza; Supervision, Hannalene du Plessis and Vongai M Paradza; Project administration, Hannalene du Plessis; Funding acquisition, Hannalene du Plessis;



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Sciforum-209923: Efficacy of the native entomopathogenic nematodes (EPN) on the survival of *Ceratitis capitata*

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Ceratitis capitata (Mediterranean fruit fly) is a globally significant pest causing major yield losses and trade restrictions in fruit production. Although native entomopathogenic nematodes (EPNs) from South African soils offer potential for sustainable pest control, their efficacy against C. capitata remains poorly understood. This study evaluated two indigenous EPN isolates, Steinernema jeffreyense and Heterorhabditis bacteriophora, against larval and pupal stages of C. capitata under laboratory conditions. Larvae were exposed to 0, 25, 50, 75, and 100 IJs/50 µL, while pupae received 0, 100, 150, 200, and 250 IJs/50 µL. Both trials used 2 × 5 factorial designs with five replications and were repeated twice. Data were analyzed using two-way ANOVA in Statistix 10, with means separated by Tukey's HSD test ($\alpha = 0.05$). Variables measured included mortality, mortality speed, infectivity, and pupation rate. No significant interaction between EPN species and concentration was observed in the larval trial, whereas the pupal trial showed highly significant interactions for all variables. Both species caused concentration-dependent mortality, with H. bacteriophora consistently outperforming S. jeffreyense. Interestingly, the highest larval mortality occurred at the lowest concentration tested (25 IJs), while significant pupal mortality was only achieved at the highest concentration (250 IJs). These findings demonstrate that H. bacteriophora and S. jeffreyense are promising biological control candidates against C. capitata. However, field validation, assessment of nematode persistence across soil types, and formulation improvements are necessary to translate these laboratory results into practical, sustainable fruit fly management strategies.

Author contributions: Conceptualization, Ntokozo Carol SHABALALA; Supervision, ZAKHELENI Palane DUBE and Ludzula Mukwevho;



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Session 2. Crop Rotation and Management—An Agroecological Approach

Sciforum-173961: Assessing Crop Yield Performance in Maize-Beans Intercropping Systems: A Comparative Analysis

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Intercropping, often known as polyculture or mixed cropping, is a sustainable farming practice where several crops are grown together in a single field to maximize output and resource efficiency. This technique is especially beneficial for small-scale farmers in developing areas, resulting in improved land and nutrient use, diminished pest and disease prevalence compared to monoculture, and reduced exposure to market volatility and total crop failures. This study examines two main hypotheses: first, whether intercropping maize (Zea mays L.) with beans (Phaseolus vulgaris L.) can mitigate the negative environmental effects associated with sole maize cultivation while still being profitable; and second, that intercropping provides various environmental, economic, and social benefits. These benefits include stable seasonal yields, increased resource efficiency, erosion prevention, and better management of weeds, pests, and diseases. The research assesses various intercropping strategies—row intercropping, mixed intercropping within rows, and strip intercropping—comparing them with maize and bean monocultures. The key performance indicators analyzed include yield, land equivalent ratio (LER), economic returns, and productivity measures.- The results indicate that beans achieved notably higher yields in row intercropping, followed by strip and mixed intercropping systems. In contrast, maize recorded the highest yields in mixed intercropping, with strip and row intercropping ranking next. Overall, intercropping demonstrated improved yield performance when compared to monoculture, with LER values exceeding 2, which indicates significant land efficiency. Importantly, mixed cropping realized a productivity increase of 120% when compared to monoculture, requiring only a 2.20% larger land area to achieve comparable output. The mixed intercropping system also provided better economic advantages, net profits, and productivity metrics, reinforcing its effectiveness as a viable agricultural method.



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Sciforum-182920: Effect of crop management practices on rainfed winter wheat (*Triticum aestivum* L.) growth, physiology and yield components in corn-soybean-wheat rotation system

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Increasing yield efficiency of winter wheat (*Triticum aestivum* L.) is critical to meet growing food demands. However, interactive impacts of multi-cropping factors on wheat growth, physiology, kernel characteristics and yield components for optimizing productivity remain less characterized in rainfed agroecosystem. In this study, we assessed effects of different agronomic management practices such as cover cropping (CC) (absence and presence of cereal rye), tillage (conventional and strip-till) and nitrogen (N) application (standard 224.17 kg/ha and enhanced additional 44.83 kg/ha) on wheat in corn-soybean-wheat rotation system.

The study was conducted in Northwest Ohio of the USA in Split Split Block Design in 2024-2025. Flag leaf size and chlorophyll measurements were done after Spring. At Feekes 11.4, stand count, plant height, total spikes, spike length, spikelets per spike, kernel number per spike (KNS), kernel weight per spike (KWS), stover, root and grain dry weight, thousand grain dry weight (TGDW) were measured including harvest index, shelling efficiency and final yield. Single Kernel Characterization System (SKCS) was used to measure kernel hardness index (KHI), kernel moisture (KM) and kernel diameter (KD).

The results showed that there was no consistent single management practice effect on growth and yield performance. Enhanced nitrogen application improved chlorophyll, aboveground biomass, TGDW and KHI. Strip tillage effect on plant height and CC effect root dry weight increase were observed. CC and N interaction was significant for TGDW, KNS and flag leaf angle. Finally, total spikes and KWS were the primary yield factors which are consistent with existing research. However, further detailed soil chemical properties examination is necessary for better understanding of the relationship between yield components and final yield.

These findings show that strip-tillage combined with enhanced nitrogen and cover cropping integration can improve wheat agronomic and physiological performance and multi-cropping factors could be a pathway for long-term improved wheat yield.



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Sciforum-189719: Impacts of vining peas on soil carbon and nitrogen in a crop rotation

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Vining peas are a higher-value, underutilised rotation crop that have a known benefit of nitrogen fixation. This fixation leads to peas offsetting fertiliser needs for the following crop, and the organic inputs from higher quality residues compared to other crops like cereals can benefit soil organic matter too. In commercial farms, however, the capacity of pea crops to benefit soils and greenhouse gas emissions from increased carbon sequestration remains poorly documented.

In this study, eight fields under commercial vining pea production in the northeast of England were sampled post-pea harvest, and one year later, post-harvest of the following crop to assess the impact of pea residue decomposition. Three samples were taken in the pea growing area, and three in an area left fallow during the pea year but returned to cropping in the following year. Total soil carbon and nitrogen, along with soil pH and bulk density, were measured using one core and one bulk measurement at three depths of 0-10, 10-20 and 20-30 cm depths.

Peas showed a marginal benefit to both soil carbon and nitrogen compared to the fallow; however, these effects vary in direction and magnitude across the fields sampled. The variation across fields suggests that the different soil types interact with the impact of the pea crop. The effect of peas on soil carbon and nitrogen was smaller than expected, suggesting a legacy effect of peas from previous crop rotations, meaning that the fallow treatment had a limited effect from removing the crop for only one year. These data will now be used to develop a wider scale trial assessing impacts of peas across the rotation, providing a direct comparison between different crops.



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Sciforum-191243: Mitigation of water stress and enhancing productivity of cowpea in summer rice fallows

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Introduction

Cowpea is a vital grain legume in crop rotations and a key pulse for Kerala's summer rice fallows. Despite drought tolerance, rising temperatures, erratic rainfall, and severe moisture stress have reduced productivity, with yield losses up to 30%. High temperatures during flowering and pod setting exacerbate oxidative damage from reactive oxygen species (ROS), limiting the crop's ability to benefit from elevated CO_2. To address these challenges, this study evaluated exogenous application of plant growth regulators (PGRs) and nutrient mixtures to mitigate water stress and enhance cowpea productivity in rice fallows.

Methods

Field experiments were conducted over two consecutive summer seasons (2021–22 and 2022–23) at three locations representing Kerala's agro-ecological zones: Padannakkad, Pattambi, and Vellayani. The crop was raised following Kerala Agricultural University's package of practices. A randomized block design with three replications was adopted, testing seven treatments: control, thiourea (500 ppm), salicylic acid (100 ppm), ascorbic acid (2 mM), Sampoorna multimix (0.5%), Triple 19 (10 g/L), and Ayarmicro (15 ml/L). Foliar sprays were applied at 20 and 35 days after sowing, and yield parameters were recorded.

Results

Significant variation was observed across treatments and locations. Triple 19 consistently recorded the highest pooled yield (1985.78 kg/ha), followed by salicylic acid (1844.44 kg/ha). Improvements were associated with increased pod number, seed set, and dry matter accumulation. Ascorbic acid and multimix treatments also enhanced yield compared to control, though to a lesser extent. The findings confirm that nutrient and PGR applications modulate physiological responses under moisture stress, thereby sustaining productivity.

Conclusions

Climate-induced moisture stress remains a major constraint for cowpea in rice fallows. Exogenous application of nutrients and growth promoters, particularly Triple 19 and salicylic acid, proved effective in mitigating stress and enhancing yield. These interventions offer a practical strategy for sustaining pulse productivity in Kerala's vulnerable summer rice fallows.



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Sciforum-196577: Effect of intercropping on the growth and grain yield of sorghum in the Czech Republic

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Intercropping, the simultaneous cultivation of two or more crops on the same piece of land, enhances crop productivity through improved utilization of light, water, nutrients, and space, while suppressing weeds, increasing biodiversity and land-use efficiency, and contributing significantly to sustainable agricultural production systems. A field study was carried out in České Budějovice, Czech Republic, to evaluate the effect of intercropping on the growth and grain yield of sorghum. Five treatments were established: sole sorghum and sorghum intercropped with common buckwheat (Zoe and Harpe varieties), Tartary buckwheat, and pea, laid out in a randomized complete block design with three replicates. Data were collected on vegetative growth traits from 2 to 10 weeks after planting (WAP), while grain yield was assessed at harvest. Intercropping significantly ($p \leq 0.05$) influenced the growth characteristics of sorghum throughout the study period, except for stem diameter at 6 WAP and number of leaves at 2 and 8 WAP. Yield components and grain yield were similarly affected. Sorghum + Zoe recorded the longest panicles (17 cm), highest number of seeds per panicle (1,067), greatest 1,000-seed weight (23.30 g), and highest grain yield (6.65 t/ha), while sorghum intercropped with Tartary buckwheat had the shortest panicles (13 cm), lowest number of seeds per panicle (472), lowest 1,000-seed weight (20.99 g), and lowest grain yield (3.53 t/ha). Intercropped sorghum recorded a higher mean grain yield (5.25 t/ha) than the monoculture (4.59 t/ha). Correspondingly, the partial land equivalent ratio (PLER) was greater in the intercrop (1.15) than in sole sorghum (1.00), indicating that sorghum utilized available resources more efficiently when intercropped. These findings suggest that intercropping sorghum with common buckwheat enhances grain yield and productivity, making it a promising strategy for sustainable crop production.



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Sciforum-197492: Improving Agriculture Resilience by Adopting Brassica-Based Intercropping Systems

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Intercropping systems are often adopted to improve soil use, as well as to possibly better compete against weeds and use more efficiently available resources. The majority of intercropping systems often includes legumes, able to fix atmospheric N, and cereals, able to compete with weeds. Otherwise, the inclusion of *Brassicaceae* species into intercropping has been so far only seldom investigated so far. The combination of grain legumes, such as pea (*Pisum sativum*), lentil (*Lens culinaria*), and chickpea (*Cicer arietinum*), with the emerging oilseed brassica, camelina (*Camelina sativa* L.), has been the focus of a European project, entitled SCOOP, funded by CORE Organic. Different intercropping systems including pea, lentil and chickpea and camelina have been sown for two consecutive years (2022-24) at the experimental organic farm of Bologna University in Ozzano dell'Emilia (44°27′N, 11°29′E) in comparison to their respective mono-cropping. In the intercropping the seeding rate was 50:50 of the typical rate for each crop. Pea and chickpea intercropping were planted in autumn, while lentil ones in spring. Each intercropping system was evaluated during its growing cycle assessing sowing coverage, weed presence, and at harvest seed and straw yield was assessed, together with the main quality characteristics of each crop. Different intercropping indicators, such as LER, MAI, aggressivity index, were also calculated. Only for the pea-camelina system additional analyses were carried out to investige how intercropping was affecting soil and rhizosphere biodiversity as well as crop functioning in term of N fixation in the legume. All the intercropping had LER (Land Equivalent Ratio) >1, suggesting yield improvement in comparison with sole crop. The pea-camelina combination had a LER=1.61, with pea being the main crop. Intercropping profoundly alters the architecture of the diazotrophic community at rhizosphere level. Camelina forced pea to over-regulate signalling for symbiosis, resulting in peaks in symbiont biomass.



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Sciforum-198948: Effect of Compost Soil Incorporation and Turfgrass Cultivar Selection on Turf Performance Under Non-Irrigated Conditions.

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Urban landscapes are increasingly affected by water scarcity, stricter irrigation regulations, and the need to reduce nonpoint source pollution, creating demand for sustainable turfgrass systems capable of persisting with minimal or no irrigation. Soil amendments and improved turfgrass cultivars may provide strategies to enhance soil function and maintain turf quality under water-limited conditions. This study evaluates the effects of compost soil incorporation and turfgrass species/cultivar selection on turf performance in non-irrigated lawn systems. A field experiment was initiated in June 2025 in Citra, Florida, and will continue through April 2027. This abstract describes the experimental design and the ongoing research. The study uses a split-plot design with soil amendment (compost incorporation at 329 m^3 ha^{-1}) versus non-amended soil as the whole-plot factor and turfgrass species/cultivars and groundcovers as split-plot treatments. Evaluated materials include bahiagrass (1 cultivar), bermudagrass (6 cultivars), St. Augustinegrass (6 cultivars), zoysiagrass (6 cultivars), and perennial peanut (1 cultivar). After a 30-day establishment, no irrigation is applied for the remainder of the study. To account for seasonal establishment variability, the experiment is replicated across two planting dates: June 2025 (favorable conditions) and March 2026 (less favorable conditions), allowing comparison of treatment performance under contrasting establishment environments. Turf performance is assessed through monthly visual quality ratings, digital image analysis-derived percent green cover, normalized difference vegetation index, and volumetric soil moisture measurements. Soil physical and chemical properties, including bulk density, water-holding capacity, nutrient availability, organic matter, pH, and cation exchange capacity, are evaluated before and after the study period. The objective of this research is to determine whether compost-amended soils enhance turfgrass persistence and soil quality under non-irrigated conditions and to identify turfgrass species and cultivars capable of maintaining acceptable quality without supplemental irrigation. The findings from this ongoing study will contribute to the development of agroecologically based best management practices that improve soil health, reduce irrigation demand, and mitigate environmental impacts in urban landscapes.



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Sciforum-199332: "Dye Plants as Flower Strips for Sustainable Agroecosystems: a Comprehensive Analysis of Agronomic Performance, Pollinator Dynamics, Biological Potential

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Introduction

modern agroecosystems face harsh sustainability and biodiversity problematics due to the implementation of industrial monocultural systems. *Dye plants strips* (DPS) could represent a means to obtain both ecological and economical feedback. Yet, their agronomic performances, pollinators attractiveness, and biological activities require deeper investigation. Five species - *Cosmos sulphureus*, *Tagetes erecta*, *Cota tinctoria*, *Coreopsis tinctoria*, *Persicaria tinctoria* - are evaluated, proposing their use as DPS for enhancing the overall sustainability of the agrifood systems.

Methods

DPS agronomical trials conducted in 2025 monitored germination and growth stages using the BBCH scale. Three different flowering stages were evaluated concerning the pollinator attractiveness by a systematic observation of insect visits (e.g. *Apis mellifera*, *Bombus* spp. and wild bees). Recorded data were analyzed via one-way ANOVA. Dyestuff biomass (flowers or leaves) yield ratio was quantified. Additional analyses will characterize the polyphenolic and flavonoid profiles, and antioxidant capacity.

Results

agronomical traits monitoring revealed strong differences between species in germination time and ratio, growth parameters, and flowering period. *Cosmos sulphureus* in the BBCH 65 stage (full blooming) showed the highest attractiveness to pollinators with 0.78 visits/15 min session/plant. Wild bees group is the most abundant overall for number of visits, with 0.13 visits/plant. Biomass yield varied across species, with maximum dry dyestuff production/plant of 7.25g in *Cosmos sulphureus*, and maximum *dry/fresh* ratio of 29.3% in *Cota tinctoria*.

Conclusions

DPS could enhance the functional biodiversity and amenity of agricultural landscape, providing a solution for the differentiation in crop production, furnishing a valuable side-production, along with the main culture. Dye plants cultivation could promote the rediscovery of derived products rooted in the folk tradition. The services furnished meet with "Farm to Fork" goals for promoting circular agrarian systems, enhancing the resilience of agroecosystems, and developing a modular approach implementable in sustainable agrarian schemes.



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Sciforum-199549: Research on an Evaluation Method for the Benefits of Crop Rotation

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Current status of Crop rotation in the concrete region is constrained by natural conditions such as soil, climate, and biological population distribution in this region, it is also influenced by traditional crop production customs shaped by the individual preferences and accumulated experience of local agricultural producers. The quantitative analysis of crop rotation benefits in the designated region has significant practical significance.

Therefore, the benefit evaluation of crop rotation is taken as the research object in this paper. Under the premise of determining the conditions for crop rotation, such as region, climate, and crop rotation period, the impacts of crop rotation on 'soil nutrient and fertility status', 'soil physicochemical properties', 'Regional agricultural ecology', 'Prevention and control of pests, diseases, and weeds' and 'Agricultural economic development performance' are regarded as sub-indicators for the evaluation, all of them are denoted as a_{1}, a_{2}, a_{3}, a_{4}, a_{5}, and every sub-indicator function is defined as f(a_{i}) = b_{i, 2}/b_{i, 1}, b_{i, 1} is the measured value of this sub-indicator during the current crop rotation period, and b_{i, 2} is the measured value of this sub-indicator during the previous crop rotation period. Furthermore, by weighting the sub-indicators, a benefits evaluation composite function is expressed as F(a_{1},..., a_{5}) = 5 ∑ i = 1 α_{i}f(a_{i}) , (α_{i} is the weight of the corresponding sub-indicator, 5 ∑ i = 1 α_{i} = 1), and the terminal evaluation conclusion can also be easily drawn.

Some simple experiments have been designed and carried out, the preliminary experiment results indicate that this method is effective, because the crop rotation cycle is relatively long, the final experimental results from comparative analysis have not yet been formed, but the characteristics of this evaluation method which based on quantitative analysis can accurately evaluate the benefits of crop rotation, and facilitate the implementation of optimal crop rotation in the region.



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Sciforum-199855: Advancing learning outcomes through agroecology based school feeding programmes in Uganda

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School feeding programmes in Uganda have long been recognized as vital interventions for improving enrolment, literacy, and nutrition among vulnerable communities, yet it continue to face challenges related to climate change, soil degradation, biodiversity loss, and unstable food trade. This study examined different models of school feeding initiatives, including parent and community-led, government-supported, and donor-driven approaches, and found that agroecology-based practices significantly enhanced its effectiveness. By encouraging communities and schools to grow a variety of crops locally, agroecology reduced reliance on imported food relief or single staple foods, ensuring learners received diverse meals that included cereals, legumes, vegetables, and fruits. These practices not only improved dietary diversity but also built resilience to climate shocks through better soil health, water conservation, and sustainable land management thereby contributing to stable food supply in the face of environmental challenges. The findings further revealed that agroecology-based feeding contributed to increased school enrolment and reduced absenteeism among both learners and teachers, underscoring the direct link between nutrition and educational outcomes. Importantly, food diversity varied across regions depending on parental income levels, community capacity, and external support, highlighting the need for equitable policies that strengthen local food systems. Overall, the integration of agroecology into school feeding programmes demonstrates a powerful synergy between sustainable agriculture, education, and community empowerment, offering a replicable model for other countries grappling with similar challenges. By aligning with global goals on hunger, education, and climate resilience, Uganda's experience illustrates how agroecology can serve as a transformative policy lever to secure nutritious, diverse, and sustainable school meals that advance learning outcomes and strengthen community resilience.



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Sciforum-199925: The effect of crop rotation and catch crops on selected properties of light soil

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Conventional crop production, as well as highly intensive cultivation, is characterized, among other things, by the use of improper crop rotations and even long-term monocultures, which contribute to soil degradation. The use of unfavorable agrotechnical practices results in the depletion of organic matter inputs, increases pest pressure and leads to the deterioration of the biological, chemical and physical properties of the soil, which ultimately impacts yield levels.

The unfavorable condition of the soil environment requires the implementation of regenerative measures, including the use of well-designed crop rotations. In recent years, increasing attention has been given to actions aimed at protecting the natural environment and enhancing the natural fertility of agricultural soils. This aligns with the principles of sustainable agriculture, in which proper plant succession plays a key role. A well-planned crop rotation is a fundamental element of sustainable agricultural practices, which in the long term will contribute to stable yields and increased profitability of crop production. To enhance the value of a site in crop rotation, cover crops are increasingly being incorporated into cropping practices. They play a crucial role in protecting soil from degradation – they improve its structure, reduce compaction, and protect against erosion.

The aim of the study was to assess the response of rye grown on light soil in crop rotations with varying shares of rye in the cropping structure and to determine the effect of catch crops, white mustard and a mixture of legumes, on selected physical properties of the soil, including moisture, porosity, soil bulk density and soil structure parameters.

The obtained research results indicate that deviating from proper crop rotation resulted in the deterioration of selected soil properties. The introduction of catch crops generally had a positive effect on the analyzed parameters, often achieving effects comparable to those observed in a four-field rotation.



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Sciforum-201909: Comparative Performance of Two Indigenous Armenian Grape Varieties, 'Black Kharji' and 'Yeghegnadzor Black', under the Conditions of the Armavir Region, Armenia

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The conservation and scientific evaluation of indigenous grapevine varieties play a vital role in preserving genetic diversity, promoting sustainable viticulture, and supporting the development of distinctive wine-producing regions. Armenia, recognized as one of the world's oldest centers of grapevine domestication and winemaking, is home to numerous indigenous grape varieties that represent an important component of the country's agricultural heritage. Despite their historical and economic significance, many native cultivars remain insufficiently studied under modern viticultural conditions. This research presents a comparative evaluation of two indigenous Armenian black grape varieties, Black Kharji and Yeghegnadzor Black, cultivated under the agroecological conditions of the Armavir region of Armenia.

The study aimed to compare the agronomic performance, phenological development, productivity, fruit quality, and technological characteristics of both varieties under identical environmental and vineyard management conditions. Field observations and biometric measurements were conducted throughout the growing season. Growth parameters, cluster morphology, yield components, and berry quality indicators relevant to grape processing and future winemaking applications were comparatively assessed using standard viticultural methodologies.

The results demonstrated clear differences between the two indigenous cultivars in vegetative growth, productivity, and fruit characteristics. Black Kharji exhibited vigorous growth, stable productivity, and favorable technological characteristics, while Yeghegnadzor Black showed desirable berry quality attributes and complementary agronomic traits. These findings indicate that both varieties possess valuable potential for sustainable vineyard management and provide a scientific foundation for their broader utilization in the production of distinctive Armenian wines.

The study contributes to expanding scientific knowledge of Armenia's indigenous grapevine genetic resources and provides practical information for researchers, grape growers, and the wine industry. Furthermore, the findings support the conservation and wider cultivation of native grape varieties, encouraging future research on their oenological potential and reinforcing the identity, sustainability, and international competitiveness of Armenian viticulture and winemaking.



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Sciforum-208242: Digging Deeper: Dry Matter Allocation, Root Growth and Grain Production in Perennial Wheat derivatives

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Perennial wheat is a promising dual-purpose crop that produces grain while maintaining living roots between growing seasons. However, limited information is available on biomass allocation and root development across successive regrowth cycles. This study examined dry matter production, root distribution, and grain yield of four perennial wheat derivatives (147235a, 147280b, OK7211542, and 11955), a perennial grass (148055), and a replanted annual wheat cultivar (Wedgetail) grown in large soil columns over three years under southern Australian conditions. Perennial genotypes accumulated substantially greater biomass than the annual wheat. By the third year, total dry matter averaged 137 g plant^{-1} for the perennial wheat lines and 194 g plant^{-1} for the perennial grass, compared with 55 g plant^{-1} for Wedgetail. Root distribution differed markedly among genotypes. Annual wheat roots were concentrated in the upper soil profile, particularly between 30 and 60 cm depth, and were absent below 120 cm. In contrast, perennial wheat lines progressively increased root biomass below 60 cm with each regrowth cycle, while the perennial grass developed the greatest root biomass at depths exceeding 120 cm. In the third year, grain weight was highest in the replanted annual wheat cultivar Wedgetail (27 g plant^{-1}, after correction for bird damage), followed by the perennial wheat lines 11955 (26 g plant^{-1}), OK7211542 (22 g plant^{-1}), 147235a (10 g plant^{-1}), and 147280b (3 g plant^{-1}) and harvest index averaged 40, 22, 16, 5 and 5 %, for annual wheat Wedgetail and perennial wheats 11955, OK7211542, 147235a and 147280b, respectively. Grain production in the perennial grass (148055) was negligible. Perennial wheat derivatives-maintained grain production while developing deeper, larger root systems than annual wheat. These enhanced roots improve access to water and nutrients, supporting survival and regrowth in dry conditions and highlighting the potential of perennial wheat for resilient, resource-efficient grain production in water-limited environments.



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Sciforum-208741: Developing a short hop supply chain in Tuscany: cultivation, on-farm drying and cone preservation

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The establishment of local hop value chains in Mediterranean regions requires both the adaptation of hop (*Humulus lupulus* L.) cultivation to local conditions and effective postharvest practices for rapidly stabilizing freshly harvested cones. Field trials conducted over successive growing seasons in Tuscany showed successful establishment and productive performance of Cascade and Chinook, with approximately 450–500 and 300–350 cones plant^{-1}, respectively. Despite its lower cone number, the greater individual cone weight of Chinook resulted in estimated dry cone productions of 36–40 and 45–53 g DW plant^{-1} for Cascade and Chinook, respectively. Previous harvests also revealed distinct cultivar-specific quality profiles, including bitter-acid and volatile profiles.

Building on these results, the present study combined fresh-cone characterization with controlled postharvest drying and storage of the two cultivars Cascade and Chinook. Fresh cones were characterized for individual weight, moisture content, morphometric traits and colour. Both cultivars were subjected to the same 16-h temperature-modulated drying protocol consisting of successive phases at 36, 40 and 36°C, reducing moisture content from approximately 79% to 9%. The same assessments were repeated after drying, with particular attention to cone integrity, colour changes and visible lupulin-associated areas. Dried cones were vacuum-packed and stored at 5 °C, with periodic assessments planned for up to 12 months to monitor changes in cone integrity and lupulin-associated visual traits during storage. Chemical characterization of α- and β-acid contents and VOC profiles by PTR-ToF-MS is currently in progress on subsamples stored at -20°C.

Overall, these findings support the suitability of Cascade and Chinook cultivation under Tuscan conditions and provide preliminary quantitative information for developing drying and storage strategies potentially transferable to on-farm processing, contributing to a regional short hop supply chain.

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Sciforum-210586: Pesticide Load Indicators: Tools with multiple applications

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An overarching goal of the pesticide policies in the European Union is to reduce the impact of pesticide use on human health and the environment. In most countries, pesticide use is monitored by collecting data on pesticide sales annually or less frequently. As pesticides are applied at doses ranging from a few grammes to several kilos per hectare and the toxicological and ecotoxicological profiles of pesticides vary significantly, pesticide use data does not reflect the potential impact of pesticide use. Pesticide Load Indicators (PLI), on the other hand, incorporates information on the toxicity of the pesticides to humans and the environment along with information of the amonut of pesticides used. Several PLIs have been developed and a they can be broadly divided into two groups. One group bases the calculation solely on the inherent properties of the pesticides and the amount of pesticide used, i.e. calculating a potential rather than an actual impact. An example is the Danish Pesticide Load Indicator (DK-PLI), which has been used in Denmark since 2012 and is also the basis jfor a pesticide taxation scheme. The second group of PLIs considers the actual exposure associated with the use of pesticides when calculating the impact, i.e., with these indicators the actual impact of pesticide use is calculated. The indicator SYNOPS, used to monitor the impact of pesticide use at a national level in Germany, is an example of such a PLIs. SYNOPS requires more input parameters than DK-PLI. Recently, the application of PLIs at farm or field level as a tool to visualise the benefits of IPM for human health and the environment, and thereby promote the implementation of IPM among European farmers, has received increased attention. A web application of the DK-PLI is available to Danish farmers but to be of real interest to advisors and farmers it is generally recognized that a tool should assess not only pesticide impact but also other effects of adopting IPM. This is important as adoption of IPM may be associated with a change in costs or conflict with other sustainability goals such as climate change. With this in mind, an IPM Self Assessment Tool (ISAT) was developed in the EU H2020 project SUPPORT. ISAT is build around an improved version of the DK-PLI but also considers costs of crop protection and greenhouse gas emissions. In this presentation, the development and application of DK-PLI and SYNOPS is briefly discussed followed by a presentation of ISAT and a discussion of potential future applications of ISAT as a decision-support platform to increase awareness of the benefits of IPM and to help farmers and advisors to make informed decisions on crop protection strategies.

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Session 3. Fertility Management in Sustainable Agricultural Systems

Sciforum-180616: Enhanced P Use Efficiency in Rice (Oryza satival) by Nano and Molecular Phosphatic Fertilizers

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Nano-fertilizers represent an emerging class of advanced nutrient delivery systems that operate at the nanoscale, offering improved efficiency and environmental sustainability compared to conventional chemical fertilizers. The present study was conducted to evaluate the effects of nano-phosphorus (nano-P) fertilizers in comparison with conventional molecular phosphorus fertilizers on phosphorus use efficiency (PUE) and yield performance of rice grown in deep clay soil (Vertisol) under supplemental irrigated conditions. A pot culture experiment was carried out, wherein rice plants were treated separately with nano-scale phosphorus fertilizers and commonly used molecular phosphorus sources such as single super phosphate (SSP).

The experimental results indicated that the application of nano-P fertilizer significantly enhanced grain yield and nutrient uptake in rice. However, the performance of nano-P fertilizer was found to be statistically on par with SSP, suggesting comparable efficiency under the given soil and environmental conditions. The improved performance of nano-fertilizers can be attributed to their higher surface area, enhanced reactivity, and controlled nutrient release mechanisms, which facilitate better nutrient availability and uptake by plants.

Furthermore, the findings highlight that the effectiveness of nano-fertilizers is strongly influenced by factors such as particle size, shape, surface functionalization, concentration, and timing of application, along with soil properties such as texture and mineral composition. The study emphasizes that integrating nanotechnology in to fertilizer management practices can be a promising strategy to an enhance phosphorus use efficiency, reduce nutrient losses, and improve crop productivity. Therefore, nano-fertilizers have significant potential to contribute towards sustainable rice production systems and environmentally sound nutrient management practices.



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Sciforum-188881: Managing living roots to manage fertility

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To assess an agricultural soil's potential fertility, soil scientists frequently attempt to locate a comparable soil remnant existing under the natural vegetation that preceded cultivation. Soils of natural ecosystems are known to sustain higher levels of organic matter, exhibit more developed soil structure, and promote more biodiverse and structured microbiomes compared to cultivated soils. Two defining characteristics of plant communities that facilitate soil development in natural ecosystems but are relatively uncommon in row crop agriculture are diversity and perenniality. Aware of benefits, farmers have historically integrated diversity and perenniality into agroecosystems though perennial pasture rotations and agroforestry designs like alley cropping. Interest in integrating perenniality and diversity into agriculture is experiencing a resurgence in response to climate change and chronic soil degradation in continuous annual monocultures. In addition to traditional methods of integration, researchers are making exciting progress in breeding perennial grain crops that may eventually replace annual grains. With new perennial crop "hardware" the gap between actual and potential fertility in agricultural soils is expected to narrow. Using experimental results involving the novel perennial grain Kernza the presentation will illustrate how the cessation of tillage and increases in root biomass following perennialization of annual croplands sets in motion soil successional changes that frequently include greater nutrient retention, increases in soil organic matter fractions and water stable aggregates, greater microbial biomass and soil food web diversity, and increased water infiltration rates. Farmers' access to perennial grains are currently limited to regional releases of Kernza in the U.S. and perennial rice in SW China. With sustained breeding and cropping systems research, current efforts to perennialize wheat, sorghum, quinoa, barley and as assortment of new crop species could begin to fill a critical role in closing the gap between natural ecosystems and agriculture within decades.



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Sciforum-193016: Harnessing rice reproductive traits for fertility management in sustainable systems

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Hybrid rice underpins global food security, yet the sustainability of its seed production is constrained by the labour-intensive, input-dependent nature of conventional cross-pollination management. Harnessing intrinsic floral mechanisms that promote natural outcrossing offers a low-input, plant-level alternative to manual and chemical interventions. This study evaluates panicle and stigma exsertion, flag leaf orientation, floret opening angle, and duration of floret opening across twelve parental lines of hybrid rice: six WA-cytoplasmic genic male sterile (CGMS/A) parental lines and six restorer testers, phenotyped following standardised descriptors, and validates the functional relevance of these traits through fertility restoration analysis across thirty-six F_1 cross combinations, in which pollen and spikelet fertility were quantified and genotypes classified as restorers, partial restorers, or maintainers. All parental lines exhibited a semi-erect flag leaf orientation, minimising interference with wind-mediated pollen dispersal, while female parental lines displayed medium-to-high stigma exsertion and floret opening angles ranging from 24 to 33 degrees, the widest recorded in IR79156A, favouring greater stigma exposure and pollen receptivity. Among the testers, Manu Ratna and VTL 8 emerged as broad-spectrum restorers, effectively restoring fertility across four to five of the six CMS parental lines, while Annapoorna combined the highest filled-grain count per panicle with superior pollen (97.3%) and spikelet (95.4%) fertility. More than twelve of the thirty-six F_1 combinations exceeded 80% pollen and spikelet fertility, confirming the reliability of morphology-based parental selection, and the early-flowering CoMS23A and CoMS24A parental lines were identified as favourable female parents owing to flowering synchrony with elite restorers. Integrating floral trait screening with F_1 fertility validation thus provides a resource-efficient, trait-based strategy for restorer identification and parental line selection, reducing dependence on manual and chemical outcrossing aids and establishing a practical foundation for a locally adapted, sustainable hybrid rice seed production pipeline from Kerala germplasm.



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Sciforum-198888: Comparative Analysis of Antioxidant Capacity and Photosynthetic Pigments in Bulgarian Pepper (*Capsicum annuum* L.) Cultivars under Water Deficit Conditions

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Drought stress (DS) is one of the abiotic constraints that causes oxidative damage and adverse effects on the photosynthetic apparatus. This study investigated the effects of DS on antioxidant enzyme activities and photosynthetic pigments in 15 pepper (*Capsicum annuum* L.) cultivars obtained from the Maritsa Vegetable Crops Research Institute (Plovdiv, Bulgaria).

Pepper cultivars were grown under greenhouse conditions in 2025 under two irrigation regimes: non-stressed (NS, 100% optimum irrigation) and drought-stressed (DS, 50% optimum irrigation). The experiment was arranged in a randomized complete block design with three biological replicates, each consisting of ten plants. Drought treatment was initiated at full flowering and maintained until the end of the growing season. Leaf samples were analyzed for superoxide dismutase (SOD), catalase (CAT), and peroxidase (POX) activities, together with chlorophyll a, chlorophyll b, total chlorophyll, and carotenoid contents. Data were analyzed using PAST software. Differences between NS and DS were evaluated using Student's *t*-test ($p < 0.05$).

DS induced significant cultivar-dependent biochemical responses. POX activity increased markedly in all cultivars (1.4–49-fold), whereas SOD activity increased by 1.1–3.4-fold. In contrast, CAT activity did not differ significantly under DS. Photosynthetic pigments showed genotype-dependent responses. Total chlorophyll increased in most cultivars, remained unchanged in DS3, DS4 and DS13, and decreased only in DS8. Carotenoid content also varied among cultivars, showing increases, decreases, or no significant changes depending on genotype. The highest POX induction was observed in DS13, while DS8 exhibited the only significant reduction in total chlorophyll.

DS-induced cultivar-dependent changes in antioxidant enzyme activities and photosynthetic pigments. Cultivars combining strong antioxidant responses with lower pigment loss may represent promising candidates for drought-tolerance breeding. The observed variation among cultivars suggests different adaptive mechanisms and supports the use of biochemical markers for identifying drought-tolerant pepper genotypes. This study was supported by the Bulgarian National Science Fund (KP-06-H86/5/06.12.2024).



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Sciforum-199035: Environmental impact of manure reallocation as a circular fertility management strategy in a small-scale mixed farm

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Sustainable fertility management in small-scale mixed crop-livestock systems requires balancing nutrient supply, soil health maintenance, and greenhouse gas mitigation. As demand for meat and dairy rises in developing regions, integrated approaches that optimize organic fertilizer use while minimizing environmental trade-offs are urgently needed. This paper evaluates net greenhouse gas (GHG) emissions (CO_2, CH_4, N_2O, expressed as CO_2-equivalents) across three farm years in a small-scale system transitioning from low to high integration of manure into soil fertility management. The integration consisted of progressively increasing manure allocation to pasture/rangeland (from 50% to 74%) while reducing solid storage, with animal numbers and total land area (5.68 ha) held constant. Emissions and carbon sinks were quantified using IPCC Tier 2 methods, alongside assessment of organic fertilizer potential (N, P, K) from manure. Results showed that shifting manure toward pasture reduced net farm emissions by approximately 18%, primarily through lower methane from storage and enhanced soil organic carbon sequestration on perennial vegetation. However, pasture deposition could increase N_2O emissions from urine/dung patches on grazed land, indicating a nitrogen loss pathway that reduces fertilizer use efficiency. Secondary analysis revealed substantial organic fertilizer potential, since manure from the system could supply over 726 kg N, 116 kg P, and 319 kg K annually across scenarios, underscoring its value as a renewable nutrient source. Biogas capture, if implemented, could further produce digestate with enhanced nutrient availability while displacing fossil fuels. These findings support manure redistribution to pasture as a low-cost strategy for improving soil carbon stocks and reducing methane, but highlight the need for integrated fertility management to optimize nutrient cycling. This study demonstrated that fertility management, when designed as a holistic system, can simultaneously enhance soil health, recycle nutrients, and contribute to climate change mitigation in smallholder agriculture.



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Sciforum-199548: Foliar zinc biofortification of bread wheat under irrigated and rainfed Mediterranean conditions

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Zinc deficiency remains one of the most widespread micronutrient deficiencies worldwide, making agronomic biofortification a promising strategy to improve the nutritional quality of cereal-based diets. However, the effectiveness of this approach is influenced by environmental factors. This study evaluated the response of the wheat cultivar Roxo grown under contrasting Mediterranean conditions in Portugal, namely irrigated and rainfed field systems. Foliar $ZnSO_4$ was applied at booting and heading stages (rates of 8.1 kg ha^{-1} and 18.2 kg ha^{-1}, total application across both stages), alongside an untreated control. Net photosynthesis was monitored during grain development, while grain yield and Zn concentration were determined at harvest. Irrigation enhanced crop performance, resulting in significantly higher grain yields for treatments 0 kg ha^{-1} and 8.1 kg ha^{-1} under rainfed conditions in comparison to non-irrigated. Although Zn application successfully increased grain Zn concentration, it was associated with moderate yield reductions, ranging from 13.9 to 17.8% under rainfed conditions and from 12.1 to 18.7% under irrigation. Foliar Zn application effectively increased grain Zn concentration under both water regimes (by 14.8 to 21.0% under rainfed conditions and by 20.3 to 35.9% under irrigation). Despite this response, irrigated plants generally exhibited lower Zn concentrations than rainfed plants, suggesting a dilution effect associated with increased biomass production and grain yield. Net photosynthesis declined throughout the crop cycle, particularly under rainfed conditions. Nevertheless, irrigated plants maintained higher P_n values during grain filling, which likely contributed to improved grain filling and higher grain yield. These findings demonstrate that agronomic biofortification with Zn is a viable strategy to enhance wheat nutritional quality in Mediterranean production systems. Optimizing Zn regime rates according to water availability is essential to maximize biofortification efficiency and maintain agronomic sustainability, since higher concentrations of $ZnSO_4$ led to Zn increases, but also yield decreases under the two different water regimes.



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Sciforum-199559: Rootstock-Mediated Growth and Photosynthetic Responses of Grafted Tomato Seedlings under Drought Stress

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Drought stress is a major constraint affecting tomato seedling establishment, growth, and physiological activity. Grafting onto vigorous rootstocks may improve drought adaptation by maintaining root development and physiological activity under water-limited conditions. This study evaluated the effect of different rootstocks on root growth, leaf area and net photosynthetic rate of grafted tomato seedlings under drought stress. The experiment was conducted in a controlled-environment growth chamber. Tomato scion 'Jalila F1' was used as a self-rooted control and was also grafted onto four rootstocks 'Auroch', 'Ficus', 'Goldrake', and 'TOR23901'. After graft establishment, seedlings were subjected to three substrate moisture levels corresponding to volumetric water content (VWC) of 60% (well-watered), 40% (mild drought) and 20% (severe drought) for 15 days. Drought stress significantly reduced plant height, leaf area, biomass accumulation, and gas-exchange parameters, with more pronounced reductions observed under severe drought ($p < 0.05$). In self-rooted 'Jalila F1', photosynthetic rate decreased significantly from 3.49 µmol CO_2 m^{-2} s^{-1} under well-watered conditions to 1.72 µmol CO_2 m^{-2} s^{-1} under severe drought. In contrast, 'Auroch'-grafted seedlings maintained a significantly higher photosynthetic rate (3.09 µmol CO_2 m^{-2} s^{-1}) under severe drought. Under mild drought, 'Auroch'-grafted seedlings maintained a significantly greater leaf area (108.53 cm^2) than self-rooted seedlings (79.33 cm^2). Under severe drought, seedlings grafted onto 'Goldrake', 'Auroch' and 'TOR23901' produced significantly longer roots (32.0, 29.67, 28.0 cm, respectively) than self-rooted seedlings (19 cm). These findings demonstrate that drought tolerance varies among rootstock-scion combinations and suggest that appropriate rootstock selection can enhance seedling-stage drought resilience by maintaining root growth, leaf area, and photosynthetic activity under water-limited conditions.



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Sciforum-199778: Foliar zinc sulfate application in *Triticum aestivum* L. (*cvs.* Roxo and Paiva): Impacts on thousand kernel weight, yield, test weight, and zinc concentration

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To mitigate malnutrition in zinc (Zn) for a growing global population, agronomic biofortification with foliar applications serves as an effective strategy to enhance Zn accumulation and nutrient bioavailability in staple crops as bread wheat. This research sought to evaluate the effects of foliar $ZnSO_4$ application rates on the grain Zn concentration, grain yield (GY), grain quality traits in Paiva and Roxo cultivars of bread wheat. Within this framework, in one year, field trials in Beja, Portugal (four replicates), evaluated foliar $ZnSO_4$ applications at booting and heading stages (0 – P0S, R0S; 8.1– P1S, R1S; 18.2 kg ha^{-1} – P2S, R2S, cumulative doses) to enrich *Triticum aestivum* L. (*cvs.* Roxo and Paiva). Post-harvest grain analyses evaluated GY (combine harvester); protein content (Infratec™ 1241 Grain Analyzer); test weight (TW); moisture content (MC); thousand-kernel weight (TKW); and Zn quantification (micro-energy dispersive X-ray fluorescence). Data was statistically analyzed using software R 3.6.3 to obtain One-Way ANOVA ($p \leq 0.05$). It was found that the Zn content increased by *ca.* 1.6 fold and, approximately, 2.0 fold for samples P1S and P2S, respectively, compared to the control sample (P0S). On the other hand, increases of 1.4 fold (R1S) and 1.9 fold (R2S) were observed compared to the control (R0S). No significant differences were observed in MC and in TW between the cultivars. The TKW ranged from 43.15 to 48.76 g for Paiva and from 33.07 to 36.90 g for Roxo, with the control samples having higher values. Roxo cultivar had higher protein content. A decrease in GY was observed as the concentration of $ZnSO_4$ increased, and it was found that Paiva showed higher GY than Roxo. In summary, our workflow with $ZnSO_4$ can biofortify bread wheat, despite reducing GY and TKW, but does not affect TW. Paiva cultivar demonstrated superior GY and TKW, whereas Roxo showed higher protein content.



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Sciforum-199799: Innovative Controlled-Release Fertilizers for Enhancing Nutrient Availability in Sustainable Agricultural Systems

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To improve the efficiency of nutrient use and reduce the environmental impact of conventional fertilizers, there is a need to develop sustainable fertilization techniques. The new controlled release fertilizer (CRF) presented in this work is based on the incorporation of ammonium-loaded biochar into a biodegradable polymer matrix based on starch, derived from food waste. The proposed approach integrates the principles of the circular economy by using food waste as a source for both biochar and polymer films. Thus, the starch used for the film production was extracted from starch-rich food waste, while the biochar was produced by thermal treatment of the residual biomass left after starch extraction. The starch extraction process was optimized by evaluating the influence of several parameters, namely: solvent to biomass ratio, extraction time, pH and extraction method (mechanical agitation or ultrasound-assisted extraction). Under optimal conditions, an extraction yield of 44.69% was obtained. The biochar synthesis involved the thermal treatment of the residual biomass at 300 °C, followed by the impregnation of the resulting biochar with an ammonium solution. The maximum retention efficiency of ammonium ions reached 89.6%. After the two components were synthesized, various fertilizer formulations were prepared in the form of starch films containing ammonium-loaded biochar in percentages ranging from 0 to 15%. The swelling degree, water solubility and ammonium release kinetics under different environmental conditions (pH, temperature and humidity) were investigated. The experimental results indicated that the interaction between the biochar and the polymer matrix contributed to the improvement of the nutrient release performance. In addition, the gradual degradation of the starch film can supplement the soil with organic matter. Compared to conventional mineral fertilizers, the proposed controlled-release system has the potential to reduce nutrient losses and reduce the frequency of fertilizer applications.



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Sciforum-199836: Long-Term Sustainability of Wheat Production under Diversified Crop Rotations and Manure Supply in the Mediterranean Environment

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The increasing need to harmonize agricultural productivity with environmental sustainability has renewed interest in long-term agronomic experiments as valuable approaches for assessing cropping systems under variable climatic conditions. This study investigated the long-term effects of crop rotation, manure application, mineral fertilization, and climate variability on common wheat (*Triticum aestivum* L.) grain yield in a Mediterranean environment.

Nineteen years of data from a long-term experiment conducted at the University of Bologna (North Italy) were analyzed. The experiment was arranged in a split-plot design with two replicates, comparing mineral and organic fertilization treatments within three crop rotations: continuous wheat, a 2-year wheat–corn rotation, and a diversified 9-year rotation including alfalfa. Fertilization treatments consisted of a control, three mineral nitrogen and phosphorus rates (0, 100 kg N ha^{-1} + 50 kg P_2O_5 ha^{-1}, and 200 kg N ha^{-1} + 100 kg P_2O_5 ha^{-1}), and two organic fertilization levels (0 and 20 Mg ha^{-1} of cattle manure). The influence of meteorological conditions on interannual yield variability was also evaluated.

Grain yield was significantly affected by agronomic management and weather conditions, with yields ranging from 2.89 Mg ha^{-1} in 2025 to 7.17 Mg ha^{-1} in 2012. Differences among years were largely associated with nitrogen availability resulting from fertilization strategy, crop rotation, and climatic conditions during critical crop development stages. Recursive partitioning analysis identified mineral fertilization as the main factor driving yield variation. The diversified rotation, including a legume crop in the rotation scheme, and manure application generally contributed to higher and more stable yields over time. These findings emphasize the importance of integrated nitrogen management, with a strategic role of crop diversification and organic amendments, to maintain wheat productivity under Mediterranean conditions and increasing climatic uncertainty, reducing environmental and economic risks.



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Sciforum-207539: Assessing Agroecological Functions of the Milpa Intercropped with Fruit Trees (MIAF) System in Central Mexico

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The Milpa Intercropped with Fruit Trees (MIAF) has been proposed as an agroecological strategy to improve soil conservation and enhance sustainability of maize-based agroecosystems. However, integrated approaches that simultaneously assess multiple agroecological functions remain limited. This study evaluated the contribution of a MIAF-system to three agroecological functions: Soil Fertility (SFF), Perennial Vegetation (PVF), and Soil Conservation (SCF) in San Lorenzo Tlalmimilolpan, Tlalmanalco, State of Mexico. The MIAF-system comprised three functional zones: milpa (maize+faba bean) cultivated upslope of the fruit-tree barrier (M1), milpa cultivated downslope of the barrier (M2), and the fruit-tree barrier itself (M3). M1 and M2 represented the cultivated areas associated with the barrier, M3 represented the perennial vegetation component expected to contribute to soil conservation. A conventional maize system (CMS), located immediately adjacent to the MIAF system, served as reference. Soil fertility was evaluated using soil organic matter (SOM), pH, available nitrogen (NO_3^--N and NH_4^+-N), phosphorus (PO_4^{3-}-P), and potassium (K^+). The perennial vegetation was assessed through tree height, trunk diameter, canopy area, phenological stage, and phytosanitary condition. Soil conservation was evaluated from field evidence of sediment retention, runoff reduction, and soil accumulation. These indicators were integrated into an exploratory MIAF-Agroecological Functions Assessment (MIAF-AFA) framework using normalized values. Across the MIAF-zones, SOM averaged 3.3% versus 1.5% in the CMS. Nutrient availability increased by 4 mg kg^{-1} NO_3^--N, 0.6 mg kg^{-1} NH_4^+-N, 11.3 mg kg^{-1} PO_4^{3-}-P, and 100 mg kg^{-1} K^+. The SFF averaged 0.79 in MIAF-zones, compared with 0.63 in CMS. The PVF averaged 0.59, indicating satisfactory establishment of the fruit-tree barrier. SCF was supported by evidence of sediment retention, reduced runoff, and soil accumulation behind the live barrier, whereas these processes were absent in CMS. Overall, the MIAF system, supported perennial vegetation establishment, and contributed to soil conservation compared with the CMS system. The exploratory MIAF-AFA integrates these complementary functions using field and laboratory indicators and provides a practical approach for multidimensional assessment of agroecological soil management.

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Sciforum-207689: Development and Assessment of a Soy-Based Slow-Release Granular Fertilizer for Home Lawn Use

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Residential lawns have been a prominent component of urban and suburban landscapes in the U.S. for centuries, originating from wealthy landowners' efforts to replicate the well-maintained turfgrass landscapes of European countries. Today, home lawns are managed for recreational, aesthetic, and property-value benefits while providing environmental functions, including stormwater filtration, erosion reduction, air cooling, pollutant and sediment capture, and carbon sequestration at rates ranging from 0.9 to 5.4 Mg C ha^{-1} yr^{-1}. However, lawns face criticism for their reliance on fertilizers, pesticides, and irrigation. In recent decades, sustainable management practices, including the adoption of slow-release fertilizers such as coated urea, have been implemented to reduce input requirements while maintaining a steady nitrogen (N) supply for plant nutrient demands. Despite these benefits, coated urea relies on non-degradable polymer coatings that can introduce microplastics into soils while synthetic N fertilizers may contribute to N runoff and subsequent water-quality degradation. Therefore, this research aimed to develop a sustainable, plant-based slow-release alternative for home lawn fertilization using soybean flour as the N source and a biodegradable polymer as the coating material. Using soybean flour, an abundant by-product of the U.S. soybean industry, as the N input could reduce dependence on urea derived from natural gas while creating a cyclical economy for a material that is in excess supply. In the first phase, soybean flour was formulated into soluble granular pellets suitable for application with standard fertilizer spreaders. Pellets were coated with polylactic acid, a biodegradable polymer, to promote slower nutrient release and reduce N leaching. The second phase evaluated turfgrass performance and soil health after applying this novel product at N rates of 36.6 and 48.8 kg N ha^{-1} under greenhouse conditions using perennial ryegrass and under field conditions using a mixed-seed lawn. Turf quality, NDVI, and soil health parameters were assessed. Initial observations indicated that turfgrass receiving different soy-based pellet formulations performed similarly to conventional fertilizer under field conditions and better than the non-fertilized treatment under greenhouse conditions. Overall, this study demonstrated the potential of soybean flour as a user-friendly and environmentally responsible alternative for sustainable home lawn fertilization.

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Sciforum-208330: Australian Dryland Wheat Growth and Yield Are Positively Impacted by a Methylobacterium symbioticum Biostimulant Under Reduced Nitrogen Supply

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Alternative sources of fertilizer N are increasingly important for dryland cereal production due to rising cost and reduced availability of synthetic N sources. Improving grain production per unit of fertiliser nitrogen (N) while maintaining yield is now a major priority for Australian dryland wheat systems. This study evaluated whether foliar application of *Methylobacterium symbioticum* SB23 could sustain crop productivity when fertilizer N rate in the form of urea was reduced by 25%. An experiment was conducted on a commercial grain farm at Junee Reefs, New South Wales, using Australian Prime Hard wheat cv. Rockstar arranged in a two-factor randomized complete block design with five replicates. Treatments comprised moderate or lower N rate (115 or 86.3 kg N ha^{-1}) with or without SB23 applied foliarly using a commercial sprayer at 333 g ha^{-1} at maximum tillering (Zadoks 29). Plant growth as assessed by biomass, yield and N uptake were assessed throughout the growing season. SB23 treatments increased leaf chlorophyll by 21–23% at 30 days after application (DAA). At 60 DAA, inoculated plants retained 19% more chlorophyll under reduced N, compared with 6% under the full N rate, indicating that the physiological response was strongest when N supply was constrained. Under reduced N, biomass increased by 20%, 14% and 23% at 60, 90 and 120 DAA, respectively. Across N rates, SB23 increased plant height from 72.8 to 77.6 cm, spike length from 8.96 to 9.71 cm and thousand-seed weight from 44.57 to 47.45 g. Combining SB23 with reduced N increased grain yield from 3.90 to 4.46 t ha^{-1}, a gain of 0.56 t ha^{-1} or 14.4%. Biomass N accumulation increased from 122 to 153 kg N ha^{-1}, while N utilisation efficiency rose from 34 to 37 kg grain kg^{-1} N uptake. This treatment achieved the highest partial factor productivity of N, 51.8 kg grain kg^{-1} N applied, compared with 45.4 for reduced N alone and 36.8–37.2 for the full-N treatments. Harvest index and N harvest index were unaffected, indicating that biomass and N allocation to grain were maintained. The yield response generated an estimated net benefit of A$170 ha^{-1} compared with reduced N alone. Although biological N fixation was not directly measured, the results demonstrate that SB23 improved crop growth, N accumulation, grain yield, N productivity and economic return under reduced fertiliser supply. Integrating SB23 with moderate N reduction may therefore support efficient and profitable N management in Australian dryland wheat, although validation across seasons and environments is required.

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Sciforum-208412: Mitigating salinity stress in spinach (*Spinacia oleracea* L.): The role of extended photoperiods on growth, physiology, and metabolic profiles

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This study investigated how light duration and salt concentration jointly affect the growth and metabolite accumulation of spinach (*Spinacia oleracea* L.). A controlled salinity screening was conducted in growth chambers to differentiate between control and salt-stressed spinach growth traits and metabolite profiles under different photoperiods. Such controlled environments allow for precise stress standardisation, early-stage selection, and accurate phenotyping, offering advantages over field trials where conditions are variable and harder to interpret. Spinach plants were grown under two photoperiods: a prolonged 22-hour light/2-hour dark cycle and a standard 12-hour light/12-hour dark cycle. In commercial glasshouses, extended photoperiods are used, particularly for year-round production and crop scheduling, but generally as supplemental LED (light-emitting diode) and HPS (high-pressure sodium) lighting. Four salt concentrations were tested: 0, 100, 200, and 300 mM NaCl. Although elevated salinity consistently reduced spinach growth and biomass, extended photoperiods markedly mitigated these negative effects. At the highest salinity (300 mM NaCl), plants under the extended photoperiod produced over twice the biomass and showed improved physiological metrics compared to those grown under standard conditions. LC-MS metabolite profiling (using a triple quadrupole mass spectrometer) was performed on seedlings 21 days after salt exposure (300 mM). Targeted/absolute quantification of the metabolites was obtained using standard curves (authentic standards, calibration and validation). This revealed distinct metabolic changes in roots and shoots depending on photoperiod and salinity level. Salinity stress increased lysine and glutamine in roots, while extended light enhanced allantoin and serine accumulation. In shoots, key metabolites distinguishing treatments included betaine, lysine, glutamine, citric acid, and allantoin. Most shoot metabolites, except proline and alanine (stress indicators), positively correlated with biomass. Metabolic markers such as betaine and glycine betaine were linked to osmotic adjustment, membrane stabilisation, and antioxidant defence under stress. Allantoin emerged as a potent stress marker, being involved in nitrogen recycling and stress signalling. These findings suggest that enhancing light duration is an effective strategy to stimulate growth and modulate metabolic processes for greater stress resilience in spinach under saline conditions. The research was conducted at the Plant Eco-physiology Laboratory, Arid Land Research Centre, Tottori University, Japan, with support from the JSPS KAKENHI Grant (Number 24K08858).

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Sciforum-208552: Eco-friendly Strategies to Mitigate the Impact of Microplastic Stress on Plants in Arsenic-Contaminated Soil.

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Arsenic contamination and the ubiquity of the presence of microplastics (MPs) in agricultural soils are the major threats to soil health and food safety. The combined effects of these two contaminants on contaminant mobility and uptake are poorly understood. The interactions of arsenic-microplastics with spinach growth and the suitability of sustainable biochar amendment of soils for removing arsenic from rice straw biochar (RSB) and iron-modified rice straw biochar (Fe-RSB) were examined. The experiment was set up in a pot for 45 days under controlled environmental conditions and was conducted using soil amended with arsenic compounds, RSB, and Fe-RSB with the addition of polystyrene microplastics (PSMP). Plant growth, biomass, and arsenic accumulation were evaluated, and inductively coupled plasma optical emission spectrometry was employed for quantifying the arsenic concentrations in plant tissues. Significant accumulation of arsenic in spinach shoots was observed, and the biomass of plants decreased by about 50% relative to the control when the plants were exposed to arsenic spiking. The mobility of arsenic and plant uptake were also affected by the presence of microplastics, demonstrating how multiple contaminants interact in agricultural soils. Rice straw biochar reduced the toxicity of arsenic, while Fe-RSB exhibited a better effect by reducing arsenic accumulation and improving the growth status of plants. This higher remediation efficiency has been attributed to a higher amount of sorption capacity and the prominent presence of reactive surface functional groups in Fe-RSB that act as a promoter to immobilize arsenic. Based on these results, the interaction of multiple contaminants should be taken into account when reducing the environmental risk, as well as the valorization of agricultural residues in biochar to enable sustainable methods in soil remediation. The study provides insights for improving soil health, food security, and the resilience of agricultural systems under multiple environmental stressors.

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Sciforum-208574: Development and Evaluation of a Waste-Derived Biodegradable Slow-Release Fertiliser for Improving Nitrogen Use Efficiency

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Enhancing nitrogen use efficiency (NUE) while maintaining crop productivity is a key challenge for sustainable fertility management. Conventional urea fertilisers are susceptible to nitrogen losses through leaching, volatilisation, and gaseous emissions before crop uptake, reducing fertiliser efficiency and increasing environmental impacts. Although commercial slow-release fertilisers (SRFs) improve nitrogen availability, many rely on petroleum-derived polymer coatings that may contribute to persistent microplastic contamination. This study developed a fully biodegradable SRF by incorporating urea-loaded apricot shell-derived biochar into an agar–beeswax hydrogel matrix coated with natural shellac. Nitrogen release was regulated by four coating architectures that varied exposed surface area while maintaining constant coating thickness, providing a strategy for controlled nutrient delivery.

The four architectures were characterised using Fourier-transform infrared spectroscopy (FTIR), water absorbency, nitrogen release, and durability testing. Cumulative nitrogen release after 24 h in water ranged from 10.38 to 48.69% across the four architectures. Two architectures were subsequently selected for greenhouse evaluation using ryegrass (*Lolium perenne* L.) and radish (*Raphanus sativus* L.) grown in a potting mix with no added fertiliser. Ryegrass was grown for 59 days with harvests on days 19, 39, and 59, while radish was grown for 30 days. In the radish trial, at 50% of the recommended nitrogen (N) rate, the two SRF architectures achieved mean partial factor productivities of 65.33 and 58.83, compared with 30.25 g dry biomass g^{-1} N applied for conventional urea ($P < 0.05$), while mean agronomic efficiencies were 31.83 and 25.33, compared with 13.50 g dry biomass g^{-1} N applied for urea. Crop performance was comparable to commercial SRFs (Kiwi Garden and Osmocote), supporting the potential of biodegradable SRF formulations.

These findings indicate that biodegradable SRFs can maintain crop productivity at substantially reduced nitrogen inputs while improving NUE, providing a promising alternative to polymer-coated fertilisers for sustainable fertility management.

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Sciforum-208589: Optimization of a Hydroponic Nutrient Solution and Evaluation of Foliar Silicon Dioxide Nanoparticles under Salinity Stress in *Cyamopsis tetragonoloba* L.

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Guar (*Cyamopsis tetragonoloba* L.) is a multipurpose legume adapted to arid and semi-arid regions, valued for its edible immature pods and galactomannan-rich seeds, which are the source of guar gum used widely in food and industry. Salt-affected soils are well documented in Armenia's Ararat Valley, underscoring the agronomic relevance of salinity, while comparative optimization of complete nutrient formulations for hydroponic guar remains scarce. In Experiment 1, three established hydroponic nutrient solutions were compared in an outdoor ebb-and-flow system: Knop's, a classical mineral formulation associated with early water-culture research; Steiner's, a widely used hydroponic formulation based on balanced ionic relationships; and Davtyan's, a formulation developed and extensively evaluated through long-term outdoor hydroponic research at the G.S. Davtyan Institute under Ararat Valley conditions. All three have documented use in the Institute's research program and provide contrasting nutrient regimes. Experiment 1 therefore aimed to identify the most suitable of these established formulations for guar. Davtyan's contained the highest N, P, and K concentrations, whereas Steiner's contained the highest Ca and Mg. Seed biomass with Davtyan's was 1.6 and 2.7 times that obtained with Steiner's and Knop's, respectively, and it was therefore selected for Experiment 2. Under controlled phytotron conditions, all plants received Davtyan's solution as the common nutritional background. This hydroponic system provided defined mineral nutrition and allowed NaCl stress to be imposed at known concentrations while minimizing variability associated with soil nutrient availability and salt distribution. In the NaCl treatments, NaCl was added at 51.3 mmol L^{-1} and increased to 85.6 mmol L^{-1} after one week because no visible stress symptoms developed. Based on published evidence that foliar nanosilica can mitigate salinity-induced physiological damage, amorphous silicon dioxide nanoparticles (SiO_2 NPs; 20 to 30 nm, $>$99% purity) were evaluated using four treatments: control, SiO_2 NPs, NaCl, and NaCl + SiO_2 NPs. SiO_2 NPs were applied at 500 mg L^{-1} (25 mL $plant^{-1}$) twice at one-week intervals; groups without SiO_2 NPs received equal-volume distilled-water sprays. Relative to control, NaCl reduced chlorophyll *a* and *b* by approximately 45% and 40%, respectively. Under NaCl stress, SiO_2 NPs reduced ABS/RC and DI_0/RC by approximately 35% and 52%, respectively, and increased carotenoids by approximately 43% relative to NaCl alone. Davtyan's solution was the most suitable of the three tested formulations for hydroponic guar under the tested outdoor conditions, while foliar SiO_2 NPs partially alleviated salt-induced photosynthetic impairment under controlled conditions. Because no non-nanoparticulate silicon comparator was included, nanoscale-specific effects cannot be inferred. This research was supported by the Science Committee of the Republic of Armenia (Project № 22RL-028).

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Sciforum-208624: Partial Replacement of Mineral Fertilizers with Organic Amendments Sustains Apple Tree Performance under Mediterranean Conditions

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Reducing mineral fertilizer inputs without compromising orchard productivity is a major challenge for sustainable fruit production under Mediterranean conditions. This study evaluated whether locally available organic amendments can partially replace mineral fertilizers while maintaining tree physiological performance and productivity in commercial 'Gala' apple orchards. Four fertilization strategies representing a realistic gradient of mineral N replacement were assessed in three commercial orchards over three growing seasons (2023–2025): 100% mineral fertilization (M1); 75% mineral fertilization combined with composted cattle manure and pig slurry (M2); 75% mineral fertilization combined with pig slurry (M3); and 50% mineral fertilization combined with composted cattle manure and pig slurry (M4). Treatments were designed to provide comparable total nitrogen inputs within the regional recommendation range for 'Gala' orchards (approximately 70–90 kg N ha^{-1} $year^{-1}$). Tree responses were evaluated using leaf functional traits, gas exchange, chlorophyll fluorescence, spectral vegetation indices, vegetative growth, fruit production per tree, and mean fruit weight. Mixed-model analysis showed that orchard and year effects explained a larger proportion of the variability than fertilization strategy. Nevertheless, treatment effects were detected within individual orchards. M3 maintained photosynthetic activity, vegetative growth, fruit size, and fruit production at levels statistically comparable to M1 while replacing 25% of mineral fertilization with pig slurry. In contrast, M4 occasionally reduced photosynthetic performance under specific orchard-year combinations, although without consistent reductions in productivity. The superior performance of M3 likely reflects the greater availability and synchronization of slurry-derived nutrients with crop demand. Overall, these results support site-adapted fertilization strategies in which pig slurry can partially replace mineral fertilizers without compromising apple tree physiological performance or productivity under Mediterranean commercial orchard conditions. Under regions with locally available livestock effluents, these strategies may also contribute to reducing dependence on purchased mineral fertilizers and improving long-term soil fertility.

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Sciforum-208633: Advancing Wheat Productivity and Nutrient Use Efficiency through Biochar-Based Integrated Nutrient Management

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Declining soil fertility and poor nitrogen (N) and phosphorus (P) use efficiency have emerged as major constraints to sustainable wheat production, necessitating integrated nutrient management strategies. This study evaluated the effect of integrating biochar-based fertilizers, vermicompost, and inorganic fertilizers on growth, yield, nutrient uptake, nutrient use efficiency, and profitability of wheat (*Triticum aestivum* L.). A field experiment was conducted at the Crop Research Centre, Govind Ballabh Pant University of Agriculture & Technology, Pantnagar, Uttarakhand, India, using a randomized complete block design with nine nutrient management treatments. The experimental soil was silty clay loam with near-neutral pH (7.3), medium organic carbon (0.69%), low available nitrogen (188.5 kg ha^{-1}), medium available phosphorus (23.6 kg ha^{-1}), and high available potassium (274.2 kg ha^{-1}). Treatments included nutrient omission plots, recommended dose of fertilizers (RDF; 150:60:40 kg ha^{-1} N, P_2O_5 and K_2O), RDF integrated with vermicompost (VC), enriched biochar (EB; biochar composted with poultry manure), biochar-coated urea (BCU), reduced fertilizer doses (75% RDF), and micronutrient application ($ZnSO_4$ and borax at 0.5% each). The treatment comprising **75% RDF (N through BCU) + EB @ 2 t ha^{-1} + micronutrients** consistently recorded the highest plant height, tiller density, dry matter accumulation, yield attributes, grain and straw yield, nutrient content, nutrient uptake, and nutrient use efficiency, and remained statistically at par with other integrated nutrient management treatments. The same treatment also resulted in the highest gross and net returns and benefit ratio. The findings demonstrate that integrating biochar-based fertilizers with reduced inorganic fertilizer rates and micronutrients can sustain wheat productivity while improving nutrient use efficiency and economic returns. This strategy offers a climate-smart and resource-efficient approach for sustainable wheat production and reduced dependence on chemical fertilizers.

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Author contributions: Conceptualization, Vipin Chandra Dhyani; Methodology, Vipin Chandra Dhyani; Formal analysis, Pankaj Chand; Investigation, Pankaj Chand; Data curation, Pankaj Chand; Writing - review and editing, Vipin Chandra Dhyani, Sumit Chaturvedi and Gurvinder Singh; Supervision, Vipin Chandra Dhyani;



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Sciforum-208643: Response of Low-Glycemic Wheat Varieties to Liquid Fermented Manure and Nano Urea

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Wheat quality directly influences human health, particularly in managing diabetes through its glycemic index (GI). This field experiment was conducted during the 2023–24 rabi season at the Norman E. Borlaug Crop Research Centre, G.B. Pant University of Agriculture and Technology, Pantnagar-India. Four indigenous wheat varieties namely Bansi, C 306, Khapli, and Sona Moti were taken for evaluation and kept in main factor. However, three plant nutrition treatments viz Control, Liquid fermented manure and Nano-Urea were taken as second factor. Factorial randomized block design with three replications was taken for study . Seed, grain, and leaf samples were analysed for enzymatic activity (APX, POD, SOD), non-enzymatic compounds (phenols, flavonoids, phytic acid), protein profiling, elemental composition (XRF), glycemic index (Goni method). Among the varieties, Khapli exhibited the most favorable and statistically significant results across all biochemical, elemental, and molecular parameters, along with the lowest glycemic index. Among fertilizer treatments, liquid fertilizer produced the best overall response, while nano-urea showed statistically comparable effects, indicating its viability as an efficient alternative. The study demonstrates that nano-fertilizer-based interventions can modulate at the molecular level, enhancing the nutritional quality of wheat. These findings position Khapli as a promising low-GI, health-oriented wheat variety and support nano-fertilization as a sustainable strategy for developing diabetic-friendly wheat cultivars.

Author contributions: Conceptualization, Rajeew Kumar; Validation, Namratha HN; Writing - review and editing, Priyanka Pandey ;



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Sciforum-208647: Microbial Biofertilizers Sustain Apple Tree Performance under Reduced Mineral Fertilization

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Reducing mineral fertilizer inputs while maintaining orchard productivity is an important goal for sustainable fruit production. This study evaluated whether microbial biofertilizers can support a 30% reduction in mineral fertilization without compromising the performance of commercial 'Gala' apple orchards under Mediterranean conditions. A five-year field experiment (2018–2022) evaluated three microbial biofertilizers—Mycoshell®, Kiplant iNmass® and Kiplant All-Grip®—each applied at two rates, alongside 100% and 70% conventional mineral fertilization, in a 0.092-ha experimental orchard. Treatments were established at orchard-row scale, with one row per treatment and approximately 40 trees per row; individual trees were used as subsamples rather than independent treatment replicates. The study integrated soil fertility, leaf nutrient status, vegetative growth, fruit production, fruit quality, gas exchange, chlorophyll fluorescence, spectral vegetation indices, chlorophyll content and specific leaf area to assess tree responses over time. Selected biofertilizer treatments maintained or improved agronomic performance despite the lower mineral fertilizer input. Mycoshell® and Kiplant iNmass® treatments showed recurrent positive responses in vegetative growth and fruit production across multiple growing seasons. Cumulative shoot growth reached 68.8 m in the Mycoshell® Myc4 treatment compared with 44.7 m under conventional mineral fertilization, illustrating the long-term differences in tree development. In contrast, physiological traits—including gas exchange, chlorophyll fluorescence, vegetation indices, chlorophyll content and specific leaf area—showed no consistent treatment effects, indicating that reduced mineral fertilization did not impair photosynthetic functioning or overall physiological status. Overall, the results indicate that microbial biofertilizers can contribute to maintaining apple tree performance under reduced mineral fertilizer inputs, supporting more resource-efficient and potentially more sustainable orchard management. The study received financial and product support from Asfertglobal, Lda., while the research was independently conducted by INIAV researchers.

Author contributions: Conceptualization, Miguel Leão de Sousa; Methodology, Marta Gonçalves, Margarida Rodrigues, Francisco Martinho and Miguel Leão de Sousa; Software, Susana Ferreira, Marta Gonçalves, Margarida Rodrigues, Francisco Martinho and Miguel Leão de Sousa; Validation, Marta Gonçalves, Margarida Rodrigues, Francisco Martinho and Miguel Leão de Sousa; Formal analysis, Susana Ferreira, Marta Gonçalves, Margarida Rodrigues, Francisco Martinho and Miguel Leão de Sousa; Investigation, Marta Gonçalves and Miguel Leão de Sousa; Resources, Miguel Leão de Sousa; Data curation, Susana Ferreira, Marta Gonçalves, Margarida Rodrigues and Francisco Martinho; Writing - original draft, Susana Ferreira; Writing - review and editing, Susana Ferreira, Marta Gonçalves, Margarida Rodrigues, Francisco Martinho and Miguel Leão de Sousa; Supervision, Marta Gonçalves, Margarida Rodrigues, Francisco Martinho and Miguel Leão de Sousa; Project administration, Miguel Leão de Sousa; Funding acquisition, Susana Ferreira and Miguel Leão de Sousa;

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Sciforum-208650: Effects of a biofertilizer on Lactuca sativa growth, rhizosphere bacterial community, and soil biological functioning in a microplastic-contaminated agricultural soil

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The low availability of phosphorus (P) in calcareous soils reduces fertilizer efficiency and has increased interest in biofertilizers containing microorganisms capable of solubilizing phosphate or enhancing its mobilization in the rhizosphere. This study compared three treatments in a lettuce (Lactuca sativa L.) crop: (1) conventional mineral fertilization (M), (2) inoculation with the phosphate-solubilizing bacterium (PSB) Bacillus CM07 (B), and (3) inoculation with the PSB combined with a 50% reduction in conventional mineral fertilization (M+B). All treatments were applied to an agricultural soil contaminated with low-density microplastics, specifically polyethylene and polypropylene. Crop performance was assessed alongside changes in soil physicochemical properties, microbial diversity, community structure, and functional processes involved in P cycling. At harvest, the combined application of biofertilizer and reduced mineral fertilization (M+B) maintained marketable fresh weight and foliar N contents at levels comparable to those obtained with conventional mineral fertilization (M). In contrast, biofertilization alone (B) reduced yield by approximately 29% relative to full mineral fertilization. Foliar P concentrations did not differ significantly among treatments; however, soil available P was higher under biofertilization alone (B). Enzymatic activities and overall soil biological quality, as assessed by the Geometric Mean of Enzymatic Activities (GMEA) index, were highest under biofertilization alone, with intermediate values observed under the combined biofertilization and reduced mineral fertilization treatment. The biofertilizer promoted changes in the structure of the bacterial community, favouring the abundance of genera potentially involved in nutrient mobilization and organic matter recycling, such as Nocardioides. The combined treatment therefore appears to be the most agronomically promising strategy, as it allowed a 50% reduction in mineral fertilization without compromising lettuce yield, while partially improving soil biological functioning. In contrast, biofertilization alone enhanced several soil biological indicators but did not provide sufficient nutrient supply to maintain crop productivity. This research was supported by the Spanish Plan Nacional-FEDER Project PID2024-159820OB-I00

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Sciforum-208662: Fertilizer-N supply modulates growth, yield, and N remobilization responses of dryland wheat to *Methylobacterium symbioticum* SB23

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Effective nitrogen (N) management in dryland wheat requires matching fertilizer supply with crop demand and water-limited yield potential. Insufficient N restricts growth and yield, whereas excessive N may reduce fertilizer-N productivity without increasing yield in rainfed systems. Previous research showed that foliar *Methylobacterium symbioticum* SB23 could maintain wheat productivity with 25% less fertilizer N, but its efficacy across a wider N gradient remains unclear. A dryland field experiment at Junee Reefs, New South Wales, Australia, evaluated wheat responses to four fertilizer-N rates (46, 69, 92, and 138 kg N ha^{-1}) and two SB23 levels (untreated and foliar-treated) using a factorial randomized complete block design with four replications; data were analyzed in R using two-factor analysis of variance, with replication included as the blocking term.

SB23 application increased leaf chlorophyll concentration by 8–25%, flowering biomass by 8–24%, and flowering biomass N accumulation by 2–52% across the N gradient. Plant N concentration at flowering increased by 58%, indicating improved crop N status. Grain yield and partial factor productivity of fertilizer N increased by 1–17%, with the largest responses under low-to-moderate N supply and little benefit at the highest rate. Yield gains under lower N coincided with increases of up to 31% in grains $spike^{-1}$, 20% in effective tillers, and 9% in thousand-grain weight. Grain protein declined by up to 11%, indicating dilution of grain N concentration where yield increased.

Averaged across fertilizer-N rates, SB23 significantly increased apparent vegetative N remobilization from 10.0 to 37.3 kg N ha^{-1} and remobilization efficiency from 23.6 to 52.2%. Grain N uptake, final crop N concentration, and N harvest index were unaffected. Overall, SB23 improved crop N status at flowering, fertilizer-N productivity, and apparent redistribution of vegetative N during grain filling, with the clearest productivity benefits under low-to-moderate fertilizer-N supply.

Author contributions: Conceptualization, Oli Ahmed Fakir, K M Shamsul Haque and Leslie Ann Weston; Methodology, Oli Ahmed Fakir; Software, Oli Ahmed Fakir; Validation, Oli Ahmed Fakir; Formal analysis, Oli Ahmed Fakir; Investigation, Oli Ahmed Fakir and K M Shamsul Haque; Data curation, Oli Ahmed Fakir; Writing - original draft, Oli Ahmed Fakir; Writing - review and editing, Oli Ahmed Fakir, K M Shamsul Haque, Leigh M. Schmidtke and Leslie Ann Weston; Visualization, Oli Ahmed Fakir; Supervision, K M Shamsul Haque, Russell A. Barrow, Joanne R. Ashnest, Leigh M. Schmidtke and Leslie Ann Weston; Project administration, K M Shamsul Haque; Funding acquisition, K M Shamsul Haque and Leslie Ann Weston;



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Sciforum-208683: Beyond NPK: Combined Application of FYM and Lime for Yield Enhancement and Soil Health Improvement

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Acid soils are widely distributed globally and constitute an important constraint to crop productivity because of low soil pH, nutrient imbalances and associated limitations to nutrient availability. About 34% of the cropped area in India, is affected by acid soils, causing 13.7% reduction in crop yield. Liming is an established practice for ameliorating soil acidity and is generally recommended to achieve a desired target pH. However, under field conditions, the effectiveness of liming may vary with its method of application and integration with organic and inorganic nutrient sources. Therefore, to evaluate the influence of fertilizers (Nitrogen (N), phosphorus (P) and potassium (K)), farmyard manure (FYM) and lime application methods on maize productivity and soil chemical properties, representative soil samples were collected from a field experiment established during *kharif* 2019 at the Research Farm of Department of Soil Science, CSK HPKV Palampur. The soil of the study area was silt loam in texture and acidic in pH (5.49). The experiment consisted of ten treatments replicated thrice in 12 m^2 plots using a randomized block design. Treatments details were as follows: T_1: control, T_2: 100% NPK (recommended dose of fertilizers (RDF), T_3: 100% NPK + 5 t FYM ha^{-1}, T_4: 100% NPK + 10 t FYM ha^{-1}, T_5: 100% NPK + lime incorporation @ 100% LR, T_6: 100% NPK + lime incorporation @ 1/10th LR in furrow, T_7: 100% NPK + 5 t FYM ha^{-1} + lime incorporation @ 100% LR, T_8: 100% NPK + 10 t FYM ha^{-1} + lime incorporation @ 100% LR, T_9: 100% NPK + 5 t FYM ha^{-1} + lime incorporation @ 1/10th LR in furrow and T_{10}: 100% NPK + 10 t FYM ha^{-1} + lime incorporation @ 1/10th LR in furrow. Yield of maize was recorded at harvest during *kharif* 2023 and 2024 and the surface (0-0.15 m) and sub-surface (0.15-0.30 m) soil samples were collected after harvesting. Results revealed that the highest grain yield of maize (6236 and 6166 kg ha^{-1} in 2023 and 2024, respectively) was recorded under treatments T_8 which was not significantly different from T_{10}. Combined application of NPK, FYM and lime raised the soil pH to near neutral, enhanced OC, CEC and macro nutrients availability. These findings indicated that integrating lime with inorganic and organic nutrient sources can effectively improve soil chemical properties and sustain maize productivity in acidic soils. Further, the comparable performance of in-furrow lime dose also suggested its potential to reduce lime requirements under field conditions.

Author contributions: Data curation, Sagun Mahajan;



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Sciforum-208688: Valorising Indigenous Irish Feedstock using the Framework of GROUND UP: Growth-media Reengineering using Organic Upcycled Nutrient Diversification for Upstream Production

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The GROUND UP framework is a regionally focused, engineered implementation pathway that converts Ireland's under-utilised biomass streams into diversified peat-alternative growing media. Built around five interlinked workstreams (supply inventory; pre-conditioning ; physico-chemical characterisation; cascade processing and compost stabilisation; techno-economic analysis), GROUND UP applies bioeconomy approaches in the field of Irish horticulture. Evidence informing the framework was mapped using a PRISMA-aligned screening (Web of Science and Scopus, Jan 2013–May 2026) as a concise methodological input; those findings were integrated with process engineering, composting practice, and economic modelling to define practical levers for industry uptake. Synthesis highlights five priority themes that underpin the framework: (1) phytosanitary efficacy is achievable when beneficial catalyst and biocontrols are matched to carrier matrices and substrate maturity but remains highly feedstock dependent and requires routine germination tests, seedling bioassays and agronomic performance monitoring; (2) thermochemical conditioning routes such as biochar, hydrochar, torrefaction and chemical modification produce feedstock specific agronomic trade-offs and generally require post treatment (washing and co-composting) to limit phytotoxicity and stabilise plant-available nutrients; (3) nutrient dense residues can supply crop relevant NPK when incorporated via rigorous conditioning and multi-component mixture design that mitigates immobilisation and leachate risk; (4) irrigation and fertigation protocols must be reengineered for peat-reduced matrices using matric potential testing and crop targeted nutrient availability test to avoid desiccation or waterlogging and to synchronise NPK delivery with crop demand; and (5) scaling to commercial horticulture demands harmonised biomass property characterisation (particle distribution, pH, EC, bulk density, moisture-release curves), and transparent TEA reporting to demonstrate feasibility. Overall, GROUND UP consolidates these priorities into a hierarchical decision framework to guide soilless "ponics" agriculture and nursery industry in Ireland, prioritising standardisation, phytosanitary quality control, and demonstrable agronomic and bioeconomic outcomes.

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Sciforum-208697: Olive Harvest Timing Affects Fruit Oil Accumulation and Carbohydrate Reserves in Trees

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In 2024, a field experiment was conducted in central Italy in an 8-year-old olive orchard of 'Moraiolo' trees trained to the vase system to evaluate the effects of harvest timing on olive oil accumulation and carbohydrate reserves. Harvesting was performed on two dates, 22 October and 4 December, using two highly uniform groups of trees (five trees per treatment for agronomic assessments). Before treatments, the groups did not differ in fruit weight, oil content, or carbohydrate reserves. Olives harvested in December showed no significant change in fruit weight compared with those harvested in October. However, oil content increased significantly ($P \leq 0.05$), reaching approximately 16% of fresh weight. Fruit yield did not differ significantly between harvest dates, averaging approximately 21 kg tree^{-1}. Carbohydrate reserves were assessed in two-year-old branches by separately analysing bark and wood tissues (three trees per treatment). The compounds quantified were mannitol, galactose, glucose, sucrose, fructose, raffinose, stachyose, and starch. At the first sampling date, concentrations of all carbohydrates were similar between groups. By the second sampling date, carbohydrate concentrations differed markedly according to harvest timing. Trees harvested in October accumulated greater carbohydrate reserves than those harvested in December. Total carbohydrate content differed significantly ($P \leq 0.05$), reaching about 114 versus 79 mg g^{-1} dry weight (DW) in the bark and 70 versus 53 mg g^{-1} DW in the wood of October- and December-harvested trees, respectively. Significant differences ($P \leq 0.05$) were also observed in soluble sugars and starch. Overall, harvest timing significantly affected both oil accumulation in the fruit and carbohydrate storage in the trees. The agronomic implications were examined in light of the relevant literature, focusing on trade-offs among oil quality, quantity, and economic value; challenges of early versus late harvesting; and potential consequences for tree physiology and subsequent performance.



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Sciforum-209646: Soil Biological Indicators and Rhizosphere CO_2 Emission Dynamics Under Different Fertilization Regimes in a Field Experiment with Squash (Cucurbita moschata)

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Repeated fertilizer inputs in intensive vegetable production reshape soil microbial functioning and soil-to-atmosphere carbon flux, yet the comparative effects of organic, mineral and organo-mineral regimes remain insufficiently resolved. This study evaluated soil biological indicators as early diagnostics of fertilization impact in squash (Cucurbita moschata, Matilda F1). A randomized block experiment was established on a Mollic Fluvisol at ISSAPP “N. Poushkarov”, Tsalapitsa, Bulgaria, comprising four treatments — unfertilized control, organic NPK, mineral, and combined (50% organic + 50% mineral) — in four replicates of 30 m2. CO2 emissions were measured in situ in rhizosphere and bulk soil at four phenological stages (EGM-5 analyzer). Laboratory analyses at the Agricultural University – Plovdiv covered basal and substrate-induced respiration (SIR), the metabolic quotient, dehydrogenase, phosphatase and β-glucosidase activities, community-level physiological profiles (Biolog EcoPlate), pH and electrical conductivity, determined at vine formation and fruit development. Soil pH shifted from slightly acidic toward neutral in all treatments, while electrical conductivity increased without reaching salinity thresholds, peaking under organic input. CO2 emissions were consistently higher in the rhizosphere than in bulk soil, significantly so under organic fertilization at flowering and under the combined regime at flower initiation, indicating active root–microbe interaction rather than elevated basal mineralization. Microbial activity assessed through basal respiration and SIR was most stable under organic and combined fertilization, whereas SIR in the control declined by about 25% toward fruit development; consistently low metabolic quotients confirmed efficiently functioning communities. Phosphatase activity increased by 78–92% between phases, and β-glucosidase by 73% and 76% under organic and combined fertilization respectively, compared with about 70% in control and mineral treatments, while dehydrogenase activity was highest under organic input. Shannon and Pielou indices remained stable, indicating functional resilience to the fertilization regime. Organic and organo-mineral fertilization sustained higher and more stable soil biological activity than mineral fertilization alone.This work was supported by the Bulgarian National Science Fund, project KP-06-N76/9.

Author contributions: Investigation, Teodora Velikova Tomova;



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Sciforum-209845: Soil Eukaryome of Sweet Maize in Response to Organic and Mineral Fertiliser Application

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This study evaluates the influence of various agroecological practices on the diversity, structure, and functional potential of soil microbial communities in the sweet corn rhizosphere. We compared five treatments: control, mineral fertilisation, organic fertilisation, combined mineral and organic fertilisation, and the application of a consortium of beneficial microorganisms (SynComs). Utilising high-throughput sequencing of the ITS2 region, we assessed microbial communities of the eukaryome through α- and β-diversity analysis, taxonomic profiling, functional characterisation, and multivariate statistical methods. The results indicated that species richness and diversity were highest in the SynComs treatment, while the lowest was found in those with organic fertilisation applied alone, and stronger dominance by individual taxa was observed. The results were confirmed by all α-diversity indicators. β-diversity analysis revealed a clear distinction among variants, with the most significant alterations in microbiome structure observed following the introduction of beneficial microorganisms. Taxonomic analysis established the dominance of Ascomycota in all treatments. At the genus level, *Fusarium* dominated across the treatments, while in the presence of SynComs, the rest of the genus was divided more uniformly among *Alternaria, Humicola, Aspergillus, Didimella, Verticillium, etc.* Functional profiling indicated a predominance of chemoheterotrophic activities and organic matter decomposition, emphasising the critical role of microorganisms in sustaining soil fertility. In addition, 143 common species were observed among treatments, while the highest number of unique species was found in the SynComs-amended treatment (414) and lower in the organic one (236). The analyses of the main coordinates (PCoA) revealed the unique characteristics of the applied consortium of beneficial microorganisms. Overall, these findings demonstrate that diverse agroecological practices significantly affect soil eukaryome composition and function: organic and combined fertilisation strategies stimulate specific microbial groups and functional processes, whereas the application of microbial preparations induces more selective community shifts.

Author contributions: Conceptualization, Stefan Shilev; Methodology, Stefan Shilev and Mariana Krasimirova Petkova; Validation, Mariana Krasimirova Petkova; Formal analysis, Mariana Krasimirova Petkova and Teodora Tomova; Investigation, Teodora Tomova; Data curation, Teodora Tomova; Writing - original draft, Stefan Shilev and Mariana Krasimirova Petkova; Supervision, Stefan Shilev; Funding acquisition, Stefan Shilev;



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Sciforum-209959: Nano DAP in Combination with Conventional Fertilizers for Sustainable Wheat Production in Acid *Alfisols*

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Wheat supplies 20% of global dietary calories and protein, with India contributing 15% of global production. In hill regions, acidic, erosion-prone soils and low N and P availability due to substantial N losses (60–70%) and P fixation (15–20% available) limit crop productivity. These limitations necessitate efficient fertilizers that improve nutrient availability while reducing losses and input costs. Therefore, a study was conducted to evaluate foliar-applied Nano-DAP (IFFCO Pvt. Ltd., India) on wheat yield (HPW-368), nutrient uptake and soil N fractions in acidic silt loam *Alfisols* of the western Himalayas at CSK HPKV, India (32°6′ N, 76°33′ E). Nano-DAP contains 8% N and 16% P_2O_5 (w/v) as nano sized clusters (20-50 nm) functionalized with biopolymers and other excipients and was applied @ 4 ml L^{-1} as one spray (60 days after sowing (DAS)), two sprays (45 and 90 DAS), or three sprays (45, 75 and 105 DAS). The experiment comprised 8 treatments in randomised block design *i.e.* T_1 (Control), T_2: $N_{100}P_{100}K_{100}$, T_3: $N_{75}P_{75}K_{100}$ + one spray of Nano-DAP, T_4: $N_{50}P_{50}K_{100}$ + one spray of Nano-DAP, T_5: $N_{75}P_{75}K_{100}$ + two sprays of Nano-DAP, T_6: $N_{50}P_{50}K_{100}$ + two sprays of Nano-DAP, T_7: $N_{75}P_{75}K_{100}$ + three sprays of Nano-DAP and T_8: $N_{50}P_{50}K_{100}$ + three sprays of Nano-DAP, each replicated three times. Treatment notation for N, P, K indicates the percentage of their respective recommended fertilizer doses. Wheat was sown on 15 November 2023 and 16 November 2024 and data was recorded at harvest during *rabi* season 2023-24 and 2024-25 and the surface (0-0.15 m) soil samples were collected after harvesting. Treatment means were compared using LSD at the 5% significance level. Results revealed that the highest grain yield was recorded under treatment T_2 *i.e.* 3267 and 3157 kg ha^{-1} in 2023-24 and 2024-25, respectively and was not significantly different from T_7. Also, the maximum N, P, K uptake by wheat was recorded under T_2 and was not significantly different from T_7. The inorganic fractions of N *viz*, NH_4-N and NO_3-N and organic fractions *viz*, HNH_4-N, HA-N, ST-N, AA-N, TH-N, UN-N and NH-N were recorded to be highest in treatment T_2, followed by T_3. This concluded that integrating three foliar sprays of Nano-DAP with 75% recommended NP maintained wheat yield and nutrient uptake comparable to 100% NP, indicating potential to reduce conventional NP fertilizer use by 25% in acid *Alfisols* for wheat cultivation.

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Session 4. Biostimulants and Biocontrols for Use in Sustainable Systems

Sciforum-168268: Synergistic Effects of *Pseudomonas* and *Bacillus* Inoculants on Plant Productivity, Soil Bacterial Succession, and Functional Metabolic Pathways

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Chemical fertilizers are globally deployed to mitigate declining agricultural productivity; however, their intensive use often leads to diminished soil quality and biodiversity loss. This study evaluated the potential of co-inoculating *Pseudomonas* sp. and *Bacillus* sp.—strains capable of producing indole-3-acetic acid (IAA) and ammonia—to promote the growth of *Brassica chinensis* under field conditions. We further investigated the impact of these strains on the soil bacterial community structure and functional potential using metagenomic and metabolic pathway analyses. Statistical significance was determined via Analysis of Variance (ANOVA) followed by Duncan's Multiple Range Test ($p < 0.05$). Our results demonstrate that co-inoculation significantly ($p < 0.05$) enhanced plant productivity, yielding a dry weight of 290.66 ± 6.99 kg/plot compared to 179.39 ± 7.65 kg/plot in the uninoculated control. The treatment also significantly ($p < 0.05$) increased essential macro- and micronutrients, including total N (3.24 ± 0.05%), P (0.95 ± 0.03%), K (4.79 ± 0.03%), Ca (3.36 ± 0.02%), Mg (0.39 ± 0.00%), and Na (2.81 ± 0.02%), whereas control values were markedly lower across all parameters. Illumina sequencing revealed that inoculant establishment restructured the soil bacterial community, causing a localized reduction in alpha-diversity and richness. This decline represents a targeted niche colonization by beneficial taxa, evidenced by significant increases in the relative abundance of *Gammaproteobacteria* and *Bacilli*. Functional prediction via PICRUSt2 indicated an enrichment of genes associated with chemotaxis proteins, acyl-carrier proteins, and nitrate reductase. Furthermore, metabolic pathways related to glucose and acetylene degradation were significantly more prevalent in co-inoculated soils. These findings suggest that the observed diversity shift is a functional restructuring toward growth-promoting taxa rather than an undesirable loss of ecosystem stability. This research provides critical insights into the synergy between introduced bacteria and indigenous microbiota, offering a sustainable strategy for agroecosystem management.



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Sciforum-183188: Differential effects of microbial consortia and single arbuscular mycorrhizal inoculation on durum wheat performance and root microbiome across Mediterranean environments

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The transition toward sustainable agriculture requires strategies that improve nutrient use efficiency while reducing external inputs. This study evaluated two seed-applied microbial inoculants in durum wheat under Mediterranean conditions in Sardinia, Italy: a microbial consortium composed of arbuscular mycorrhizal fungi (AMF), *Trichoderma harzianum*, and bacterial strains (MIX), and a single-isolate AMF inoculum of *Rhizophagus irregularis* DAOM197198. Field trials were conducted across three sites with contrasting soil and environmental conditions, using modern and old genotypes. Inoculated treatments were compared with non-inoculated controls under low-input fertilization. Grain yield, nutrient uptake, grain and semolina quality, AMF root colonization, bacterial biomass, and root-associated microbial diversity were assessed.

Microbial inoculation produced site- and genotype-specific responses, with the clearest yield effects at Villanovafranca and Pabillonis. At Villanovafranca, *R. irregularis* outperformed MIX, increasing grain yield by 54% (+8.3 q ha^{-1}) in Nuraghe compared with control and MIX, and by 48% (+4.2 q ha^{-1}) in Russello compared with MIX. At Pabillonis, both inocula increased yield by 97% (+2.2 q ha^{-1}) compared with the control. At Cabras, yield responses were weaker and genotype-dependent, although inoculation affected grain nutrient accumulation. Nutrient uptake also varied by inoculant, site, and genotype. At Villanovafranca, both inocula increased grain P by 67% in Nuraghe, while no P response occurred in Russello. At Pabillonis, only *R. irregularis* increased grain P, by 155% over the control in both genotypes. Grain N was also enhanced by *R. irregularis*, increasing by 41% at Villanovafranca and 91% at Pabillonis.

Responses were not explained solely by AMF colonization: both inocula increased colonization by about 24% at Villanovafranca, whereas *R. irregularis* reduced bacterial biomass in Nuraghe. Root-associated microbial profiling showed site-, genotype-, and formulation-dependent shifts in bacterial and fungal communities. Overall, inoculant effectiveness depended on microbial formulation, genotype, and local soil conditions, supporting tailored microbial strategies for Mediterranean wheat systems.



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Sciforum-187543: Improving the use of biological pesticides and natural biostimulants to protect winter rapeseed in organic farming system

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Introduction

Rapeseed cultivation in organic farming is difficult. The aim was to evaluate the effectiveness of integrated protection strategies.

Method

Two winter rapeseed cultivars, Graf and Harry, were grown in 2024–2025 using microbiologically treated and untreated seeds. Crops were sown at 12.5 cm row spacing or in a strip-sowing system. Organic fertilisers and biostimulants were applied during the growing season, together with biological treatments based on *Bacillus subtilis*, *Beauveria bassiana*, spinosad and liquid silicon. Plant health, SPAD index, leaf nitrogen content and yield were assessed. Data were analysed by two-way ANOVA, with Tukey's test at $p \leq 0.05$.

Results

No significant pest pressure was observed. Plant health was higher with treated seeds, reaching 6.67a for Harry and 5.90a for Graf, compared with 5.53b and 5.33b for untreated seeds, respectively. SPAD index and leaf nitrogen content did not differ significantly between cultivars or sowing systems. In 2024, the highest yields were obtained at 12.5 cm spacing with treated seeds: 2.93a t ha^{-1} for Graf and 2.53a t ha^{-1} for Harry. Strip sowing resulted in lower yields. In 2025, yields increased to 3.02a t ha^{-1} for Graf and 3.10a t ha^{-1} for Harry. Overall, both cultivars yielded better at 12.5 cm spacing and with treated seeds.



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Sciforum-189672: Ericoid mycorrhizal fungi modulating rhizosphere, root architecture, and plant growth to mitigate the adversity of high-temperature stress on *Rhododendron moulmainense*

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Background

High-temperature (HT) stress is a major factor limiting plant growth, particularly in arid and semi-arid ecosystems. Ericoid Mycorrhizal Fungi (EMF) modulate rhizosphere and plant growth performance. How *Rhododendron moulmainense*-EMF interaction regulates high-temperature stress remains poorly understood.

Results

This study investigates the EMF-mediated resilience of Rhododendron moulmainense by examining the crosstalk between the rhizosphere microbiome, root architecture, nutrient acquisition, and plant physiological functions under heat stress (HS) at 40°C. EMF (*Oidiodendron maius*) HT-HJ144 induced significant shifts in both bacterial and fungal communities compared to HT alone, such as promoting the abundance of Actinomycetota by 34%, *Pseudomonadota 2%*, *Ascomycota 35%,* and *Basidiomycota 32%,* as well as restoring the HT-induced *Planctomycetota by 34% and Chloroflexota by 18%*. Inoculation with the HJ144 strain demonstrated the highest colonization efficiency and resulted in thicker cortical layers, denser vascular tissues, and enhanced root morphology compared to the control, indicating improved nutrient transport and mechanical stability. Inoculation with EMF HJ144 increased soil enzymatic activities of urease by 29%, β-Glucosidase 27%, catalase 19%, and phosphatase 21%, photosynthetic enzymes including Rubisco by 26%, CS 42%, SS 29%, and SPS 39%, and antioxidant defenses, such as SOD, POD, and CAT by 26%, 21%, and 41%, respectively, compared to HT alone, mitigating oxidative stress and enhancing plant metabolic functions. Structural Equation Modeling (SEM) and Random Forest analysis identified soil properties and mycorrhizal fungi as key determinants of plant stress responses by regulating nutrient cycling and improving photosynthetic efficiency. Mantel's test revealed significant correlations between microbial communities and soil variables such as soil moisture and root development, further demonstrating the role of mycorrhizal fungi in modulating the rhizosphere microbiome.

Conclusions

These findings underscore the potential of EMF as a sustainable strategy to enhance plant stress tolerance, improve soil health, and promote beneficial plant-microbe interactions, offering a promising approach for mitigating the adverse effects of high-temperature stress on plants.



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Sciforum-191037: Integrated physiological, biochemical and metabolomics elucidate stage and treatment-specific response in tomato under waterlogging, salt, and combined stress conditions during the flower and fruit initiation

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Salinity and waterlogging frequently co-occur in agricultural systems, particularly in Mediterranean and semi-arid regions, and their combined impacts are expected to intensify under climate change. However, their integrated effects across reproductive developmental stages particularly in horticultural crops remain poorly understood. To our knowledge, few studies have investigated the integrated physiological, biochemical, photosynthetic, and metabolomic responses of determinate cherry tomato (Solanum lycopersicum L. cv. Ciliegino a Terra). The plants were exposed to salinity, waterlogging, and combined stress during early flowering and early fruiting stages under 36 h stress exposure in controlled environmental conditions over a one-month experimental period. Combined stress caused synergistic suppression of shoot growth at both stages, while oxidative stress responses varied with development. Lipid peroxidation showed antagonistic effects under combined stress at early flowering but synergistic increases at early fruiting. Similarly, combined stress induced coordinated upregulation of CAT, SOD, and APX activities at final harvest in early flowering, whereas no significant antioxidant enzyme response was observed at early fruiting. Importantly, untargeted metabolomics revealed strong stage- and treatment-dependent metabolic reprogramming. Combined stress produced the highest number of unique metabolites at early flowering but shared most metabolites with waterlogging at early fruiting. AMOPLS-DA further confirmed developmental stage as the dominant factor driving metabolic variation (RSS = 43.80%, $p < 0.01$). Despite maintaining the highest SPAD values, salinity completely inhibited fruit production, associated with phenylpropanoid suppression and the absence of proline derivatives at early flowering. In contrast, waterlogging and combined stress promoted flower abortion, likely through ethylene-mediated abscission. Overall, metabolomic profiling more effectively captured stage and treatment-specific responses than photosynthetic or biochemical markers, highlighting its implementation for predicting yield-related stress outcomes across different phenological stages.



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Sciforum-192614: A-NBRS: The Programmable Plant Revolution

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Global agriculture confronts a dual crisis: nitrogen leaching wastes approximately 70% of applied fertilizer, while viral pathogens cause up to 40% annual yield losses, disproportionately affecting smallholder farmers across South Asia. This research introduces A-NBRS, a swarm of invisible robotic helpers built from biodegradable jute-chitosan and powered by tiny ZnO energy harvesters. These swarms enter plants through breathing pores, fueling themselves via internal water flow of the Xylem. Acting as a "digital immune system," they use molecular "search and delete" tools to neutralize viruses before symptoms appear. Existing interventions chemical fertilizers and broad-spectrum pesticides fail to address either problem at the cellular level, resulting in systemic inefficiency and compounding environmental degradation. This study proposes A-NBRS (Autonomous Nano-Bot Robotic Swarm System), a biodegradable nano-robotic platform designed for simultaneous precision nutrient delivery and in-planta viral suppression in staple crops. The system comprises jute-chitosan bionanocomposite nano-carriers (100–500 nm) incorporating CRISPR-dCas9 molecular payloads and zinc oxide piezoelectric nanogenerators. Entry into the plant vascular system is achieved through electrostatic docking at stomatal apertures (+42.8 mV cationic surface charge), powered entirely by harvested transpiration pressure (1–2 MPa; 2.1 $\mu W/cm^2$). Swarm intelligence algorithms enable autonomous navigation toward viral RNA signatures and nutrient-deficient cell targets, eliminating dependency on external power or human intervention. Drawing on peer-reviewed literature, the proposed system projects a nutrient use efficiency of 85.4% compared to 32.5% under conventional urea application, alongside 92% viral RNA suppression and a 28% total crop yield increase. Full post-function biodegradation eliminates chemical residue accumulation and environmental leaching. Projected deployment cost is approximately USD 7 per hectare (Tk 750/ha), enabling full return on investment within a single four-month harvest cycle. A-NBRS represents an integrated convergence of nano-biotechnology, molecular biocontrol, and precision agriculture. It offers a scalable, zero-waste crop protection and nutrition framework specifically designed for the 16.5 million smallholder farmers of Bangladesh and the broader South Asian agricultural context.



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Sciforum-193199: Actinobacteria: biofungicides and biorremediators of agricultural soils

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Forty percent of global agricultural production is lost due to phytosanitary problems. Conventional control relies heavily on synthetic agrochemicals, which degrade soil health and promote resistant phytopathogens. Additionally, microplastic (MP) pollution of agricultural soil negatively impacts its quality. Beneficial microorganisms, including plant growth-promoting rhizobacteria (PGPR) with antifungal activity, can manage disease and MPs effects.This study evaluate and characterize actinobacterial strains (SS322 and C3A19) with fungicidal activity against the well-known pathogens *Sclerotium rolfsii* and *Sclerotinia* spp. Direct confrontation assays showed complete inhibition (100%). Diffusible compounds were extracted for GC–MS analysis and relevated 72 compounds; a total of 37 for strain SS322 and 35 for strain C3A19. Antifungal-associated metabolites (e.g., diketopiperazine, quinoline and phenolic derivatives) retained their activity after exposure at 120°C at effective concentrations of 25-100% of extracted metabolite mixed with agar. Metabolites associated with PGPR were assessed by qualitative assays with three replicates and a positive control confirmed that both strains were positive for nitrogen fixation (100%), phosphorus solubilization (100%), and polyamine synthesis (100%). Furthermore, to evaluate the role of Actinobacteria in MPs potential degradation, microbial communities and MPs were analyzed from agricultural soils irrigated with wastewater, with well-water-irrigated soil as a control. A total of 1,524 MPs particles were recovered from 50 g of soil and Fourier Transform Infrared Spectroscopy (FT-IR) analysis confirmed the presence of MPs, mainly polyethylene (PE:35%) and polystyrene (PS:15%), in the wastewater-irrigated soils. PacBio long DNA reads showed high abundance (25-35%) of actinomycetes (e.g., *Nocardioides, Streptomyces, Rubrobacter*), suggesting a possible interaction between these microorganisms and potential MPs degradation in agricultural soils. The evaluated actinobacterial strains and field-isolated actinobacteria exhibited high potential as biological control agents and promise for the degradation of MPs.



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Sciforum-195158: Formulation Optimization and Immune Priming Effects of *Trichoderma virens* for Sustainable Oil Palm Basal Stem Rot Management

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Basal stem rot (BSR) caused by *Ganoderma boninense* poses a severe threat to oil palm plantations, necessitating sustainable biocontrol strategies. This study developed and optimized a wettable powder (WP) formulation of *Trichoderma virens* K1-02, a potent antagonist, using Plackett-Burman design (PBD) screening followed by response surface methodology-central composite design (RSM-CCD). The optimal formulation comprised 89.36 g tapioca starch, 126.66 g kaolin, 15.15 mL 3% mannitol, and 1.87 mL Tween 80 per batch, with the most significant factors influencing water dispersibility, suspensibility, and conidial viability. The formulation exhibited appropriate physicochemical properties (pH 5.3, $<$ 75 µm, $<$ 5% moisture) and consistent antagonistic activity against *G. boninense in vitro*. Four-week-old oil palm seedlings were treated with fresh *T. virens* spores (10^8 spores/mL) or WP at 100%, 50%, or 25% concentrations, with untreated controls. Root crude extracts were assayed for pathogenesis-related proteins beta-1,3-glucanase and chitinase, and defense enzymes phenylalanine ammonia lyase (PAL), polyphenol oxidase (PPO), and peroxidase (POD) at days 3, 7, and 15 post-application. Results revealed dose-dependent immune responses with critical differences at maximum concentration. WP-100% induced peak early chitinase (0.18 U/mL, day 3) and β-glucanase (0.04 U/mL, day 3), but exhibited unexpected suppression at day 15: PAL levels declined below baseline (58.30 U/mL), while POD plateaued (183.91 U/mL). This inhibition at the highest dose suggests potential immune tolerance or negative feedback regulation. In contrast, WP-50% maintained balanced responses with sustained PAL (121.70 U/mL, day 3) and peak POD (188.44 U/mL, day 15). WP-25% promoted priming with secondary chitinase activity (0.14 U/mL, day 15). Fresh spores showed transient responses collapsing by day 7. Polynomial trends predicted optimal re-application intervals: 18–21 days (WP-25/50), 14 days (WP-100), 7-10 days (fresh spores). These findings suggest that moderate formulation concentrations, rather than maximum doses, provide superior and sustained immune priming for BSR management.



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Sciforum-195649: From biodiversity to bioproducts: exploring nature's microbial and chemical resources for sustainable agricultural innovation

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The transition toward sustainable agricultural systems requires innovative approaches capable of enhancing crop productivity while reducing dependence on synthetic agrochemicals. Among the most promising strategies is the exploitation of beneficial microorganisms and their secondary metabolites (SMs), which play fundamental roles in plant health, soil fertility, and ecosystem performance.

Beneficial microorganisms promote plant growth and productivity through multiple mechanisms, including improved nutrient acquisition, enhanced root development, and activation of plant defense responses. In addition, they contribute to the suppression of plant pathogens through competition for nutrients and spaces, mycoparasitism, and the production of antibiotics.

Secondary metabolites produced by beneficial microorganisms represent a diverse group of biologically active molecules that mediate plant/microbe/pathogens interactions. Recent advances in metabolomics have expanded our understanding of the complex biochemical networks underlying these interactions, revealing numerous microbial metabolites capable of modulating plant metabolism, stimulating vegetative growth, and enhancing natural defense mechanisms. Several of these compounds exhibit direct antagonistic effects against phytopathogens while simultaneously promoting root and shoot development.

Recent research is moving beyond the application of single microbial strains toward the development of multifunctional formulations that combine selected microbial consortia, secondary metabolites, and co-formulants derived from natural sources. Plant-derived compounds are increasingly being incorporated into these formulations to enhance microbial establishment, improve product stability and efficacy, and provide complementary biostimulant and protective effects.

The growing knowledge of microbial secondary metabolites and their interactions with plants is fostering the development of next generation bioproducts designed according to agroecological principles (bio-inspired). The integration of microbial consortia, bioactive metabolites, and natural co-formulants into crop management strategies offers a sustainable pathway to improve crop performance, reduce chemical inputs, support soil health, and enhance agroecosystem functionality. Consequently, these biological solutions represent key tools for advancing agroecological intensification and promoting environmentally sound agricultural production systems.



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Sciforum-197806: Reducing Synthetic and Irrigation Inputs in Zoysiagrass Lawns through Microbial Nitrogen Fixation

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Zoysiagrass is a popular choice for warm-season turfgrass lawns but often requires supplemental fertilization and irrigation to maintain high quality turf. Nitrogen-fixing bacteria, such as *Azospirillum Brasilense* (Azb), may provide nitrogen (N) and improve nutrient uptake and rooting, potentially reducing fertilizer and irrigation needs. A field experiment was conducted at the University of Florida (Gainesville, FL, USA) from summer 2024 through spring 2026 on 'CitraZoy' zoysiagrass established on a sand-based rootzone. Treatments consisted of three commercial Azb-based products (Tazo-B® Liquid, Azopro® Turf, and AzoRoot®) and a non-inoculated control. Products were applied monthly in combination with three N rates (48.8, 24.4, and 0 kg N ha^{-1}). Treatment combinations were applied within two irrigation levels (5.4 and 4.05 cm of water weekly). The experimental design was a strip-plot, with irrigation as the main plot factor and treatments and N rates arranged factorially within a randomized complete block as the subplot factor. Every two weeks data collection included normalized difference vegetation index, visual quality, soil moisture, green cover determined via digital image analysis. Before and after each growing season, soil physical, chemical, and biological properties were assessed. Data were analyzed using analysis of variance, and treatment means were separated using Fisher's Protected Least Significant Difference test at $p \leq 0.05$. Results indicated that Azb-based biostimulants mitigated the effects of reduced irrigation by maintaining greater soil moisture and turf performance compared with non-inoculated treatments. Applications of Tazo-B® Liquid and AzoRoot® combined with 24.4 kg N ha^{-1} produced turf quality comparable to treatments receiving the full N rate. Furthermore, Tazo-B® Liquid applied with the full N rate under reduced irrigation maintained green cover similar to fully irrigated treatments. These findings demonstrate that Azb-based biostimulants can improve resource use efficiency and support more sustainable zoysiagrass management through reduced fertilizer and irrigation inputs while maintaining turf quality.



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Sciforum-197992: “Ecosystem service provided by sown wildflower strips”

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Introduction

Conventional cropping systems have substantially reduced agroecosystem biodiversity. Within this context, one of the major concerns is the decline of pollinator populations, One agronomic strategy to mitigate this issue is the establishment of strips of insect-pollinated plant species, providing pollen and nectar resources that support the survival and persistence of beneficial insect communities. The aim of this study was to identify a seed mixture composed of ten wildflower species and to evaluate their performance in terms of attractiveness to pollinators.

Methods

During October 2024 and October 2025, ten wildflower species were sown in 3 × 30 m strips (3 replicates) established within the experimental fields of the Department of Agricultural and Food Sciences (DISTAL), University of Bologna. In addition, strips of durum wheat (Triticum durum) were established as a non-flowering control treatment. Three replicated strips were sown and arranged according to a randomized complete block design. Seeds had been previously collected from agroecological refuges, where the species had persisted under moderate, environmentally friendly agronomic management.

Results

Most wildflower species exhibited generalized pollination patterns, receiving visits from a broad spectrum of pollinators. In contrast, *Consolida ajacis* showed a marked specialization for long-tongued pollinators. In terms of visitation frequency, *Centaurea cyanus* exhibited outstanding performance, owing both to its high attractiveness to all major pollinator groups and to its extended flowering period, which lasted from late April to early June. Notably, *Nigella damascena*, *Agrostemma githago*, and *Glebionis coronaria* displayed excellent agronomic performance, characterized by high germination and seedling emergence rates under field conditions.

Conclusions

Overall, the results suggest that the selected wildflower mixture can serve as an effective model for pollinator biodiversity enhancement measures, especially within intensive farming systems, where the availability of floral resources is frequently constrained.



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Sciforum-198125: Field Evaluation of Oregano (*Origanum vulgare*) Elicitation with Salicylic Acid and Methyl Jasmonate for Improved Crop Resilience and Quality

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Foliar application of salicylic acid (SA) and methyl jasmonate (MJ) has gained attention as a sustainable strategy to stimulate plant defense responses and enhance bioactive compound production in oregano (*Origanum vulgare*). By modulating secondary metabolism, these elicitors may improve crop resilience while enhancing quality traits such as essential oil yield and composition. However, their effectiveness under field conditions remains insufficiently understood. This study investigated the effects of SA and MJ on oregano cultivated in monocropping and intercropping systems with cowpea (*Vigna unguiculata*).

A three-year field trial was established in April 2025 using a randomized complete block design with three blocks. At the beginning of flowering, oregano plants grown in monoculture (MCO + 2 mM) and intercropped with cowpea (IC + 2 mM) were treated with 2 mM SA or MJ at a two-week interval. Control treatments without elicitor application consisted of monoculture cowpea (MCC + 0 mM), monoculture oregano (MCO + 0 mM), and intercropping (IC + 0 mM).

Elicitor treatments had no significant effect on oregano biomass, chlorophyll, or free and total phenolic contents during the first year, likely due to crop establishment. Nevertheless, despite a 62% reduction in oregano dry biomass ($p < 0.001$), biomass-based LER ranged from 1.65 to 2.15 across elicitor treatments, demonstrating improved overall land-use efficiency. Under control conditions, bound phenolic content was 57% higher in intercropped than monocropped oregano ($p = 0.043$), accompanied by a reduced chlorophyll a/b ratio.

These preliminary results indicate limited effects of SA and MJ during crop establishment. Further analyses in the second and third years will determine whether elicitor treatments enhance bioactive compound accumulation and essential oil yield and composition in established oregano, clarifying their potential to improve plant defense capacity, crop quality, and productivity.



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Sciforum-198385: Biostimulant-based elicitation to improve bioactive compound accumulation in medicinal and aromatic plants under open-field conditions

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Introduction

Medicinal and aromatic plants (MAPs) are valuable crops for sustainable and agroecological production systems due to their applications in pharmaceutical, nutraceutical, cosmetic, and food sectors. Their commercial value is strongly linked to bioactive secondary metabolites, which may vary according to species, environment, and crop management. Biostimulant-based elicitation represents a low-impact strategy to improve phytochemical quality without increasing synthetic inputs. This study evaluated foliar chitosan and salicylic acid, used as elicitor-type biostimulants, on yield and bioactive compound accumulation in three MAP species under open-field conditions.

Materials and Methods

A two-year open-field trial was conducted in 2023 and 2024 at Agribioenergia S.C.A. in Medicina, Bologna, Italy, on *Melissa officinalis* L., *Passiflora incarnata* L., and *Echinacea purpurea* L. Three treatments were compared in a randomized complete block design: untreated control, foliar chitosan hydrochloride, and foliar salicylic acid. Four foliar applications were performed at eight-day intervals before harvest. Fresh and dry biomass yield were recorded. Dried plant material was analysed for total polyphenols, total flavonoids, antioxidant activity by DPPH assay, and marker compounds: rosmarinic acid in *M. officinalis*, vitexin in *P. incarnata*, and chicoric acid in *E. purpurea*.

Results

Treatments did not significantly affect fresh or dry biomass yield in any species, indicating no yield penalty. Secondary metabolite responses were species- and year-dependent. Chitosan significantly increased rosmarinic acid content in *M. officinalis* by 19.5% compared with the control and enhanced total polyphenols in *E. purpurea* in 2023, whereas salicylic acid showed limited effects. In *P. incarnata*, vitexin accumulation was mainly influenced by year rather than treatment.

Conclusions

Foliar chitosan and salicylic acid may support sustainable MAP production by selectively improving bioactive compound accumulation without reducing yield. Species-specific responses and climatic variability should be considered when integrating elicitor-type biostimulants into agroecological cropping systems.



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Sciforum-198740: Effects of *Ascophyllum nodosum* extracts on physiological and morphological function of drought-stressed canola

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Drought is the most yield-limiting environmental stress in agriculture. As drought events in Australia become more frequent and extreme under climate change, there is a need to establish sustainable methods to mitigate crop stress and improve yield. Seaweed extracts (SWE) have gained attention due to their reported ability to ameliorate drought symptoms and improve yield of under drought, but the mechanisms driving this potential efficacy remain unclear. The aim of this project was to evaluate whether and to what extent SWE applications impact the ecophysiological and morphological function of canola, one of Australia's most economically significant and drought vulnerable crops, to improve growth under drought.Canola plants were grown in a glasshouse trial under well-watered and deficit irrigation regimes, and treated with one of three *Ascophyllum nodosum*-derived commercial SWEs (two foliar applications over 10 weeks). The SWEs differed in extraction pH and pressure; their composition and relative bioactivities were assessed by metabolic profiling with gas chromatography-triple quadruple-mass spectrometry (GC-QQQ-MS), followed by principal component analysis (PCA). The ecophysiological response of canola to each of the three SWEs was assessed by measuring net photosynthesis (*A*), stomatal conductance (*gs*), and predawn leaf water potential (Ψ_{leaf}).GC-QQQ-MS identified 176 metabolites across all SWE and revealed significant differences in their relative presence of carboxylic acids, simple carbohydrates, and sugar alcohols; PCA showed no overlap between SWE products. Deficit-irrigated plants treated with SWE1 and SWE3 raised Ψ_{leaf} by 18.2% and 17.7% above deficit-irrigation control, respectively. While Ψ_{leaf} showed significant mitigation of water stress (p-value 7.65 e-10), *A* and *gs* showed no differences between SWE treatments. Nor did we observe significant differences in total biomass accumulation (leaf area, dry weight) or distribution (root:shoot) between SWE treatments. These results highlight the need for further research to explain how SWE may be utilised to improve drought resilience in agricultural systems. Following these findings, a dose-dependency experiment is currently underway to assess concentration-dependent mechanisms of SWE functionality.



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Sciforum-198810: From Waste to Biostimulant: Insect Frass Extracts as Emerging Agents for Seed Chemo-Priming

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Insect rearing is increasingly recognised as a key component of circular economy systems, generating valuable by-products such as frass, which is gaining attention as a sustainable fertiliser and potential biostimulant. In parallel, seed priming is widely used to enhance metabolic activity prior to germination, improving plant performance and tolerance to early stress. Among these strategies, chemo-priming employs nutrient-rich solutions to stimulate seed physiological responses and improve early seedling establishment.

Frass derived from larvae of *Hermetia illucens* (HI) and *Tenebrio molitor* (TM) contains minerals and bioactive compounds, suggesting a potential role as a biostimulant and in supporting plant resilience to stress. However, its application in seed chemo-priming remains poorly explored. This preliminary study investigated aqueous extracts of HI and TM larval frass (HIF and TMF) as chemo-priming agents to improve seedling establishment and early growth of *Lactuca sativa* and *Solanum lycopersicum*.

Seeds of both crops were treated for 48 h with the extracts at two temperatures (4°C and RT), then grown for 28 days under soil (pots) and hydroponic conditions to compare responses across systems. Plant height (PH) and leaf number beyond the second true leaf (LN) were recorded.

In pot experiments, RT extracts of both HIF and TMF increased plant height, whereas 4°C extracts promoted higher leaf production, particularly in lettuce. Similar trends were observed in tomato, with TMF showing slightly greater effectiveness in enhancing LN. In hydroponics, priming with 4°C extracts improved early growth during the first three weeks, especially in tomato. *S. lycopersicum* showed enhanced seedling vigour following 4°C HIF and TMF treatments, whereas *L. sativa* responded less positively under hydroponic conditions.

These findings highlight insect frass extracts as promising, sustainable biostimulant chemo-priming agents, yet further research is required to optimise their application across crop species and cultivation systems.



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Sciforum-199112: Enhancing tomato (*Solanum lycopersicum* L.) tolerance to biotic stress through seed biopriming with algal extracts and derivatives

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Algae are mainly used in agriculture as fertilizers or biostimulants through foliar or root applications. The EXTRAFIT project, funded by MASAF, focuses on the production of solvent-free extracts from the biomass of the red alga *Jania adhaerens* (JA) and the microalga *Arthrospira platensis* (also known as Spirulina, SP), for innovative applications, such as seed biopriming for the induction of systemic resistance to biotic and abiotic stresses. For biopriming, tomato seeds were soaked in the extracts (16 h), then rinsed and dried before use. The following treatments were compared in greenhouse (DISTAL, University of Bologna) and field (CREA-AA experimental farm in Scarperia, Firenze): i) JA extract; ii) SP extract; iii) spent SP liquid culture (LC); iv) phycocyanin (FI), i.e., the phycobiliprotein purified from SP; v) Vacciplant (VA), a laminarin-based crop protection product from the brown alga *Laminaria digitata*; vi) water (control). The University of Las Palmas de Gran Canaria provided JA biomass, while Micoperi Blue Growth, Italy, provided SP and its derivatives. The greenhouse assay on potting mix infected with *Fusarium oxysporum f. sp. lycopersici* showed that all treatments effectively protected the plants, which exhibited a disease score lower than that of the infected control (-55-80%), also promoting plant height (+57%, on average). The same treatments were field tested (4 repetitions × 10 plants). In the first year (2025), under optimal soil and climatic conditions, seed biopriming did not adversely affect plant development (height, LAI, final biomass) or yield—which ranged from 2.4 (JA) to 3.5 (VA) kg of ripe fruits per plant—despite a transient reduction in nursery growth observed after JA, LC, and VA treatments. Furthermore, the pulp quality traits (6.3% dry matter content, 4.9 °Brix, and 4.2 pH, on average) positioned the product within a medium-to-high commercial quality class. Replication of the field experiment is in progress.



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Sciforum-199122: Effects of a Sweet Orange Essential Oil-Based Biopesticide on *Exorista larvarum*, a Tachinid Parasitoid with Dual Ecological Functions

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The effects of biopesticides on beneficial non-target insects remain insufficiently investigated, despite their increasing use as alternatives to conventional pesticides. This study evaluated the toxicity of a sweet orange essential oil-based biopesticide to *Exorista larvarum* (L.) (Diptera: Tachinidae), a beneficial insect that acts both as a parasitoid of lepidopteran pests and as a pollinator. Toxicity was assessed in mated females through both contact and oral exposure, using procedures adapted from internationally recognized protocols developed for pesticide testing on *Apis mellifera* L. In contact bioassays, a 1 µL droplet of biopesticide solution was applied to the thorax of each fly, whereas in oral bioassays females were offered 10 µL of treated food solution. Five concentrations of the formulation (0.25%, 0.5%, 5%, 10% and 20%) were tested, as described by Francati et al. (Entomol. Exp. Appl. 174: 933-941, 2026). In addition to survival, possible effects on reproduction were evaluated by measuring fecundity (number of eggs laid) and fertility (proportion of eggs developing into puparia). Mortality increased with concentration regardless of the exposure route, although the response differed between treatments. In contact assays, the estimated LC20 was 3.81%, whereas the LC50 exceeded the highest concentration tested (20%), indicating relatively low acute toxicity. In oral assays, the proportion of females consuming the treated solution decreased with increasing concentration. Among females that ingested more than 50% of the offered solution, mortality showed a clear dose-dependent response, with estimated LC20 and LC50 values of 2.5% and 10.8%, respectively. No significant effects on fecundity or fertility were detected following either exposure route. These findings indicate that oral exposure may pose a greater risk to *E. larvarum* than direct contact, whereas reproductive performance appears unaffected under the tested conditions.



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Sciforum-199139: Biostimulatory and Allelopathic Effects of Selected Plant Extracts on Germination of Vegetable Seeds

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Allelopathy is an important biological phenomenon in which plants, through secondary metabolites, can stimulate or inhibit the germination and early growth of other plant species. In sustainable and organic agriculture, plant extracts are increasingly investigated as natural alternatives to synthetic products to improve seed germination. This study aimed to determine the effects of aqueous extracts of chamomile (*Matricaria chamomilla* L.), stinging nettle (*Urtica dioica* L.), dandelion (*Taraxacum officinale* L.), and yarrow (*Achillea millefolium* L.), as well as their mixture, on the germination of lamb's lettuce (*Valerianella locusta* L. Laterr.) and head cabbage (*Brassica oleracea* var. capitata L.). The experiment was conducted under laboratory conditions using aqueous extracts at concentrations of 1%, 2%, and 5%. Seeds were germinated in Petri dishes, and the germination percentage was evaluated on the fifth and seventh days after the experiment began. The results showed a statistically significant effect of all tested extracts on the germination of both plant species. Lower extract concentrations (1%) generally had a stimulatory effect, whereas higher concentrations (5%) had a pronounced inhibitory effect. The highest germination rate for cabbage seeds was observed with 1% dandelion extract (73.6%), and nettle extract also showed a positive effect. In contrast, chamomile extract completely inhibited cabbage seed germination at all tested concentrations. In lamb's lettuce, the highest germination rates were observed with 1% yarrow and nettle extracts, whereas increasing extract concentration resulted in reduced germination. The findings confirm significant allelopathic effects in the plant species studied and indicate the potential use of dandelion and nettle extracts as natural biostimulants to promote seed germination. At the same time, chamomile's strong inhibitory effect suggests its potential for further research into the natural regulation of plant growth and development.



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Sciforum-199162: Green Synthesis of ZnO Nanoparticles from *Cucurbita maxima* Peels for Developing 3D Hybrid Structures and Agricultural Applications

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In the agricultural sector, the increasing accumulation of fruit and vegetable by-products and the environmental concerns associated with conventional chemical synthesis methods highlight the need for sustainable approaches for nanoparticle development. Pumpkin (*Cucurbita maxima*) peel, an agro-industrial waste rich in bioactive compounds, represents a prominent renewable resource for green nanotechnology applications. This study aimed to develop ZnO nanoparticle-based 3D hybrid structures from pumpkin peels and evaluate their agricultural, antimicrobial, and physicochemical properties. Pumpkin peel extract was used as a natural reducing and stabilizing agent for the green synthesis of ZnO nanoparticles, followed by incorporation into a Gum Arabic polymer matrix to develop hybrid nanostructures. Characterization was performed using UV-vis spectroscopy, FTIR, SEM, TEM, DLS, zeta potential, and EDX, while structural evaluation included pore size distribution analysis and CIELAB color measurements. Antioxidant activity was evaluated through total phenolic content (TPC), total flavonoid content (TFC), DPPH, and FRAP assays, while antimicrobial activity was assessed against phytopathogens to evaluate potential agricultural applications.

UV-vis spectroscopy confirmed the formation of ZnO nanoparticles, with an absorption peak at around 380 nm. Pore size distribution ranged between 50-200 µm, whereas TEM and SEM revealed particle sizes of 20-40 nm and 50-70 nm, respectively. Color analysis showed variations in parameters (L*: 75-90, a*: -2 to +3, b*: 8920). Zeta potential values of -12.5 mV and -23.96 mV indicated good stability. Pumpkin extract showed TPC values ranging from 9.72 ± 0.37 to 104.92 ± 0.46 mg GAE/g, TFC values ranging from 0.42 ± 0.04 to 3.14 ± 0.08 mg CE/g, and DPPH values ranging from 1.21 to 3.84 mg/mL. Overall, ZnO-based hybrid nanostructures demonstrate strong potential for sustainable agricultural applications, particularly in crop protection, postharvest preservation, and eco-friendly nanomaterial development.



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Sciforum-199322: Biostimulant Effects of *Ascophyllum nodosum* and *Ecklonia maxima* Extracts on Yield and Malting Quality Traits of Winter Barley under Mediterranean Conditions

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Introduction

Seaweed-derived biostimulants improve crop productivity and grain quality. In malting barley, optimal quality traits include grain protein concentration (GPC) of 9.5–11.5% and maltable and retention fractions exceeding 90% and 85%, respectively. This study evaluated the effects of two seaweed extracts from *Ascophyllum nodosum* (ANE) and *Ecklonia maxima* (EME) on the yield and quality traits of winter barley (*Hordeum vulgare* L.) cv. Fortuna in Mediterranean conditions.

Methods

Field experiments were conducted in 2023–2024, at two sites in Thessaly, Greece (Almyros and Farsala), following a randomized complete block design. Treatments included untreated control, ANE, and EME. Biostimulants were applied once at tillering (Zadoks 24) at 1 L ha^{-1}. Yield components and malting quality traits were assessed. Data were analyzed using two-way ANOVA.

Results

Biostimulant treatments significantly affected biomass, grain yield, yield components, and malting quality traits ($P < 0.05$). Significant location × treatment interactions were observed for grain yield and most quality parameters. ANE increased grain yield by 16.67% in Almyros and 93.68% in Farsala, whereas EME increased yield by only 0.34% and 11.06%, respectively. Similarly, spike density increased by 66.50% and 49.87% under ANE and by 10.49% and 36.81% under EME in Almyros and Farsala, respectively. Grain quality performance was highest under ANE. In Farsala, maltable fraction increased from 36.93% in the control to 70.98% and 97.47% under EME and ANE, respectively, while retention fraction increased from 9.58% to 31.22% and 88.99%. Grain quality in Almyros remained high across treatments. GPC decreased from 11.98% in the control to 11.42% and 10.82% under EME and ANE, respectively.

Conclusions

Seaweed extracts improved grain yield and malting quality of malting barley, with the strongest responses under ANE. ANE achieved the highest yield and grain quality, particularly in Farsala, highlighting its potential to enhance barley productivity and malting quality under Mediterranean conditions.



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Sciforum-199424: Soil microbiota influence floral signals and pollinator attraction in sunflowers

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Sunflowers (*Helianthus annuus*) are a key floral resource for pollinators, yet nectar production has declined in several regions, frequently in association with drought and other environmental pressures. Reduced soil microbial diversity may further impair plant–microbe interactions involved in floral development. Beneficial soil microorganisms can improve nutrient availability and modulate plant signalling, potentially affecting both nectar secretion and floral volatile organic compounds (VOCs), but their effects on pollination-relevant traits remain poorly understood. We conducted field experiments in Italy using the hybrid LST907 and the open-pollinated cultivar Peredovick, inoculated with plant growth-promoting bacteria (PGPB) belonging to *Bacillus*, *Paenibacillus*, *Pseudomonas*, and Lactobacillaceae. Floral VOCs were analysed by SPME-GC-MS, expression of the nectar-related genes *SWEET9* and *NEC1* was assessed by RT-qPCR, and root-associated microbial communities were characterised by Illumina sequencing. Inoculation selectively enriched Pseudomonadaceae, Streptomycetaceae, Lactobacillaceae, and Comamonadaceae, while depleting Chitinophagaceae and Micromonosporaceae, with genotype-dependent shifts that were more pronounced in Peredovick. At the compound level, *Pseudomonas* produced the broadest VOC response in the 2024 subset, significantly altering 85 compounds, including 17 monoterpenes and 26 sesquiterpenes, while *Paenibacillus* altered 44 compounds across the two cultivars. Microbiota–VOC associations were broader and more interconnected in the rhizosphere than in the endophytic compartment. Nectar-related gene regulation was also strongly context dependent: Lactobacillaceae increased *SWEET9* expression 12.1-fold in Peredovick in 2024 ($p < 0.05$), but reduced it approximately ten-fold in LST907 in 2025 (fold change = 0.10, $p < 0.01$), whereas *NEC1* remained largely unaffected. These findings quantify the capacity of beneficial soil bacteria to reshape sunflower floral chemistry and nectar-related molecular pathways in a genotype- and year-dependent manner, supporting their potential use in pollinator-friendly and climate-resilient crop management.



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Sciforum-199537: Degradation of methyl orange dye employing an endophytic *Streptomyces* sp. and its application in agriculture

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Introduction

Various sources, including the dye, chemical, fertilizer, and pharmaceutical industries, are polluting surface marine and freshwater all over the globe. The traditional physiochemical processes are highly expensive and produce harmful secondary sludges. Actinomycetes are considered a diverse group with the capability to yield various secondary metabolites that are used in many biodegradations of hazardous compounds and remediation studies. At present, researchers are investigating alternative approaches to address this issue through the use of endophytic organisms. The key aims of the present investigation are to degrade methyl orange dye using *Streptomyces* sp. and use remediated water for agriculture.

Methods

In the current study, endophytic actinomycetes were selectively isolated from marine algae samples using starch casein agar under saline conditions using the soil dilution method. The endophytic actinomycetes were primarily identified as *Streptomyces* sp. using morphological, biochemical, and molecular characters. The screening for methyl orange decolorization was conducted via in vitro plate assay.

Results

The marine algae harbored endophytic actinomycetes *Streptomyces* sp. The preliminary plate-assay screening successfully identified an endophytic actinomycete isolate demonstrating robust extracellular methyl orange degradation, evidenced by halos surrounding the microbial colonies with the clearance of 10 mm. Current studies indicate that specific pH and temperature adjustments significantly accelerate clearance velocities. Following optimization, the bioprocess will be scaled within a benchtop bioreactor to generate high-density biomass. Subsequently, the post-treated filtrate will be evaluated for sustainable use in agriculture.

Conclusions

The endophytic actinomycete *Streptomyces* sp. biodegraded MO dye using a plate assay with the following optimal conditions: starch casein agar, pH 7.4, temperature 30 °C and dye concentration of 50mg/L for 7 days incubation. The organism biodegraded the azo dye MO. However, further optimization and use of degraded water in agriculture are to be optimized in future work.



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Sciforum-199666: Biostimulants and Biochar: Unlocking Phosphorus Uptake in wheat

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Phosphorus (P) is a key nutrient that often limits crop productivity. Its availability is influenced by soil biological and physicochemical processes. Soil microorganisms improve P cycling by converting unavailable P into plant-accessible forms, while biochar enhances soil structure, water retention, and microbial habitat, supporting P availability and plant uptake. This study evaluated the effects of biochar and plant growth-promoting microorganisms on P availability and uptake in wheat grown in two contrasting soils (Chromosol and Vertosol), with six replicates. Treatments included microbial inoculants, biochar, and synthetic fertiliser, while plant growth, nutrient composition, and rhizosphere microbial communities were assessed. Both soils maintained a near-neutral to alkaline pH (6.6-8.1), creating favourable conditions for nutrient availability and microbial activity. Biochar application influenced P dynamics differently between the two soils. In the Vertosol, biochar increased the phosphorus buffering index (PBI) by up to 21%, indicating greater P retention, although Colwell P generally declined relative to the planted control, except in the Bacillus + biochar treatment, where available P increased by 40%. In contrast, the Chromosol responded strongly to biochar, with Colwell P increasing by 54-73% and PBI by 82-114%. These improvements may be linked to a higher abundance of Actinobacteria, which are known to promote phosphorus solubilisation and nutrient cycling. Nitrate-N concentrations were generally higher in the Vertosol, particularly in the biochar-only treatment (+83%), whereas most Chromosol treatments reduced nitrate-N. Biochar also enhanced organic carbon, increasing concentrations by up to 25% in the Vertosol and 19% in the Chromosol, demonstrating improved carbon storage alongside enhanced phosphorus retention and availability. The findings highlight the potential of integrating biochar and microbial inoculants to improve phosphorus use efficiency and support sustainable wheat production in Australian soils effectively. These outcomes suggest strategies for farmers to improve fertiliser efficiency, reduce costs, and enhance soil health under diverse field conditions.



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Sciforum-199744: Biostimulant-mediated modulation of nutrient dynamics in durum wheat

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Enhancing nutrient use efficiency in wheat cropping systems is a major challenge for sustainable agriculture. In this context, biostimulants may improve nutrient acquisition and redistribution, supporting crop productivity under reduced fertilizer inputs. This study assessed the effects of combining biostimulants (Blue N® - *Methylobacterium symbioticum* (strain SB23); Contribute ibNP - *Azospirillum brasilense* (strain CECT 9381) and *Pseudomonas putida* (strain CECT 9382); and Status® - MTU® (2 g/L) and pidolic acid (320 g/L)) with conventional and reduced nitrogen fertilization on the uptake, translocation and accumulation of phosphorus, potassium, calcium, sulfur, zinc and molybdenum in durum wheat (*Triticum durum* Desf. cv. Don Ricardo). Field experiments were conducted under Mediterranean conditions in southern Portugal using soil- and foliar-applied biostimulants associated with two nitrogen regimes. Plant samples were collected at 118 and 171 days after sowing, and mineral concentrations were quantified by X-ray fluorescence spectrometry. Nutrient accumulation and translocation patterns differed markedly between sampling dates, with reductions of up to approximately 50% being observed for several nutrients during crop development. Potassium and sulfur consistently exhibited the highest accumulation levels, whereas molybdenum showed the lowest concentrations. At 118 days, sulfur and molybdenum were preferentially directed to vegetative tissues, with stem translocation differing by approximately 24% and 9%, respectively, with the highest mean values recorded under Contribute ibNP and Blue N® (both at the conventional nitrogen rate), respectively. During grain filling, phosphorus translocation to grains increased by up to 17%, reaching its highest value under Status® combined with the conventional nitrogen rate. Zinc allocation to grains increased most under Status® combined with reduced nitrogen, with treatment differences approaching 19%, highlighting the strong influence of management practices on micronutrient partitioning. Biostimulant application modified nutrient redistribution patterns, resulting in contrasting nutrient-use efficiencies and grain enrichment potentials, suggesting that integrated fertilization-biostimulant strategies can improve nutrient allocation within the plant.



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Sciforum-199772: Effects of biostimulant application on durum wheat grain quality

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The improvement of grain quality in durum wheat (*Triticum durum* Desf.) is essential to enhance the nutritional and technological value of this crop while promoting sustainable agricultural practices. This study evaluated the effects of three biostimulants (Contribute ibNP - *Azospirillum brasilense* (strain CECT 9381) and *Pseudomonas putida* (strain CECT 9382); Status® - Sodium salt of dicamba (44.0%) and diflufenzopyr (17.1%); and Blue N® - *Methylobacterium symbioticum* (strain SB23) on the qualitative characteristics of durum wheat grain cultivated under Mediterranean conditions in southern Portugal (namely in Beja). Field trials were conducted under a standard fertilization regime (150 kg ha^{-1}). After harvest, grain samples were processed into semolina and assessed for moisture, ash, wet and dry gluten, total protein (Kjeldahl method), total lipids (soxhlet extraction method) and soluble sugars (high-performance liquid chromatography). The application of biostimulants did not significantly affect grain moisture, ash content or wet gluten, indicating that the intrinsic technological characteristics of the cultivar were preserved. However, significant changes were detected in grain biochemical composition. Compared with the control, Blue N® increased total lipid concentration by approximately 31%, whereas soluble sugar accumulation increased by about 27% and 44% following Contribute ibNP and Blue N® applications, respectively. Conversely, biostimulant treatments reduced total protein and dry gluten contents by up to 10% and 20%, respectively, suggesting substantial modifications in nitrogen partitioning and grain filling processes. Variations among treatments reached approximately 57% for soluble sugars and 31% for total lipids, highlighting the strong influence of biostimulants on grain biochemical composition. These responses may reflect enhanced photosynthetic efficiency and photoassimilate translocation towards carbohydrate and lipid biosynthesis. Still, Blue N® exhibited the most promising performance, highlighting the potential of selected biostimulants to improve specific quality traits in durum wheat grains.



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Sciforum-199928: Life cycle assessment of microbial biostimulant integration in legume cover crop systems: a comparative environmental modelling study for rain-fed wheat production in the Po Valley (Italy).

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Background

Microbial biostimulants are increasingly advocated as tools to reduce synthetic nitrogen dependency in cereal systems. However, existing studies evaluate agronomic performance in isolation, without accounting for the full life cycle of inoculant production, cover crop management, and displaced synthetic inputs. Comparative life cycle assessment (LCA) evidence for integrated scenarios in Mediterranean rain-fed wheat systems is particularly lacking.

Objectives

This modelling study quantifies and compares the environmental profiles of four agronomic scenarios for rain-fed winter wheat production in the Po Valley, northern Italy: S_0 conventional baseline, S_1 legume cover crop without inoculant, S_2 microbial biostimulant application without cover crop, and S_3 their combination. Foreground inventory data were derived from peer-reviewed literature and publicly available datasets (LUCAS Soil JRC-EU; FAOSTATS).

Methods

LCA modelling was performed in SimaPro 9.1 using Ecoinvent 3.10 as the background database. Impact assessment followed the EF 3.1 method as primary. The functional unit is 1 ha per cropping season, cradle-to-farm-gate. Uncertainty was characterized via Monte Carlo simulation (n = 1,000), with sensitivity analysis conducted across cover crop nitrogen fixation rates, biostimulant efficacy on nitrogen uptake, and synthetic nitrogen displacement factors.

Results

Preliminary modelling indicates that the integrated scenario S_3 yields the greatest reduction in global warming potential (-22% relative to S_0) and reactive nitrogen losses to air and water (-18%). Inoculant production contributes less than 4% of total system emissions, confirming a favorable environmental leverage relative to displaced synthetic fertilizer. S_1 drives eutrophication reductions predominantly through nitrate leaching abatement; S_2 shows selective benefits in climate change and soil quality impact categories.

Conclusions

Coupling microbial biostimulants with legume-based cover crop rotation constitutes an environmental strategy for Mediterranean wheat systems, with benefits across impact categories. The approach offers a replicable, data-efficient methodology for evidence-based assessment of biological alternatives to synthetic inputs, aligned with EU Green Deal and Farm-to-Fork targets.



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Sciforum-201923: Bacterial Biopreparations as Modulators of Soil Algal Growth during Biocrust Formation

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Soil algae in biocrusts enhance soil stability and nutrient cycling, but effects of bacterial biopreparations on their growth remain unclear in agroecosystems. We evaluated bacterial biopreparations on algae dynamics. A 28-day mesocosm experiment was conducted using Haplic Luvisol with light clay texture collected from an agricultural field in northern Poland. To stabilize environmental conditions, the mesocosms were incubated for the first 14 days under controlled laboratory conditions (full-spectrum white light, 40 μmol m^{-2} s^{-1}, and a 12 h light/12 h dark photoperiod). After this stabilization period, a non-axenic soil algal culture dominated by Klebsormidium sp., isolated from the same site, was inoculated onto the soil surface to initiate biological soil crust (biocrust) formation. Bacterial biopreparations were applied at four times the manufacturer's recommended dose (400%). The experimental design included two controls: CS (soil without algal inoculation) and CSA (soil inoculated with algae). Experimental variants comprised BP1 (Pseudomonas sp. and Azotobacter sp.), BP2 (Bacillus amyloliquefaciens and Bacillus subtilis), and BP3 (Methylobacterium symbioticum), each established in duplicate. During incubation, biocrust coverage, soil pH, redox potential (Eh), and electrical conductivity (EC) were monitored. Soil pH increased from 6.3–6.6 at the beginning of the experiment to 6.7-7.1 after 28 days, indicating only minor effects of bacterial inoculation on soil chemistry. Eh values (365–443 mV) confirmed the maintenance of aerobic conditions, while EC decreased from 4-6 to 0.8-1.7 mS cm^{-1} during incubation. After inoculation of the mesocosms, BP2 and BP1 achieved 83.10% and 81.79% biocrust surface coverage, respectively, on day 21 of the experiment, exceeding the mean value recorded for the CS treatment (80.33%). Overall, bacterial biopreparations primarily influenced the development and succession of biological soil crusts rather than their initial formation, while exerting only limited effects on the physicochemical properties of the soil.

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Sciforum-203753: Evaluation of the insecticidal and repellent activities of essential oils from thyme (*Thymus vulgaris* L.) and rosemary (*Rosmarinus officinalis* L.) against the black thistle aphid (*Brachycaudus cardui*)

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This study forms part of an integrated pest management approach, aimed at limiting the use of synthetic pesticides to control the black thistle aphid (*Brachycaudus cardui*). The main objective is to evaluate the insecticidal potential and repellent properties of essential oils from rosemary (*Rosmarinus officinalis*) and thyme (*Thymus vulgaris*), derived from plants harvested in the Boumerdès region (Algeria).

The methodological approach is based on standardised bioassays conducted under controlled laboratory conditions. The evaluation comprises direct contact toxicity tests via topical application, alongside behavioural repellency tests using choice arenas. For this purpose, adult insects were exposed to a range of four distinct concentrations: 2.5, 5, 10 and 20 µL/mL. Data were subjected to probit analysis to determine lethal parameters.

The results reveal that both plant extracts possess remarkable biological activity, which is closely dependent on concentration and duration of exposure. They are capable of inducing total mortality (100 per cent) in the test subjects after 72 hours. Thyme and rosemary exhibit significant insecticidal efficacy, characterised by particularly low median lethal concentrations (LC50), amounting to 1.75 µL/mL and 1.92 µL/mL respectively after just 24 hours. Furthermore, kinetic analysis highlights the rapid action of rosemary, which has a median lethal time (LT50) of 12.5 hours, compared with 18.31 hours for thyme. In terms of behaviour, thyme stands out by exhibiting maximum repellent efficacy, classified as category V, from the very first 24 hours.

In conclusion, this research highlights the exceptional potential of these essential oils as credible biopesticide alternatives. They open up promising prospects for the development of sustainable biocontrol strategies against this agricultural pest.



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Sciforum-207472: Evaluation of *Paenibacillus terrae* B6a as a Sustainable Biocontrol Agent Against *Fusarium proliferatum*

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The extensive use of chemical fungicides for crop protection has raised significant environmental and health concerns, highlighting the need for sustainable and environmentally friendly alternatives. Biological control using antagonistic microorganisms such as *Paenibacillus terrae* B6a represents a promising strategy for the management of fungal phytopathogens. This study evaluated the biocontrol potential of *P. terrae* B6a against *Fusarium proliferatum* PPRI 31301 by investigating its *in vitro* antagonistic activity, effects on fungal morphology and cell wall-associated components, and ability to alleviate pathogen-induced stress in maize. *In vitro* antagonistic activity was assessed using dual culture and intracellular crude metabolite (ICM) assays, with ICM representing the bacterial cell-associated fraction obtained following centrifugation and resuspension of the bacterial pellet. For the *in planta* assay, three biological replicates of 50 maize seeds per treatment were bio-primed with *P. terrae* B6a (1×10^6 CFU/mL), inoculated with a *F. proliferatum* spore suspension (1×10^6 spores/mL), and incubated under controlled germination conditions for seven days. Dual culture and ICM treatments inhibited *F. proliferatum* growth by 70.15% and 71.64%, respectively. High-resolution scanning electron microscopy (HR-SEM) revealed marked morphological alterations in fungal hyphae following B6a treatment. These changes were accompanied by significant reductions ($p < 0.05$) in chitin content (48.03%), extracellular polysaccharide content (48.99%), and endo-β-1,4-glucanase activity (42.32%). *F. proliferatum* infection significantly reduced maize root length by 37%, whereas B6a bio-priming increased root length by 44.99% relative to pathogen-infected seeds. Oxidative stress assessment showed that B6a bio-priming reduced superoxide (O_2^-) and hydrogen peroxide (H_2O_2) accumulation and lipid peroxidation, measured as malondialdehyde (MDA), while modulating superoxide dismutase (SOD) and ascorbate peroxidase (APX) activities. Collectively, these findings demonstrate the potential of *P. terrae* B6a as a biocontrol candidate against *F. proliferatum* and support its further investigation for the development of sustainable biocontrol strategies for the management of *F. proliferatum* in maize.

Author contributions: Conceptualization, Enriquay Smith and Ashwil Klein; Methodology, Enriquay Smith; Software, Enriquay Smith; Validation, Enriquay Smith, Augustine Innalegwu Daniel and Marshall Keyster; Formal analysis, Enriquay Smith, Augustine Innalegwu Daniel and Ashwil Klein; Investigation, Enriquay Smith; Resources, Enriquay Smith and Ashwil Klein; Data curation, Enriquay Smith and Augustine Innalegwu Daniel; Writing - original draft, Enriquay Smith; Writing - review and editing, Enriquay Smith, Augustine Innalegwu Daniel, Marshall Keyster and Ashwil Klein; Visualization, Enriquay Smith; Supervision, Augustine Innalegwu Daniel, Marshall Keyster and Ashwil Klein; Project administration, Ashwil Klein; Funding acquisition, Ashwil Klein;



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Sciforum-207921: Dual effect of Rugulosin A: Inhibition of Botrytis cinerea and Alternaria alternata growth and protection against mold disease in grapevine plantlets and berries.

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Rugulosin A (RugA), a bis-anthraquinone, was isolated and purified from the *Coniochaeta velutina* endolichenic fungus. To test RugA potential effects on phytopathogenic fungi such as Botrytis cinerea and Alternaria alternata, RugA was firstly evaluated on mycelial growth and spore germination of both fungi species. RugA showed four-fold greater potency against *Botrytis cinerea* mycelial growth than against *Alternaria alternata*, with IC_{50} values of 2.5 µM and 10 µM, respectively. Nevertheless, considering spore germination inhibition, RugA was slightly more efficient on Alternaria than on Botrytis with a MIC of 75 µM for Alternaria alternata and 100 µM for Botrytis cinerea. The expression of genes involved in *Botrytis cinerea* development and infection decreased in the presence of 25 µM of RugA. Confocal microscopy, paired with fluorochromes such as propidium iodide, DCFHDA, and 2-NDBG, indicated that RugA likely compromised membrane integrity, triggered oxidative stress, and decreased sugar uptake, all of which led to cell death. Furthermore, RugA effect was monitored during spore infection of grapevine leaves, plantlets, and berries that indeed altogether, showed a significant decrease in disease propagation. Molecular docking analyses further indicated a strong interaction between RugA and NADPH-cytochrome P450 reductase, with a binding affinity of -11.2 kcal/mol, which was associated with reduced enzyme activity and may contribute to the observed antifungal effects. Moreover, the expression of some defense genes, such as PR1, PR3, PR4, STS, HSR1, and EDS1 involved in pathogenicity, was not induced on infected leaves treated with RugA. Furthermore, RugA did not show any toxicity onto housefly maggots (*Musca domestica*) and grapevine plantlets. Taken together, these data suggested that RugA could be a promising candidate for combating phytopathogenic fungi for further applications in agriculture.



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Sciforum-208583: From Laboratory Screening to On-Farm Validation: Rhizobial Inoculation of Cowpea (*Vigna unguiculata ssp. unguiculata*) in Hungarian Organic Horticulture

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Climate change is challenging established horticultural practices in Hungary. The yield stability of common bean, an important vegetable legume, is declining under increasingly hot and dry summer conditions. Cowpea (*Vigna unguiculata* ssp. *unguiculata*) may offer a drought-tolerant alternative for fresh-pod and dry-grain production. As *Vigna* species are not native to Hungary, we investigated whether inoculation with compatible rhizobia could improve cowpea adaptation and productivity in organic horticulture.

Several rhizobial strains were screened under greenhouse conditions for their ability to establish effective nitrogen-fixing symbiosis with cowpea. The two most promising strains were multiplied and combined as an inoculum for on-farm testing in participating organic farms (three farms in 2025 and four in 2026). Newly emerged seedlings received 10 mL of liquid inoculum at a standardised viable cell concentration, applied as a soil drench at the base of each plant. At each farm, inoculated and uninoculated plots were established under comparable field conditions with a minimum plot length of 5 m, without replicated experimental design. Soil nitrate concentration was analysed before sowing, while treatment effects were assessed based on pod number, weight and length. Nodulation was assessed on the roots of plants in 2025, and bacteria were re-isolated from nodules.

In 2025, no clear yield response to inoculation was observed at two farms where soil nitrate concentrations exceeded 30 mg kg^{-1}. In contrast, at one farm with approximately 10 mg kg^{-1} nitrate, inoculation increased total pod weight and pod number by 169% and 187%, respectively, compared with the uninoculated control. Pod length was not affected. Re-isolated bacteria from nodules confirmed to correspond to the inoculated strains.

These results suggest that higher soil nitrate availability may reduce the response to rhizobial inoculation, whereas inoculation may improve cowpea productivity under low-nitrogen conditions. Ongoing trials in 2026 will provide further information on the consistency of these effects across organic production environments. Targeted rhizobial inoculation may support the introduction and adaptation of non-native legume vegetables in low-input and organic horticultural systems.

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Sciforum-208596: Mass Transfer and Reaction Characteristics of a CO_2–NaOH System in a Membrane Contactor

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Effective capture and utilization of CO_2 are critical for achieving carbon neutrality. The CO_2–NaOH reaction system represents a promising carbon capture and utilization (CCU) pathway, in which CO_2 is converted into Na_2CO_3 through reaction with an aqueous NaOH solution. However, in conventional bubble-based CO_2 injection processes, a significant fraction of CO_2 may escape before sufficient dissolution and reaction in the liquid phase, resulting in reduced mass transfer efficiency and CO_2 utilization. In this study, a membrane contactor was applied to enhance CO_2 utilization by delivering CO_2 directly into the liquid phase without bubble formation. The effects of CO_2 supply pressure on the reaction and gas–liquid mass transfer characteristics were evaluated at 0.5, 1.0, and 1.5 bar. Experiments were conducted using a 5 M NaOH solution and high-purity CO_2 (99.99%) at an operating temperature of 30–35 °C. An ultra-high-molecular-weight polyethylene (UHMWPE) hollow fiber membrane was employed as the membrane material.

Compared with the conventional sparger, the membrane contactor required less cumulative CO_2 input and achieved a shorter reaction completion time, indicating improved CO_2 transfer efficiency. The apparent volumetric mass transfer coefficient (kLa) was approximately 0.050, 0.063, and 0.060 min^{-1} at 0.5, 1.0, and 1.5 bar, respectively, with the highest value observed at 1.0 bar. Although increasing CO_2 pressure generally shortened the reaction time, a further increase in pressure above 1.0 bar did not result in a corresponding improvement in kLa. The dried solid yields remained close to the theoretical value under all tested conditions, and no significant difference was observed between the sparger and membrane contactor systems. These results indicate that increasing CO_2 supply pressure can accelerate the reaction, but does not necessarily improve gas–liquid mass transfer efficiency. Therefore, an appropriate operating pressure should be selected by considering both reaction time and CO_2 transfer performance in membrane contactor-based CO_2 utilization processes.

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Sciforum-208634: Seed-Applied PGPB-Based Biostimulants Influence Early Plant Establishment: Contrasting Responses Across Crop Species

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Biostimulants are promising tools for sustainable agriculture by enhancing crop performance while reducing dependence on conventional inputs. Plant growth-promoting bacteria (PGPB) improve nutrient availability, stimulate plant growth, and enhance tolerance to environmental constraints. However, the effectiveness of seed-applied microbial biostimulants during germination and early plant establishment remains insufficiently explored across crop species.

This study evaluated a microbial consortium composed of *Bacillus subtilis*, *Azospirillum brasilense*, and *Pseudomonas putida* as a seed-applied biostimulant in four species: clover (*Trifolium suaveolens*), lentil (*Lens culinaris*), wheat (*Triticum aestivum*), and Italian ryegrass (*Lolium multiflorum*). Germination assays compared seed soaking and spray application using the consortium at full and half concentration, with 400 seeds per species and treatment condition. Based on these results, pot experiments were performed with clover and wheat, using five biological replicates per treatment. Seeds were treated by spray application with the consortium at full or half concentration, or the consortium was applied through irrigation water. Physiological and biochemical responses were assessed, including chlorophyll content, stomatal conductance, chlorophyll *a* fluorescence, H_2O_2 accumulation, catalase activity, and biomass. Statistical analyses were performed using SPSS.

The consortium improved germination in clover, reaching 88.5% and 91.7% following spray application at full and half concentration, respectively, compared with 85.2% in the water-treated control. In lentil, treatment mainly promoted seedling growth, with longer shoots and roots than untreated controls, whereas wheat and Italian ryegrass showed limited germination responses. In the pot experiment, clover plants derived from seeds treated with the full-concentration consortium by spray application showed higher stomatal conductance and chlorophyll *a* fluorescence. In wheat, no significant physiological differences were observed. In clover, biochemical responses were also treatment-dependent, with higher H_2O_2 accumulation and lower catalase activity following spray application of the half-concentration consortium.

Overall, the consortium promoted germination and early plant responses in the tested legume species, whereas responses in the tested grasses were more limited. These findings highlight species-specific responses to seed-applied PGPB and support the development of crop-specific microbial treatments to improve early crop establishment.

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Sciforum-208674: Harnessing rhizospheric bacteria from Blue Buffalo Grass to enhance sorghum drought tolerance

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Sorghum is an important source of food and fodder. Given the increasing severity and frequency of drought due to climate change, it is prudent to enhance crops that are already drought tolerant as more sensitive crops may not survive future climatic conditions. Although sorghum is generally drought tolerant, some cultivars with desirable agronomic traits remain susceptible to water deficit. Rhizospheric microbial communities play a vital role in promoting plant growth and mitigating the effects of environmental stresses. This study aimed to identify osmotic stress tolerant rhizospheric bacteria associated with *Cenchrus ciliaris*, a grass that thrives spontaneously in the Kalahari Desert, and evaluate their potential for enhancing the tolerance of a sensitive sorghum cultivar (*Sorghum bicolor* var. *PI682164*) to water deficit stress. Fifteen rhizospheric bacteria were isolated and screened fo tolerance in PEG-induced osmotic stress (20 % and 30 % PEG 8000). The three isolates (B1, B3, B5) with the highest growth percentages in 30 % PEG (32,86 %; 49,83 %, 52,86 %, respectively) were identified by 16S rRNA gene sequencing and phylogenetic analysis as *Serratia* spp., *Corynebacterium* spp., and *Microbacterium* spp., respectively. These isolates were subsequently evaluated for enhancing tolerance of sorghum seedlings to water deficit stress under the following treatments, including, well-watered (WW), water deficit (WD), well-watered + isolate (WW + B1, B3, B5 or consortium), water deficit + isolate (WD + B1, B3, B5, or consortium). Water deficit stress was imposed by reducing soil moisture by 80% relative to the well-watered treatment. Seeds were inoculated through imbibition in bacterial cell suspension of OD_{600} = 0.6. Shoot length, shoot weight, root length, root weight, relative water content were measured to evaluate plant performance. Data were analysed using two ways ANOVA, $p < 0.05$. Results revealed that inoculation improved all agronomic traits under water deficit stress compared to uninoculated plants. *Serratia* spp. (B1), which demonstrated the most significant growth improvement in sorghum seedlings, was subsequently evaluated for improving sorghum tolerance at growth stage 6. Under water deficit stress *Serratia* spp. inoculated plants showed lower reduction in shoot weight, shoot length and stem diameter under water deficit stress (53.2 %, 30.27 %, 49.89 % respectively) relative to WW plants compared with uninoculated plants (76.55 %, 37.01 %, 65.81 %, respectively). Proline content increased in the leaves (15.86 %) and roots (3.89 %) of inoculated plants, relative to WW plants. Analyses of antioxidant enzyme activities revealed a significant association between rhizospheric bacteria-mediated tolerance to water deficit stress and improved activity of APX (252.43 %) and CAT (226.89 %) enzymes in the leaves, and increased root SOD activity (9.93 %), relative to WW plants. These findings underscore the potential of rhizobacteria for enhancing sorghum physiological and growth responses to water deficit stress. Further multi-omics research is crucial to elucidate the molecular mechanisms underlying rhizobacteria-mediated osmotic stress tolerance.

Author contributions: Conceptualization, Ali Elnaeim Elbasheir Ali and Ndiko Ludidi; Methodology, Ruvimbo Mhari, Ali Elnaeim Elbasheir Ali, Liyabona Mula, Sibusiso Methembe Mbewe and Andiswa Beauty Boya; Formal analysis, Ruvimbo Mhari; Investigation, Ruvimbo Mhari; Resources, Ndiko Ludidi; Data curation, Ruvimbo Mhari; Writing - original draft, Ruvimbo Mhari; Writing - review and editing, Ali Elnaeim Elbasheir Ali; Visualization, Ruvimbo Mhari; Supervision, Ali Elnaeim Elbasheir

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Sciforum-208693: Metabolomic insights into salt tolerance-promoting rhizobacteria-mediated salinity tolerance in wheat seedlings

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Soil salinity is a major abiotic stress that limits wheat germination, seedling establishment, and productivity worldwide, with the greatest impact occurring during early seedling development. Salt tolerance-promoting rhizobacteria (STPR) have emerged as a promising sustainable strategy for improving crop tolerance to salinity; however, the metabolic mechanisms underlying these plant-microbe interactions remain poorly understood. This study investigated the effects of selected STPR isolates, *Paenarthrobacter* spp. (3A), *Pseudarthrobacter* spp. (6A), and *Arthrobacter* spp. (9A), isolated from *Hordeum marinum*, together with their consortium, on wheat germination and early seedling growth under different salinity levels (0-200 mM NaCl). Untargeted metabolomics was used to investigate metabolic changes associated with bacterial inoculation under salt stress.

High salinity significantly reduced germination percentage, radicle length, and seedling growth across treatments. Seeds inoculated with isolate 3A failed to germinate under all conditions. Inoculation with isolates 6A, 9A, and the consortium did not significantly improve germination between 0 and 150 mM NaCl compared with the uninoculated control under non-saline conditions. However, isolates 6A and 9A significantly improved germination at 200 mM NaCl. Isolate 9A enhanced radicle growth under low to moderate salinity (100-150 mM NaCl), whereas isolate 6A significantly improved radicle growth under severe salinity (200 mM NaCl).

Metabolomic analysis revealed distinct stress-responsive metabolic profiles associated with bacterial inoculation under salinity stress. Several putatively annotated metabolites, including salicylate-related compounds and purine derivatives, were more abundant in the 6A salt treatment than in uninoculated salt-stressed and untreated control seedlings, suggesting enhanced stress-related metabolic responses following bacterial inoculation.

Overall, these findings demonstrate the potential of selected STPR isolates as bioinoculants for improving wheat tolerance to salinity and highlight the importance of metabolomics for understanding the biochemical basis of plant-microbe interactions under salt stress.



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Sciforum-209946: Understanding cucurbitacin control of root-knot nematodes

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Cucurbitacins are a natural group of triterpenoid compounds that have received extensive research attention for the management of various pests, including nematodes. These bioactive molecules were reported to inhibit juvenile hatch, mobility, and mortality *in vitro* and significantly reduce root-knot nematode population densities in vivo. However, the precise investigation by which these molecules affect nematodes at the molecular level has not been extensively studied. Hence, the primary objective of the study was to determine the binding affinity and structure-reactivity of cucurbitacin A and B toward eight *Meloidogyne incognita* molecules critical to key life processes. Molecular docking of cucurbitacin A and B against eight (namely acetylcholinesterase, odorant response gene-1 (ODR1), cytochrome-c oxidase subunit 1, heat shock protein 90 (Hsp90), neuropeptide G-protein coupled receptor (nGPCR), aspartyl aminopeptidase, chitin synthase, triacylglycerol lipase) *M. incognita* molecules critical for key life processes, such as movement, chemo-sensation, energy production, and digestion was done using the Autodock Vina option accessible on Chimera. Molecular dynamics simulations were performed using the GPU-based PMEMD engine of the Amber 18 package. There were significant docking affinity scores on all investigated M. incognita molecules, ranging from −188.3 to −15.2 kcal/mol. The best-observed ligand interactions were with Hsp90, though the interaction sites varied with the cucurbitacin molecule. Overall, the understanding of the disruption of key molecular processes in nematodes observed in this study could provide innovative ways of combating this destructive pest and ultimately protect global agricultural systems.



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Session 5. Agroecology and Precision Agriculture

Sciforum-166517: AI-Enabled Agroecological Digital Twin for Sustainable Farming: Integrating Pest Dynamics, Crop Rotation, Soil Health, Biostimulation, Regenerative Economics, Distributed Computing, Geospatial Intelligence, and Communication Technologies

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Sustainable agriculture requires integrated intelligence capable of addressing interconnected challenges involving pest dynamics, crop rotation, soil health, biostimulation, resource efficiency, climate variability, and farm economics. Conventional agricultural decision-support systems typically analyze these dimensions independently, limiting their ability to represent complex agroecological interactions and provide adaptive, location-specific recommendations. This research proposes an **AI-Enabled Agroecological Digital Twin (AI-ADT)** that integrates artificial intelligence, digital-twin modeling, distributed computing, geospatial intelligence, Internet of Things (IoT), and advanced communication technologies to support sustainable and regenerative farming.

The study adopts a **mixed-methods research design**, combining quantitative experimental evaluation with qualitative assessment of farmer usability, interpretability, trust, and decision relevance. The proposed framework integrates IoT-based soil and environmental observations, remote-sensing imagery, weather records, crop histories, pest observations, biostimulation interventions, and economic indicators. Machine-learning models, including Random Forest, XGBoost, Support Vector Machine, Long Short-Term Memory, and hybrid deep-learning models, are comparatively evaluated for pest prediction, soil-health classification, crop-performance forecasting, and intervention optimization. The Digital Twin continuously synchronizes physical farm conditions with virtual representations to simulate crop-rotation strategies, pest outbreaks, soil-health trajectories, biostimulant responses, and regenerative economic scenarios.

Performance is assessed using accuracy, precision, recall, F1-score, RMSE, MAE, AUC, prediction latency, computational efficiency, scalability, communication reliability, resource-use efficiency, economic return, carbon reduction, and farmer trust. Comparative evaluation against conventional statistical models, isolated machine-learning approaches, centralized architectures, and non-digital-twin decision systems is designed to determine improvements in predictive accuracy, responsiveness, sustainability, and economic decision quality. Qualitative findings further examine explainability, usability, contextual relevance, and perceived decision-support value. The expected contribution is a unified, adaptive, geospatially aware AI-Digital Twin architecture that transforms fragmented agricultural data into predictive and prescriptive intelligence, supporting resilient farming, improved soil health, sustainable productivity, efficient resource allocation, and regenerative economic outcomes.



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Sciforum-172664: Retrieval of Wheat Nitrogen using Radiative Transfer Models and Machine Learning

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Accurate estimation of canopy nitrogen content (CNC) is critical for improving nitrogen use efficiency and supporting sustainable wheat production. While radiative transfer model (RTM) and machine learning (ML) approaches are widely used for biophysical parameter retrieval, their robustness across crop phenological stages remains insufficiently explored. This study develops a hybrid framework for CNC retrieval by integrating PROSAIL-simulated spectral data with ML regression models using UAV-based hyperspectral imagery in the visible to near-infrared (VNIR) region (400–1000 nm). Field experiments were conducted across 54 plots, generating a dataset of 162 samples collected at key growth stages, including stem elongation, flowering and grain filling, thereby capturing temporal variability in canopy structure and nitrogen status. Principal component analysis (PCA) was applied for spectral dimensionality reduction, and an active learning strategy was employed to optimize sample selection. PROSAIL was employed to simulate canopy reflectance by coupling leaf optical properties with canopy structural parameters, and inversion was performed using Gaussian Process Regression (GPR). Validation against field-measured CNC demonstrated that retrieval accuracy varied across key growth stages, with the highest performance observed at 90 DAS (R^2 = 0.72, RMSE = 8.2), corresponding to peak vegetative development and maximum canopy closure. The RTM-ML framework showed robust predictive performance and improved biophysical interpretability, enabling reliable estimation of CNC across phenological stages. Spatial CNC maps effectively captured within-field variability, aligning with fertilizer application patterns and identifying nitrogen-deficient and sufficient zones. These findings highlight the importance of phenological timing and demonstrate that integrating VNIR hyperspectral data with RTM-ML approaches provides a scalable, non-destructive solution for high-resolution nitrogen monitoring in precision agriculture.



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Sciforum-182968: Estimation of Hazelnut (*Corylus avellana* L.) Canopy Volume Using SLAM and UAV Point Clouds

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Increasing hazelnut (*Corylus avellana* L.) demand has stimulated interest in precision agriculture, where canopy volume is a critical parameter for site-specific orchard management. This study evaluated the relationship between point clouds derived from an unmanned aerial vehicle (UAV) and from simultaneous localization and mapping (SLAM) scanning for estimating the canopy volume of hazelnut trees

Fifteen five-year-old hazelnut trees of nine cultivars were surveyed at the University of Salerno experimental site (Italy) on 7 July 2026, on fully developed canopies. UAV imagery was collected in four flights at 10 m, combining nadir and oblique acquisitions, and jointly processed in Agisoft Metashape; the terrestrial survey used a SLAM-based light detection and ranging (LiDAR) scanner. In CloudCompare, individual trees were isolated and the trunk removed below the first branch. Mean nearest neighbour distance was computed in MATLAB for each cloud, and a common absolute cell size was set, per canopy, to the larger of the two values. Estimated volume was derived by octree voxelization, summing all cells containing at least one point.

Estimated volume ranged from 2.4 to 42.9 L for canopy by UAV (UAV_{Volume}) and from 25.9 to 93.5 L for canopy by SLAM ($SLAM_{Volume}$). Linear regression showed a positive relationship ($UAV_{Volume} = 0.42 \times SLAM_{Volume} - 2.26$; $R^2 = 0.55$; $p < 0.01$). The two methodology provide quantitatively different results. The estimated canopy volume obtained using the SLAM methodology regress significantly on the values obtained using the UAV methodology.

Given that both point clouds were voxelized using the same voxel size, UAV technology has more limitations. This technology does not fully examine the canopy geometry, because some portions remain occluded, especially when the trees have a spread canopy.

The SLAM methodology appears to provide a more accurate description of the canopy shape/volume, confirming LiDAR as a fundamental technology for precision agriculture applications in tree crops.



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Sciforum-188472: The Seed Dataset Library for Dynamic Laser Speckle Raw Images

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Seeds are the cornerstone of agricultural efficiency, and evaluating their quality through digital agriculture technologies, specifically image analysis, has become a prominent research frontier. Biospeckle Laser (BSL) is a reliable image technique for monitoring biological activity and for identifying seed vigour. This work aimed to create a collaborative, free-access gateway for sharing and retrieving datasets of raw BSL images, particularly of seed images. Developed using JavaScript and PHP, the platform allows users to upload and download datasets under the Creative Commons 4.0 license. Each dataset is accompanied by metadata, detailing laser specifications, acquisition rates, the DOI / URL of the associated research among other information. Additionally, it has an interactive human-machine interface for the online BSL analysis of image collections. The platform, named “BSL on Clouds”, is accessible at bslonclouds.com. To date, BSL on Clouds hosts eleven datasets, totalling 1390 speckle pattern images across seven from commercial seed varieties and four from native species. For example, in *Zea mays* L. (maize) seeds illuminated in its longitudinal sections, one dataset features over-illuminated samples that challenge analysis, while another provides ideal speckle patterns. The seeds’ library also offers access to high- and low-vigour raw speckle images datasets of soybean (*Glycine max* L.), common bean (*Phaseolus vulgaris L.*), additionally from seeds of purple trumpet tree (*Handroanthus impetiginosus*), and red angico (*Anandenanthera colubrina* (Vell.) Brenan). In some cases, images were captured on seed with their coats (tegument), whereas in other cases, the imaging were from seeds without the coat. Speckle images from seeds of coffee (*Coffea arabica* L.) close the list of seeds’ datasets in the library. By providing both raw data and analysis tools, this open-access framework plays a vital role in advancing collaborative research and standardization in the field of seed analysis using the BSL.



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Sciforum-189717: Climate-Resilient Agro-Morphological Traits and Conservation Potential of the Wild Tea Genotype TS567LVC from Coastal Central Vietnam

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The conservation and utilization of wild tea genetic resources are increasingly important for climate-resilient agriculture and sustainable crop diversification. This study evaluated the agro-morphological characteristics and conservation potential of the wild tea genotype TS567LVC, discovered in the coastal mountains of Phu Yen Province, central Vietnam. The genotype was compared with four locally cultivated tea varieties under field conditions to identify traits associated with environmental adaptation and agronomic value.

Morphological characterization was conducted using descriptors for leaf size, shoot vigor, branching pattern, internode length, and bud density. Agronomic performance was assessed through measurements of fresh shoot yield, flushing frequency, and resistance to common pests and diseases. Physiological observations were also recorded during periods of seasonal drought to evaluate tolerance to water deficit and high temperatures.

TS567LVC exhibited several distinctive features, including vigorous growth, dense branching, large leaves, and a high density of harvestable buds. The genotype maintained stable shoot production during dry periods and showed lower incidence of insect damage and foliar diseases than cultivated varieties. Preliminary analyses indicated superior adaptability to coastal environmental conditions characterized by sandy soils, variable rainfall, and elevated temperatures. In addition, the genotype possesses unique sensory attributes that suggest potential for the development of premium specialty teas.

The results demonstrate that TS567LVC is a valuable wild tea genetic resource with significant potential for climate change adaptation, germplasm conservation, and sustainable tea production. Its incorporation into breeding and conservation programs could contribute to biodiversity preservation and the development of resilient, high-value tea systems in Vietnam and other tea-growing regions.



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Sciforum-190722: Impact of future climate change on the development period of spring highland barley in Shigatse, Xizang

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The highland barley is the main food crop over the Tibetan Plateau, and its growth and yield is highly sensitive to climate change. Based on the data on the development stage (DVS) of spring highland barley in Xizagê and the daily meteorological data on the average temperature, precipitation and sunshine duration collected from 1992 to 2024, the response of DVS of highland barley to climate change in the recent 33 years was analyzed, and the leading meteorological factors influencing DVS were also identified through several statistical methods such as climate trend, Pearson correlation coefficients, Mann-Kendall, Cramer and stepwise regression method. The results showed that: (1) The dates of various development stages of spring highland barley have delayed significantly at a rate of 2.77-9.64 days per decade, with the dough stage delaying the most, and the maturity stage was delayed the least. The length of vegetative growth period (VGP) was slightly prolonged (0.62 d•10a-1), and the length of reproductive growth period (RGP) and whole growth period (WGP) was significantly shortened, with a rate of 3.63 days and 3.62 days per decade, respectively. (2) About 90% abrupt change in the delays of development stages occurred around 2010. Except for the sowing to three leaf stage, the abrupt change in the length of each development stage mainly occurred at the beginning of the 21st century. No abrupt change in the lengths of the VGP and WGP were identified, while the length of the RGP underwent a turning point from long to short growth period in 2013. (3) The slight increase in sunshine duration was identified as leading factor causing the extension of VGP length, while the significant shortened length of RGP was attributed to the combined effects of a noticeable decrease in precipitation and a significant rise in temperature, and the significant increase in temperature led to the significant shortened length of WGP.



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Sciforum-190729: Effects of climate change on yield of highland barley in Xizang

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Monthly average meteorological data from 31 meteorological stations in Xizang's highland barley planting areas between 1981 and 2024 were adopted for the study. The datasets include mean temperature (Tm), maximum temperature (Tmax), minimum temperature (Tmin), daily temperature range (TDR), precipitation (Pr) and sunshine duration (S), together with highland barley yield data and future climate scenario data from CMIP6.On this basis, we assessed the variations of highland barley yield under climate warming, analyzed the spatio-temporal characteristics of climatic resources during the growing season and their correlation with yield, and further explored the impacts of climate change on highland barley production. Using several statistical methods such as climate tendency rate, Pearson's correlation coefficient and stepwise regression method, as well as Mann-Kendall, Cramer, Yamamoto and other five test methods, the study results showed that: (1) Over the past 44 years during the growing season of highland barley in Xizang, the T_m, T_{max} and T_{min} exhibited a significant increasing trend, with T_{min} increasing the fastest. TDR and S decreased significantly, while P_r tended to increase. In general, T_m, T_{max} and T_{min} increased at all stations, P_r increased at 68% stations, and TDR and S tended to decline at 77% and 90% stations, respectively. The planting area, total yield and yield per unit area of highland barley showed a significant increasing trend. (2) In terms of mutation, the mutation of increase in T_{min} was earlier in the growth season of highland barley in the past 44 years, which occurred in 1998. T_m and T_{max} increased abruptly around 2005, while TDR, P_r and S underwent a transition from increasing to decreasing trends in the mid-to-late 1990s, around 2004, and in 2013, respectively. The abrupt increases in barley sown area, total output, and yield per unit area occurred around 2012, 1999, and 2001, respectively.



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Sciforum-190848: Socio-Ecological Extension and Bio-Rational Innovations: Empowering Women Farmers in Abuja Through Participatory Agro-Ecological Training

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Introduction

Conventional agricultural practices in Nigeria rely heavily on synthetic pesticides such as dimethoate and chlorpyrifos, posing long-term ecological and public health risks. To address these challenges, this study evaluated a participatory agro-ecological capacity-building intervention designed to promote bio-rational pest management, community health, and cost reduction among smallholder women farmers in the Gwagwalada Area Council, Federal Capital Territory.

Methods

A participatory action research design was conducted with 50 smallholder women farmers. The intervention comprised experiential workshops on formulating botanical pesticides, including a 72-hour fermented neem leaf extract and an onion-urine blend fortified with vegetable oil and detergent for enhanced foliar adhesion. Training effectiveness, adoption rates, and production cost variations were evaluated through pre- and post-intervention structured questionnaires, focus group discussions, and field monitoring over one cropping season. A conceptual framework was also developed to explore the potential integration of AI predictive algorithms and UAV-based crop monitoring into smallholder extension workflows.

Results

Participant technical competence in bio-pesticide preparation increased significantly from baseline levels (e.g., 18% to 92% mastery), while input expenditures for pest management decreased by an average of 35% among adopting households. Field evaluations demonstrated that botanical formulations effectively controlled target soft-bodied pests without observed phytotoxicity. However, lack of certified organic market pricing structures limited immediate premium economic returns. While direct crop yields were not empirically weighed across all plots, adopting farmers reported maintained crop productivity alongside substantially reduced operating overheads.

Conclusions

Participatory extension delivering bio-rational pest control offers an immediate, cost-effective pathway to enhance smallholder women's livelihoods and environmental health in peri-urban Nigeria. Integrating digital agriculture and predictive AI toolkits represents a promising future framework to complement organic practices and optimize field-level decision-making.



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Sciforum-191114: Activities of Aromatic Plant Hydrosols as Larvicides and Repellents against Culex pipiens: A Sustainable Bio-Based Approach

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In the context of the search for environmentally friendly alternatives to synthetic insecticides, this study evaluates the larvicidal and repellent activities of five aromatic plant hydrosols (*Thymus vulgaris*, *Eucalyptus globulus*, *Salvia rosmarinus*, *Lavandula angustifolia*, and *Mentha piperita*) against *Culex pipiens*. Plant-derived hydrosols represent promising bio-based products that may contribute to sustainable pest management by reducing reliance on synthetic chemical insecticides and supporting environmentally friendly practices.

The hydrosols were obtained by hydrodistillation and tested under laboratory conditions using transparent 100 mL cups containing 20 live larvae per cup at three concentrations (5%, 10%, and 20%), with three independent replicates per concentration. Repellent activity was evaluated using a bi-compartmental cage, with each concentration tested in triplicate.

Larvicidal assays revealed variable efficacy depending on plant species, concentration, and exposure time. *Thymus vulgaris* hydrosol exhibited the highest larvicidal activity, reaching 100% mortality at a 20% concentration after 24 h of exposure. *Eucalyptus globulus* showed moderate but progressive activity, whereas *Lavandula angustifolia* and *Mentha piperita* produced intermediate effects. *Salvia rosmarinus* demonstrated the strongest repellent activity against adults, achieving 100% repellency after 15 min at 25% and 50% concentrations, with high repellency maintained after 30 min.

Statistical analyses revealed significant differences among treatments (ANOVA, $p < 0.01$), confirming the influence of plant species, concentration, and exposure time on hydrosol efficacy. These findings demonstrate the potential of aromatic plant hydrosols as environmentally friendly bio-based insect control products. The observed differences among hydrosols also suggest that their chemical composition plays a key role in their biological activity. Further studies are recommended to characterize their chemical composition, evaluate their efficacy under semi-field and field conditions, and explore their integration into sustainable insect management programs. Overall, this work supports the development of natural alternatives to synthetic insecticides that are consistent with the principles of agroecology and environmental sustainability.



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Sciforum-195514: TRACE: LoRaWAN-Based IoT Monitoring and Data Analytics for Medicinal and Aromatic Plant Cultivation in Emilia-Romagna

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Medicinal and aromatic plants (MAPs) are an important agricultural domain in which biomass yield and phytochemical quality are strongly affected by soil moisture, air temperature, humidity, solar exposure, and the timing of agronomic operations. In Emilia-Romagna, this sensitivity is amplified by climate-related pressures, including drought, heat waves, and heavy rainfall. Consequently, MAP cultivation requires monitoring strategies able to capture field-scale variability. Current production practices often lack continuous, spatially distributed, and analytically integrated measurements of crop and soil conditions. Without proper monitoring, the interpretation of water stress relies mainly on domain experts' intuition, typically through visual analysis of the plant canopy. This procedure is costly and time inefficient, and it often detects water stress only at severe stages. This is suboptimal for MAPs, since water stress must be carefully managed: moderate stress may influence secondary metabolism and active-compound accumulation, whereas excessive stress reduces yield. In this abstract, we present an IoT framework developed within TRACE, a research project funded by the EU and the Emilia-Romagna region under the CoPSR 2023–2027 rural development program, to address this gap. The framework uses LoRaWAN weather stations and soil-moisture sensors deployed across 10 participating farms to acquire sub-hourly environmental, soil-moisture, and soil-temperature measurements. The data are processed, enriched, and stored, and crop-specific water-stress behavior is interpreted using FAO-56-based indicators. Data analytics methods are then applied to identify correlations among soil-water dynamics and plant response suporting the decision-making on the farmer side (e.g., mainly when to irrigate). The expected outcome is a data-driven decision-support framework that identifies and predicts water stress in each crop, improves irrigation scheduling, and characterizes the effects of climatic events, including heat and water stress.



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Sciforum-196279: Optimizing LED Spectral Composition and Daily Light Integral for Energy-Efficient Basil Production in Plant Factory Systems: A Systematic Review

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Introduction

Plant factory systems with artificial lighting (PFALs) are increasingly being explored as a sustainable approach to year-round production of high-value horticultural crops. Basil (*Ocimum basilicum* L.) is particularly well suited to these systems because of its short production cycle, high market value, and responsiveness to environmental manipulation. However, the high energy requirements of artificial lighting remain a major challenge to the economic and environmental sustainability of indoor farming. This review synthesizes current knowledge on how LED spectral composition and daily light integral (DLI) influence basil growth, morphology, phytochemical accumulation, and energy-use efficiency under PFAL conditions.

Methods

A systematic literature review was conducted following PRISMA guidelines. Relevant peer-reviewed studies were identified through Web of Science, Scopus, ScienceDirect, and Google Scholar. Ninety studies published between 2010 and 2025 met the inclusion criteria and were evaluated to assess the effects of spectral quality, photosynthetic photon flux density (PPFD), photoperiod, and DLI on basil productivity and quality.

Results

The reviewed studies consistently showed that balanced red–blue LED spectra (R ≈ 3:1–4:1) provided the most favorable balance between biomass production, plant architecture, and phytochemical quality. Red-dominant lighting generally promoted vegetative growth and leaf expansion, whereas blue and ultraviolet supplementation enhanced phenolic compounds, antioxidant activity, and essential oil accumulation, often at the expense of biomass. Moderate DLI levels (approximately 10–20 mol m^{-2} d^{-1}) were associated with improved productivity and greater light-use efficiency. The findings also highlighted significant interactions among spectral composition, DLI, and cultivar-specific responses.

Conclusions

The evidence indicates that neither spectral quality nor DLI should be optimized independently. Instead, sustainable basil production in PFAL systems requires integrated lighting strategies tailored to specific production objectives. This review proposes a conceptual precision-lighting framework that links spectral composition, DLI management, crop quality, biomass production, and energy-use efficiency, providing a basis for more sustainable and resource-efficient indoor basil cultivation.



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Sciforum-197041: Growth performance of *Amaranthus tricolor* in response to varying light intensities in Controlled Environment Agriculture

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Amaranthus tricolor belongs to the *Amaranthaceae* family and is recognized as a climate-resilient facultative halophyte due to its innate physiological plasticity under extreme environmental conditions. While controlled environment agriculture (CEA) ensures resource-efficient food production, optimizing light intensity (PPFD) is crucial to maintain proper growth, high quality, and lower excessive energy costs. Therefore, in this study, *Amaranthus tricolor* cv Red Aztec was grown under varying photosynthetic photon flux density (PPFD) levels (150, 250, 350, and 450 µmol m^{-2} s^{-1}) in a hydroponic solution of 150 mM NaCl. All other environmental conditions, including a Blue:Red:Far-Red LED spectrum at 22:65:13, 16-h photoperiod, temperature +18/22 ± 2 °C, and relative humidity of 64%, were kept constant in a walk-in growth chamber of a deep-water culture hydroponic system throughout the experiment. Results showed no significant changes in survival rate and root length across PPFD levels. The highest plant height (15.4 cm), specific leaf area (284.9 cm^2 g^{-1}), and tissue water content (91%) were observed at 350 µmol m^{-2} s^{-1} PPFD. ΔFW/ΔDLI was highest (63%) at a shift from 350 to 450 µmol m^{-2} s^{-1} PPFD, followed by (37%) from 250 to 350 µmol m^{-2} s^{-1} PPFD. These results highlight the profound environmental plasticity that shows the climate resilience of *Amaranthus tricolor*. Optimal growth performance at 350 µmol m^{-2} s^{-1} PPFD, and the lack of statistical significance in light use efficiency between 250-350 and 350-450 µmol m^{-2} s^{-1} PPFD, justifies selecting 350 µmol m^{-2} s^{-1} as the ideal sustainable threshold for *Amaranthus tricolor*. Selecting this PPFD level not only supports better growth performance but also minimizes electricity costs, ensuring both economic and ecological sustainability in controlled-environment agriculture.



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Sciforum-198496: Predictor selection for ordinal classification of physiological fruit drop in persimmon: a comparison across rootstocks

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Physiological fruit drop is a major source of yield variability in persimmon (*Diospyros kaki* Thunb.) orchards, and its short-term, treatment-specific prediction could support data-driven irrigation scheduling within precision agroecology frameworks. This study evaluates how distinct families of predictors contribute to the ordinal classification of weekly point fruit drop in trees grafted onto *Diospyros lotus* and *Diospyros virginiana* rootstocks, under contrasting, site-specific water-supply regimes. Data were collected over five growing seasons (2015–2019) in a commercial 'Rojo Brillante' orchard (Llíria, Spain) under a randomised complete block design combining two planting layouts and irrigation strategies, including sustained and regulated deficit irrigation. Point fruit drop was assessed weekly and assigned to a five-class ordinal scheme (0; 1–4; 5–30; 31–100; $>$100 abscised organs). From an initial predictor pool spanning phenological, thermal, hydric and response-history variables, a non-redundant subset (|Spearman's rho| $<$ 0.75) was retained: photoperiod, cumulative annual hydric balance, mean minimum temperature, and the previous fruit-drop rate, alongside the previous fruit-drop value (lag-1). Tree-level ordinal models were fitted separately for each rootstock using LogitBoost ensembles within a cumulative-threshold framework, tuned via nested leave-one-year-out cross-validation with Bayesian optimisation, and then aggregated to the treatment level for direct use in orchard-scale decision-making. Models combining all four non-redundant predictors with lag-1 consistently outperformed the autoregressive-only reference (Class MAE: 0.476 vs 0.599 for *D. lotus*; 0.462 vs 0.503 for *D. virginiana*; QWKappa: 0.682 vs 0.495 and 0.767 vs 0.753, respectively), while single-predictor additions showed rootstock-dependent, often inconsistent gains. These results indicate that no single environmental driver reliably improves on persistence-based prediction, but their joint inclusion yields consistent, low-dimensional gains across genetic backgrounds, supporting a parsimonious forecasting tool deployable for treatment-level, site-specific irrigation management within precision agroecology systems.



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Sciforum-198790: Precision Agriculture in a Bibliometric Approach

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Digital technologies are increasingly reshaping agricultural production, management and knowledge systems, but the literature has evolved rapidly and is characterized by substantial conceptual and geographical heterogeneity. This study examines how research on the digitalization of agriculture has developed and how the emerging technological agenda is connected to the sus-tainability of farming systems. A bibliometric analysis and a systematic, interpretive review were conducted using a Scopus export supplied by the authors. The dataset contains 340 English-language research articles retrieved for the topic of digitalization of agriculture. Keyword co-occurrence and bibliographic coupling were used to identify the intellectual structure of the field, while a temporal synthesis was used to distinguish three interpretive phases: an emergence phase (2014–2019), an integration and Agriculture 4.0 phase (2020–2022), and an AI-enabled and sustainability-oriented phase (2023–2026). The temporal distribution shows a pronounced acceleration of research after 2020, with 234 articles published during 2023–2026. The literature indicates a transition from connectivity, precision agriculture and digital infrastructure towards integrated smart farming, Internet of Things, artificial intelligence, big data, remote sensing and increasingly autonomous or predictive systems. The contribution of digital technologies to sustainability is not automatic: evidence is strongest for resource-efficiency, monitoring, decision support and resilience, while social sustainability, data governance, digital inclusion and rebound effects remain important constraints. The study therefore conceptualizes digitalization not as an end in itself, but as a socio-technical process whose sustainability effects depend on technology characteristics, adoption capabilities, institutional governance and the objectives against which technological performance is evaluated.



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Sciforum-198800: Investigation of the possibilities for the application of fluorescence spectroscopy in comparative analysis with the male gametophyte of pepper subjected to drought

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In recent decades, drought has been a major factor limiting sustainable crop production worldwide. Drought in vegetable crops, coinciding with the reproductive period, is one of the main factors limiting plant productivity. Drought leads to the shedding of flower buds and flowers, which leads to poor quality and reduced production. The aim of this study is to investigate the drought tolerance of pepper through an integrated approach, including fluorescence spectroscopy and the study of the male gametophyte. The object of the study are thirteen Bulgarian pepper cultivars (Capsicum annuum L.) from four cultivar groups - the conical group, the large group, Kapia and those from the grinding group were studied. The studies were conducted during the growing season on optimal and 50% reduced irrigation. Fluorescence spectroscopy was applied “in vivo” on leaves and stems, and in parallel, pollen fertility and viability were analyzed in control and dried plants.

The results show that a stronger fluorescence intensity is observed under optimal conditions compared to that under reduced irrigation and that the emission wavelengths of fluorescence recorded in stems and leaves differ among genotypes. The strongest intensity under drought conditions was recorded in cultivars Kaloyan and Baltovska kapia.

The results obtained correspond to the data from the indicators of the male gametophyte, as under reduced irrigation conditions the varieties Kaloyan and Baltovska Kapia have the highest pollen fertility (45.9% and 54.0%, respectively), pollen germination (38.7% and 43.3%, respectively) and pollen tubes length (275.9μm and 266.9 μm, respectively). This gives reason to assume that fluorescence spectroscopy is applicable in primary screening for assessing abiotic stress in red pepper during the growing season in a greenhouse. Based on the performed analyses and the overall evaluation of the obtained results, a long-term plan for the development of scientific research will be prepared, which will be aimed at: New results related to the combination of cytological and optoelectronic methods.



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Sciforum-198929: IoT-Assisted Organic Compost Production in Open Piles

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Soil fertility degradation and synthetic input dependency threaten the sustainability of Mediterranean ecosystems. Reusing organic by-products to restore soil health, through recycling, resilience, and efficiency, is a core agroecology principle, yet open-pile composting remains manual and hard to track at scale. Cost-effective IoT sensing now opens new possibilities for precision agroecology at farm level.

The IoT-assisted organic compost monitoring solution, developed in the Horizon Europe OpenAgri project, turns this opportunity into practice through integrated sensor networks and data-driven decision-making that replace manual, data-poor composting with automated, evidence-based interventions (OpenAgri SIP5, 2025).

The solution deploys LoRaWAN-enabled wireless sensor nodes for low-power, long-range monitoring of temperature, moisture oxygen, and pH across multiple compost piles simultaneously. A structured data model integrates pile conditions, process states, NPK history, and live weather data into a decision engine that recognises the active composting phase (Mesophilic, Thermophilic, Cooling), predicts final NPK content, and recommends targeted interventions (aeration, watering), without manual guesswork. Two deployment models were developed and compared: a cloud-based hosted on virtual servers and b) an edge-based version, running locally at the compost managers' premises with no internet dependency. Both solutions were field-validated in Cyprus (May-September 2025) on two compost piles, using the cloud and edge based versions respectivelty, alongside a third pile manually managed. Both digital solutions reduced required field visits by close to 30% and produced higher, more mature compost than the manual control. The edge-based version proved better suited to remote piles lacking 4G/5G connectivity and both allowed piles to be installed directly where raw material was generated e.g. sheepfolds, vegetable warehouses.

These findings demonstrate that low-cost, modular IoT monitoring can bring precision composting within reach of small and medium-scale Mediterranean producers, improving both compost quality and operational efficiency without major infrastructure investment.



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Sciforum-199254: Performance of Turbulent-Flow Drip Emitters under Thermal Variability

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Water temperature can vary substantially during drip irrigation, altering emitter hydraulic behaviour through changes in water viscosity. As key components of drip irrigation systems, emitters play an important role in precision agriculture by enabling accurate water application and improved irrigation management. Temperature-induced variations in emitter performance may affect irrigation uniformity and the accuracy of water delivery under field conditions. However, current standards define nominal discharge at 23 ± 3 °C and do not explicitly account for thermal variability. This study assessed the effects of water temperature on the discharge performance of turbulent-flow drip emitters under laboratory conditions. Two commercial emitter models were evaluated at 15, 23, and 33 °C across operating pressures from 50 to 400 kPa, following the UNE-EN ISO 9261:2010 framework. Discharge, pressure-discharge behaviour, flow-rate variation, and flow-rate index were analysed. The effects of water temperature, pressure sequence, and interactions were assessed using linear mixed-effects models, while pressure-discharge relationships were characterised by nonlinear regression.

Water temperature significantly influenced emitter discharge ($F = 105.9$, $p < 0.001$), with a consistent response across emitter models. All models showed decreased flow rates with rising temperatures. Flow-rate index values remained close to 1, suggesting limited thermal sensitivity, though a gradual decline was observed with increasing temperature. Additionally, temperature affected the fitted discharge coefficient and flow exponent, while pressure-discharge relationships remained highly stable across temperature variations ($x = 0.476–0.485$; $R^2 = 1.000$). The observed temperature effects on emitter performance highlight the need to account for thermal variability in drip irrigation systems operating under field conditions. Incorporating thermal-response parameters into precision agriculture strategies may contribute to improved irrigation management, enhanced water-use efficiency, and more sustainable agroecological systems.



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Sciforum-199307: Effect of Temporal Aggregation on the Performance of Reference Evapotranspiration Estimates along the Spanish Mediterranean Coast

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Reference evapotranspiration (ET_0) is a key variable for estimating crop water requirements and supporting irrigation management. The FAO Penman–Monteith (FAO56 PM) equation is accepted as the standard method for ET_0 estimation; however, it requires a set of meteorological variables that are not always available. Consequently, simple empirical approaches such as the Hargreaves-Samani equation (HS), and many sophisticated approaches, such as machine learning techniques have been assessed as alternatives for ET_0 estimation.

Most studies have focused on daily ET_0 estimates, assuming that high daily accuracy is essential for irrigation scheduling. Nevertheless, irrigation decisions are frequently based on evapotranspiration accumulated over several days or weeks. Under these conditions, differences observed at the daily scale might not necessarily translate into equivalent differences in practice.

This study compares the performance of a simple temperature-based empirical method (HS equation) and a complex six-input artificial neural network (ANN6) for estimating ET_0, using FAO56 PM benchmarks. The analysis used records from more than 80 agrometeorological stations along the Spanish Mediterranean coast over 2000–2024. Performance was assessed by comparing daily and cumulated weekly and monthly estimates. ANN6 was validated using k-fold validation.

The results indicate that, as expected, ANN6 provided considerably lower errors than HS at the daily scale. However, the discrepancies decreased progressively as ET_0 was accumulated. At weekly and monthly scales, the improvement of ANN6 over HS was substantially reduced, as a fraction of daily errors cancelled out through temporal aggregation.

These findings suggest that the practical advantage of sophisticated models may be smaller than daily metrics indicate when irrigation scheduling relies on accumulated evapotranspiration. Over irrigation-relevant periods, reliable enough ET_0 values might be already obtained with simple methods, lowering the barriers to precision agriculture in settings where the inputs or expertise required by sophisticated methods are unavailable.



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Sciforum-199749: Non-destructive assessment of quality attributes across various apple varieties

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Harvest maturity is a key factor determining the storage life and final quality of fruit reaching the market. The growing consumer demand for high-quality fruit year-round therefore requires optimizing harvest timing. Consequently, the development of decision-support technologies is crucial. In this study, we evaluate the performance of the DA-Meter across different apple cultivars. This is a hand-held device that offers a simple, fast, and non-destructive solution for analyzing the fruit's ripeness state. Its operating principle is based on measuring the concentration of chlorophyll in the fruit through its absorbance properties, presenting the result as an index (IAD).

'Gala', 'Golden', 'Granny Smith', 'Fuji' and 'Story' apple varieties were evaluated at harvest and after cold storage at 1ºC under normal atmosphere. A pre-harvest assay was also performed with the variety 'Story'. Following the measurement of the IAD, quality parameters of the fruits were analyzed by conventional destructive methods. This allowed to assess the suitability of the IAD for monitoring the ripeness state across various apple cultivars, as well as to evaluate it correlation with key fruit qualitative attributes, namely the total soluble solids content (TSS), pulp firmness, starch index (SI), titratable acidity (TA), and tonality.

The analyses conducted with 'Story' resulted in determination coefficients (r^2) of 0.81, 0.63, 0.57, and 0.55 between IAD and SI, TSS, tonality and firmness, respectively. At harvest, varieties with similar stage of maturity showed significantly different IAD values, highlighting the need for distinct reference values for this parameter for each variety. On the other hand, the results obtained for 'Granny Smith' were inconclusive, as significant disparities in ripeness state and associated qualitative parameters did not correspond with a significant difference in the IAD for this variety.



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Sciforum-199893: Sentinel-2 NDVI as a tool to monitor potato crop development across planting calendars

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Planting date is a key agronomic decision in potato cropping systems, especially given increasing climate variability. Remote sensing offers a method for monitoring crop development repeatedly throughout the growing season. This study aimed to evaluate whether Normalized Difference Vegetation Index (NDVI) time series derived from Sentinel-2 can be used to describe potato crop development and detect differences in vegetation dynamics among plots managed under different planting schedules.

Sentinel-2 images acquired during the experimental crop cycle were used to calculate mean NDVI values for each plot, observation date, and planted variety. Invalid observations and dates outside the crop cycle were removed to improve the temporal consistency of the dataset. Subsequently, NDVI time series were analyzed for the 2024 and 2025 growing seasons. The main phases of crop development were characterized, including emergence, canopy establishment, peak vegetative growth, and end-of-season decline.

Preliminary results showed that NDVI trajectories followed consistent temporal patterns, aligned with potato crop development and observed field phenology. Filtering observations according to the actual crop cycle improved the interpretability of the curves and allowed for clearer comparisons between plots. The differences in the timing and magnitude of the NDVI increase and peak values suggest that Sentinel-2 time series can capture relevant variation associated with planting schedules and crop phenological development, and could therefore become a tool to support farmers' planting decisions.

These preliminary findings support the use of satellite-derived vegetation indices as a complementary tool for monitoring potato crop development and comparing the effects of planting schedules. Further integration with field phenology and thermal time metrics could improve agronomic interpretation.



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Sciforum-199989: When Technology Makes Sense: Personal Values and Digital Adoption by Small Dairy Farmers

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The adoption of digital technologies in dairy farming has been associated with productive modernization, increased efficiency, and improved farm management. However, among small producers, this process does not occur homogeneously, as it involves economic constraints, technical limitations, unequal access to information, and different ways of interpreting the usefulness of technologies. Therefore, this theoretical essay aims to discuss how personal values can broaden the understanding of digital technology adoption by small dairy farmers, articulating the Theory of Personal Values and the Means-End Chain Theory. The study is characterized as a reflective theoretical essay, developed from the literature on technology adoption in dairy farming, personal values, and the Means-End Chain approach. The analysis assumes that digital technologies can be understood not only through their technical attributes, but also through the perceived consequences and the values that give meaning to adoption. The proposed discussion indicates that digital adoption can be interpreted as a meaning-oriented process, in which producers evaluate technologies based on the relationship between their characteristics, their effects on productive routines, and the values they seek to preserve or achieve. Thus, ease of use, cost, accessibility, compatibility with routines, and technical support become relevant when associated with production control, loss reduction, decision-making security, income improvement, and continuity of dairy farming. These consequences may be connected to values such as security, autonomy, family well-being, permanence in rural areas, and appreciation of rural work. The theoretical contribution of this essay lies in bringing the literature on digital adoption closer to the approaches of personal values and the Means-End Chain, shifting the analysis from merely technical and economic factors to the links between attributes, consequences, and values. This approach provides insights for technology diffusion strategies that are more sensitive to the reality of small producers.

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Sciforum-200009: What Drives Digital Agriculture Adoption? Evidence from the Brazilian Coffee Sector

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Digital technologies constitute the foundation of precision agriculture, providing essential tools for resource optimization and improving agricultural production. However, adopting such innovations extends beyond their availability, depending on the perceived benefits, compatibility with existing farming practices, and broader socio-institutional factors. This study analyzes the determinants of digital technology adoption among coffee growers in the South of Minas Gerais, Brazil. The proposed framework integrates constructs from the Diffusion of Innovations (DOI), Technology Acceptance Model (TAM), and Unified Theory of Acceptance and Use of Technology (UTAUT). Specifically, DOI contributes Relative Advantage, Compatibility, Trialability, and Observability; TAM contributes Perceived Ease of Use; UTAUT contributes Social Influence; and the model incorporates Institutional Support. A quantitative, cross-sectional survey of 274 coffee producers was analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). The results indicate that Social Influence and Institutional Support are the primary direct predictors of technology adoption. Observability also influences adoption and is positively affected by Relative Advantage, Compatibility, Institutional Support, and, most notably, Trialability. Cultivated area, productivity, and prior financial performance also positively affect adoption. Beyond these structural characteristics, digital technology adoption significantly increases producers' intention to recommend these technologies to other farmers, reinforcing the role of social networks in innovation diffusion. Furthermore, when producers face barriers such as limited ease of technology use, the visible demonstration of practical benefits (Observability) becomes a key compensatory mechanism facilitating adoption. The findings suggest that advancing digital agriculture in coffee farming requires strategies that strengthen institutional environments and social networks, promote prior experimentation, and enhance the visibility of observable benefits, thereby reducing adoption barriers and encouraging broader technology uptake.

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Sciforum-201013: The Agroecology Revolution: Redesigning Food Systems for Sustainability, Resilience and Social Justice

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The global agri-food system faces unprecedented challenges, including climate change, biodiversity loss, soil degradation, resource scarcity, and growing social inequalities. In this context, agroecology is increasingly recognized as a transformative framework capable of reshaping food systems from production to consumption by integrating ecological principles, scientific knowledge, traditional practices, and social innovation.

Although often presented as a novel approach, agroecology has deep historical roots. The pioneers of organic agriculture, Rudolf Steiner and Sir Albert Howard, placed ecological interactions, soil health, biodiversity, and the harmonious relationship between farming and nature at the center of their vision of agricultural production. In this sense, agroecology represents both an innovation and a rediscovery of foundational principles that have long guided sustainable farming systems.

Drawing on recent international experiences and policy developments, this keynote will explore how agroecological approaches can enhance ecosystem services, strengthen climate resilience, reduce dependence on external inputs, and support more equitable and resilient rural communities. Particular attention will be given to the role of agroecology in advancing the United Nations Sustainable Development Goals and accelerating the transition toward regenerative food systems.

Ultimately, the agroecology revolution offers a practical and scientifically grounded pathway toward environmental sustainability, food security, and social well-being.

The keynote will discuss the opportunities and challenges associated with scaling up agroecology, highlighting the need for supportive public policies, innovative educational models, and collaboration among researchers, farmers, institutions, and civil society. Particular attention will be given to the role of agroecology in achieving the United Nations Sustainable Development Goals and supporting the transition toward regenerative food systems.

Ultimately, “The Agroecology Revolution” represents a profound rethinking of the relationship between agriculture, nature, and society. It offers a practical framework for addressing environmental and social crises while ensuring food security, ecosystem restoration, and long-term sustainability.



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Sciforum-204589: Renewable energy in agroecosystems: Physiological effects of wind farms on a terrestrial farmland mammal

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Agricultural land is primarily used for food production, but it also provides habitat for a wide range of wild species that contribute to farmland biodiversity. Increasingly, cultivated areas are also used for renewable-energy production. Wind turbines are often located on agricultural land because they cause relatively little loss of productive area while creating an additional land-use function. For wildlife adapted to farmland habitats, however, wind-energy infrastructure represents an evolutionarily novel environmental factor. Environmental impact assessments focus mainly on birds and bats, whereas effects on terrestrial mammals remain poorly understood. The aim of this study was to assess whether the integration of wind-energy infrastructure into agricultural landscapes is associated with physiological stress responses in male European roe deer, as an indicator of potential impacts on farmland biodiversity. The study was conducted in Poland during 2022–2024 in three wind-farm areas and three matched control areas located up to 20 km from wind-farm boundaries and characterized by similar major land-cover types. Male roe deer were sampled during the summer hunting season (14 May–8 September). A total of 37 fecal samples and 29 hair samples were analyzed. Fecal cortisol metabolites represented short-term stress responses, whereas hair cortisol reflected longer-term physiological burden. Fecal cortisol metabolites increased during the rut ($p = 0.002$), while wind-farm presence had no significant effect on this marker ($p = 0.112$). In contrast, hair cortisol was significantly higher in males from wind-farm areas ($\beta = 0.47$, $p = 0.010$). These findings suggest that wind-energy infrastructure may not trigger an acute stress response but may be associated with cumulative physiological costs detectable over longer temporal scales. Including long-term physiological indicators may therefore improve assessment of biodiversity impacts associated with the multifunctional use of agricultural landscapes for both food and renewable-energy production. Funding: Narodowe Centrum Nauki (2021/41/B/NZ9/04442).



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Sciforum-204594: Balancing crop production and biodiversity: Wheat and maize as contrasting habitats for the European hamster

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Modern agriculture performs an increasing number of functions that extend beyond traditional food production. One of these is the production of feedstock for renewable energy, particularly biomass used for biogas, heat, and biofuel generation. As a result, the share of high-biomass crops is increasing in many agroecosystems, with maize playing a particularly important role. From an economic perspective, such crops contribute to the goals of the energy transition and the diversification of agricultural production. At the same time, their expansion may alter crop structure, simplify agricultural landscapes, and reduce the area of traditional crops that have long provided habitat for many species associated with arable fields. The aim of this study was to assess how two contrasting crop types (wheat as a traditional cereal crop and maize as a crop of increasing production and energy importance) affect the occurrence of the European hamster *Cricetus cricetus*, a critically endangered mammal species strongly associated with agricultural landscapes. The study was conducted in south-eastern Poland, in a region dominated by arable land and characterised by a mosaic field structure. In randomly selected one-hectare study plots, hamster presence and burrow density were assessed and treated as indicators of crop habitat suitability. The results revealed clear differences between the analysed crops. Hamsters occupied wheat fields much more frequently than maize fields, and burrow density was several times higher in wheat. Wheat therefore provided more favourable habitat conditions, probably due to greater availability of food and cover during key stages of the life cycle. These findings show that decisions concerning crop structure have direct implications for the conservation of biodiversity in agroecosystems. In areas inhabited by critically endangered species, sustainable agricultural planning should take into account not only the productive and energy efficiency of crops, but also their habitat function for species of high conservation concern.



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Sciforum-208061: The potential contribution of artificial intelligence to the selection and use of farm machinery

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The use of artificial intelligence (AI) in agricultural mechanisation is well established in automated machine control, predictive maintenance and precision farming. However, its potential to support strategic and managerial decisions concerning the selection and use of farm machinery remains comparatively underexplored. This contribution examines the current role and future potential of AI in this field, with particular attention to the integration of meteorological, climatic, soil, phenological, agronomic, labour-related and farm-configuration data, as well as to the influence of the decision-maker's preferences and priorities.

Based on a review of recent literature, AI applications are classified through a two-dimensional matrix combining four functional categories—descriptive, operational support, predictive and prescriptive—with four cognitive macro-domains: physico-chemical, biological-ecological, production-organisational and economic-social. The analysis indicates a marked predominance of prescriptive applications, followed by predictive and operational-support approaches, whereas purely descriptive applications generally play a preliminary role.

Technical-operational domains are relatively mature, while production-organisational and economic-social contexts remain more complex owing to uncertainty and human behavioural factors. At the strategic level, machine learning, predictive analytics and decision support systems are mainly used to estimate performance, power requirements, costs and fleet size, often in combination with multi-criteria and optimisation methods. At the operational level, reinforcement learning, evolutionary algorithms, swarm intelligence and related computational intelligence techniques support scheduling, dynamic resource allocation and field-operation management.

The literature shows a transition from traditional decision support systems towards adaptive, closed-loop architectures integrating forecasting, optimisation, execution and feedback. This evolution is fully consistent with Smart Farming approaches. Nevertheless, strategic planning and operational management are still mostly addressed separately. Future research should therefore develop interoperable AI-based decision-making systems able to jointly optimise machinery fleet composition, scheduling and real-time rescheduling across the full agricultural mechanisation management cycle.



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Sciforum-208281: Assessing floristic diversity in Latvian apple orchards: the role of land-use history and orchard management

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Apple orchards can support spontaneous ground vegetation and contribute to biodiversity conservation in agricultural landscapes. However, species richness alone does not fully reflect ecological value, because species-rich sites may include both ruderal taxa and elements of semi-natural vegetation. This study assessed floristic diversity in Latvian apple orchards, focusing on unique taxa, field-history indications and biodiversity-oriented orchard floor management. Floristic surveys were conducted in 14 fruit orchards in different parts of Latvia in 2025. Two lists were recorded in berry (blackcurrant) plantings; therefore, the apple-orchard-specific analysis used 12 lists from 11 apple-growing locations, including one farm with two surveyed orchard locations. Species presence/absence, family affiliation, taxon frequency and unique taxa were analysed together with field-history notes on previous land agricultural use: pastures, perennial grasslands, forest borders and orchards. The apple orchard dataset comprised 137 plant taxa from 36 families. Species richness ranged from 26 to 72 taxa per list. Asteraceae, Poaceae and Fabaceae were the most species-rich families. The floristic core included *Taraxacum officinale*, *Dactylis glomerata*, *Plantago major*, *Vicia cracca* and *Trifolium repens*. In contrast, 48 taxa occurred in one list and 22 taxa in two lists, indicating high floristic heterogeneity. Seven apple-orchard lists had field histories mentioning pastures or perennial grasslands, and six mentioned forest borders or surrounding forests. These histories coincided with meadow, moist-grassland or edge-related taxa, including *Lotus corniculatus*, *Trifolium medium*, *Pimpinella saxifraga*, *Centaurea jacea* and *Lathyrus pratensis*. Lists described as orchard or agricultural land showed a more synanthropic floristic pattern. Latvian apple orchards are heterogeneous agroecosystems supporting both synanthropic and semi-natural vegetation elements. Field-history information, together with unique taxa, can help identify orchards with higher biodiversity value and guide biodiversity-oriented orchard floor management.

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Sciforum-208295: Monitoring of Tomato Phenological Phases through MOX Gas Sensors and Machine Learning

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The integration of machine learning (ML) into precision agriculture represents a transformative advancement over traditional farming approaches, which are increasingly hindered by environmental stressors such as climate change. A fundamental requirement for optimized crop management is the precise estimation of plant phenological phases (PPhases), which characterize the critical stages of growth and development. Despite their importance, the identification of these stages still largely relies on conventional observation methods that may lack the necessary precision under highly fluctuating environmental conditions. This study explores the potential of the olfactory environment of industrial tomato crops to serve as a reliable indicator of their PPhases using both unsupervised and supervised ML techniques.

Throughout a three-year period from 2020 to 2022, industrial tomato crops were continuously monitored using a multifunctional sensing station equipped with humidity and temperature sensors, as well as four specialized metal-oxide (MOX) gas sensors (SnO_2/Au, SnO_2/Pt, SnO_2/Pd, and WO_3). Initial exploratory analysis via Principal Component Analysis (PCA) revealed a distinct natural clustering of the data, indicating that sensor-response patterns associated with phenological phases possess significant discriminative power to distinguish between specific PPhases. Following this, various classification models were trained and validated using a 5-fold cross-validation approach.

The k-Nearest Neighbors (k-NN) algorithm consistently demonstrated superior performance and was applied to the extensive three-year dataset. Testing across various train/test splits (90/10, 75/25, and 50/50) yielded exceptional results, with accuracy, AUC, and other key performance metrics consistently exceeding 98%. Such high performance across different data partitions confirms the robustness of the approach and suggests that PPhases are defined by stable sensor-response patterns associated with different phenological stages.

Consequently, this study demonstrates the feasibility of developing cost-effective classification systems using low-cost MOX hardware and lightweight algorithms for digital agriculture.



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Sciforum-208540: Managing Human-Elephant Conflict and Conserving Aquatic Biodiversity for Sustainable Livelihoods: Integrative Conservation in the Lake Jipe Ecosystem

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In the transboundary basin of Lake Jipe, human-wildlife conflict involving African elephants has contributed to a cascading ecological problem affecting both community livelihoods and aquatic biodiversity. Frequent crop raids on small-scale farms in Kachero and Mkocheni have caused substantial losses of food and income, pushing local populations toward the lake as a primary source of sustenance. The resulting fishing pressure poses a threat to the endemic, critically endangered Lake Jipe tilapia (*Oreochromis jipe*). To address this, the Eco-Jipe program, an NGO based in Taveta, piloted an integrative framework designed to secure agricultural livelihoods and reduce dependence on lake resources, combining microclimate sheds that protect vegetable crops from megaherbivore incursion with community-managed beehive fences based on biological deterrence. Over a sixteen-month pilot involving 5 participating farmers across 5 shed installations and 159 metres of beehive fencing, livelihood changes were assessed through structured interviews, while fishing effort was measured as fishing trips per week in collaboration with 2 Beach Management Units. Fishing effort among participating households declined from approximately seven trips per week at baseline to three to four trips per week by the end of the pilot — a reduction of roughly half — coinciding with improved agricultural stability and supplementary income from honey sales. One shed withstood an attempted elephant intrusion during the pilot; longer-term monitoring across repeated intrusion events is needed to confirm structural effectiveness. While direct recovery of *O. jipe* populations was not measured, the observed reduction in fishing pressure represents a potential conservation benefit for the species. These pilot results suggest that mitigating human-elephant conflict through climate-smart agroecology and biological deterrence may reduce pressure on aquatic resources while supporting local livelihoods in transboundary ecosystems, warranting expanded trials and direct biological monitoring.

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Sciforum-208543: Mapping crop diversity with open remote sensing data: a regional application in NE Italy

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In the context of global environmental change, improving agriculture sustainability requires accurate and up-to-date crop maps. Although remote sensing now supports crop mapping at multiple spatial scales, two major challenges remain: distinguishing a broad range of crop types beyond dominant monocultures and maintaining classification accuracy across years despite interannual variability. This study aims to develop a fully open workflow for regional-scale crop mapping, with two objectives: a) classifying a diverse set of arable crops under strongly imbalanced class frequencies; and b) assessing model transferability across years.

The study was conducted within the SICANSE project in Friuli Venezia Giulia (NE Italy), a region characterized by a strong imbalance in crop diversity, with over 50% of arable land covered by just maize and soybeans. Crop classification was conducted at the parcel level, extracting ca. 100,000 reference polygons from the regional agricultural database (AGEA - Agency for Agricultural Payments). For each year (2019-2025), weekly Sentinel-2 composites were retrieved using openEO. Random Forest models were developed for the two main cropping seasons, extracting phenological parameters and spectral indices from the satellite time series, and evaluated on independent parcels.

Performance largely differs across classes. Common and well-represented crops, including wheat, rapeseed, maize, soybeans, were classified with good accuracy (F1 $>$ 0.7), whereas rare crops remained difficult to distinguish (e.g., oat, spelt, rye; F1 $<$ 0.4), while strategies for dealing with class imbalance (e.g., pixel-level sampling, class aggregation) partly mitigate this issue. The temporal transferability of a single-year model is low, highlighting inter-annual variability as a critical limitation, and ongoing work explores multi-year training and ancillary data as potential solutions.

Overall, these results support the use of open remote sensing data as a basis for regional crop mapping, laying the ground for broader monitoring frameworks, including conservation agriculture assessments.

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Sciforum-208563: Enhancing the Resilience of Organic Farming through Agroforestry: A Practice-Research Network across Germany

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Projected climate change, including rising temperatures and more frequent extreme weather events, is increasing pressure on agricultural production systems, underscoring the need for innovative approaches to enhance their resilience. Organic farming (OF) is known to improve resilience through increased biodiversity and soil organic matter content. Agroforestry systems (AFS), which integrate woody perennials into agricultural land, offer further potential to strengthen the ecological and socio-economic resilience of OF through increased multifunctionality. AFS can enhance carbon sequestration, resource-use efficiency, biodiversity, and microclimate regulation, while supporting animal welfare through shade, shelter, and additional feed resources. AFS may also strengthen economic resilience through production diversification and new business models. However, interactions among agroforestry components can result in trade-offs due to resource competition or increased management complexity. How these interactions can be effectively managed to enhance OF resilience and promote synergies remains insufficiently understood, particularly under site-specific management conditions. The ReAgt4Oeko project aims to establish a long-term, farm-led research network of approximately 20 organic farms across Germany, representing diverse environmental conditions and farming approaches. Farms include silvoarable, silvopastoral, or agrosilvopastoral AFS alongside treeless references. Together with research, advisory, and knowledge-transfer partners, the project will develop resilience concepts for OF through AFS. Ecological resilience will be assessed using indicators of productivity, soil health, erosion control, biodiversity, microclimate regulation, and animal welfare. Economic resilience will be assessed through an integrated framework considering production objectives, productivity, profitability, yield stability, diversification, investment, labor and opportunity costs, market opportunities, and site-specific conditions. Cost–benefit, value-chain and business-model analyses will evaluate the economic performance and potential of different AFS products, while supporting tools will be developed to facilitate farm-level planning and decision-making. Through participatory on-farm research and knowledge exchange, the project aims to generate evidence-based recommendations and transferable strategies supporting the wider adoption of agroforestry as a resilience-enhancing approach in OF.



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Sciforum-208593: Effectiveness of mechanical precision weed control in organically grown soybean

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Weed pressure is the main problem faced by organic farmers growing soybean. The crop is grown in wide rows and is thus sensitive to high weed infestation. Fortunately, precision mechanical weed control methods based on digitalization in agriculture are now available. This article presents findings on the effectiveness of two weed control methods and their impact on soybean yield. The aim of the study was to compare classic vs. precision weed control methods. In classic weed control, traditional simple hoe and simple tined weeders were used, and in precision weed control a camera guided hoe, a spring tined weeder and a rotary weeder were used. An on-farm field experiment was carried out in 2023 – 2025 on an organic farm. A randomized block design (RBD) was used to arrange experimental plots (four replications) in the field. The results were analyzed statistically using Statistica software (data analysis software system), version 12, StatSoft, Hamburg, Germany. ANOVA was carried out using Tukey's test at $p \leq 0.05$.

The mechanical weed control methods reduced weed infestation of soybean compared with the plots where no weeding was carried out. The most effective was the precision weed control method, which reduced the number of weed species from 15 to 7 and reduced the weed biomass from 593.2 to 26.2 $g \cdot m^{-2}$. Classic mechanical weeding also significantly reduced weed infestation, although its effectiveness was lower. The greatest reduction was observed for annual weeds, whose biomass decreased from 561.3 to 21.8 $g \cdot m^{-2}$ when the precision weed control system was used. The mass of perennial weeds also decreased, albeit to a lesser extent. The reduction in weed infestation led to an increase in the soybean yield. The lowest yield was obtained on the plots without weed control (0.43 $t \cdot ha^{-1}$), whilst the highest was achieved following the use of the precision weed control method (2.84 $t \cdot ha^{-1}$), representing a more than sixfold increase in yield. The results indicate that the use of the modern precision weed control method can be an effective alternative to traditional weeding methods. Acknowledgments: This work was funded by the Minister of Science under the Regional Initiative of Excellence Program.

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Sciforum-208665: UAV-Based NDVI Assessment on Open-Field Pepper Production: A Case Study in Kosovo

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High-resolution remote sensing is becoming more and more important in precision agriculture to describe crop spatial variability and enable better field management. In Kosovo, open-field pepper (Capsicum annuum L.) is a significant crop, especially in the Dukagjini Plain, where the development of precision-agriculture techniques may benefit from spatially comprehensive data on vegetation variability. In two open-field pepper parcels in Rogovë, Dukagjini area, Kosovo, this study sought to determine how well unmanned aerial vehicle (UAV)-based multispectral photography could measure and evaluate the spatial distribution and variability of the Normalized Difference Vegetation Index (NDVI). Around noon on July 7, 2026, the two parcels were scanned under nearly identical acquisition conditions as part of the same UAV campaign. A DJI Mavic 3 Multispectral UAV was used to collect multispectral data, which was then processed in Agisoft Metashape to produce georeferenced orthomosaics. The NDVI was calculated as (NIR - Red)/(NIR + Red) using the near-infrared and red spectral bands. For the vegetation-focused analysis, pixels with NDVI $<$ 0 were excluded before calculating the descriptive statistics because negative values were considered to represent non-vegetated surfaces or background effects rather than photosynthetically active vegetation. Negative NDVI values accounted for only 0.000015% and 0.000018% of the analyzed pixels in Parcels 1 and 2, respectively; therefore, their exclusion had a negligible effect on the descriptive statistics. The same exclusion criterion was applied consistently to both parcels. The coefficient of variation (CV) was used to evaluate relative NDVI variability. Both parcels' geographical distributions were quantified and compared using the same six-class NDVI classification scheme and class thresholds. Parcel 1's mean NDVI was 0.488 ± 0.233, whereas Parcel 2's was 0.548 ± 0.217, with an absolute difference of 0.060. Parcel 1's relative NDVI variability was higher (CV = 47.72%) than Parcel 2's (CV = 39.60%), suggesting that Parcel 1's NDVI distribution was more heterogeneous. The findings show that, under similar acquisition settings, UAV-based multispectral imaging can quantitatively assess variations in NDVI distribution both within and between fields in open-field pepper cultivation. This study shows how UAV-based multispectral assessment can be used as a useful instrument to further precision-agriculture applications in Kosovo.

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Sciforum-208671: OHVeNet: AI-Enabled Smart Monitoring Network for Agricultural Pests and Disease Vectors

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Timely and reliable pest monitoring is fundamental to integrated pest management (IPM) and sustainable agricultural production. OHVeNet is establishing a nationwide smart monitoring network in Portugal, currently covering approximately 2,000 monitoring sites equipped with smart traps across the main agricultural production regions. The network integrates the Internet of Things (IoT), artificial intelligence (AI), geospatial technologies, and standardized field protocols within a One Health framework. The deployed system combines smart traps with automated image acquisition, environmental monitoring, QR-code identification, mobile GIS data collection, and a centralized web platform for data management and visualization. Several thousand images have already been collected during the initial deployment. The network currently focuses on economically important pests, including *Cydia pomonella*, *Ceratitis capitata*, *Rhagoletis cerasi*, *Lobesia botrana*, and *Cryptoblabes gnidiella* in fruit crops and vineyards. The initial deployment demonstrates the operational feasibility of a large-scale, harmonized pest monitoring infrastructure, enabling the characterization of pest presence and population dynamics across monitoring regions. AI-based computer vision for automated pest identification and quantification is currently under development and validation. The monitoring data are already being used to identify regions with different levels of pest risk according to pest presence and population dynamics, while alarm and decision-support functionalities are being progressively developed. The modular architecture allows the future integration of additional sensors, target species, and analytical tools. By standardizing data collection, storage, and visualization across monitoring sites and crops, OHVeNet provides a scalable digital framework for Agriculture 4.0 and supports the development of more efficient and targeted integrated pest management strategies.

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Sciforum-208679: FruitPV: Agrivoltaic Solutions for Climate-Resilient High-Density Mediterranean Apple Orchards

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Climate change increasingly threatens Mediterranean fruit production through rising temperatures, extreme weather events and water scarcity. Agrivoltaic systems may simultaneously generate renewable energy and modify orchard microclimates, potentially mitigating specific climatic stresses. This study presents an integrated assessment of contrasting agrivoltaic solutions established in a commercial high-density 'Fuji' apple orchard in Alcobaça, Portugal, during the 2025 growing season. Environmental conditions were characterised through meteorological monitoring, photosynthetically active radiation (PAR) and canopy light distribution, while tree responses were assessed through gas exchange, chlorophyll fluorescence, spectral vegetation indices, stem water potential and fruit surface temperature. Agronomic performance was evaluated through fruit growth, yield, fruit quality and sunburn incidence. The evaluated configurations combined fixed semi-transparent bifacial photovoltaic (PV) panels with 40% transparency (FP) and opaque bifacial PV panels with 0% transparency (TP), installed over central-axis (CL) and Guyot-trained trees (G). The uncovered central-axis treatment (CL CT) provided reference conditions. Preliminary results showed clear configuration-dependent differences in light and thermal environments. During a heat event, maximum air temperature reached 35.5 °C, while fruit surface temperature in CL CT approached 48 °C. CL CT also showed the most negative stem water potential (-18.46 bar), compared with -14.92 bar in CL FP and -15.17 bar in CL TP. Peak PAR in CL FP exceeded 10,000–12,000 μmol m^{-2} s^{-1} on several dates, whereas PV configurations attenuated radiation, particularly around solar noon. At harvest, CL FP reached 31.10 t ha^{-1}, compared with 21.31 t ha^{-1} in CL CT, while sunburn incidence exceeded 34% in CL CT and was substantially lower under PV coverage. However, shading intensity influenced photosynthetic performance and fruit quality; CL CT fruits showed the highest soluble-solids content (16.11 °Brix) and firmness (6.98 kg cm^{-2}). Overall, these first-year results indicate that appropriately designed agrivoltaic systems can mitigate specific heat, radiation and water stresses and reduce sunburn risk without necessarily compromising productivity, although longer-term evaluation is required.

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Sciforum-208685: Acoustic Vibration Priming Enhances Drought Resilience in Olive (*Olea europaea*) through Physiological and Biochemical Responses

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Contemporary olive cultivation faces mounting threats from climate change and pathogen pressure, requiring sustainable, non-chemical interventions. This study investigates acoustic vibration as a physical elicitor to prime physiological defense mechanisms in *Olea europaea* (cv. Leccino) and enhance drought resilience. Two-year-old plants (n = 8 per group) were assigned to Vibro (six months of 120 Hz acoustic priming) or Control (no vibration) groups, then subjected to progressive drought at 25% field capacity with three rewatering events. Sampling occurred at Week 5 (T1, peak initial stress) and Week 10 (T2, severe prolonged drought). Physiological status was assessed via gas exchange (LI-COR 6400XT) and chlorophyll fluorescence; biochemical resilience via malondialdehyde, free amino acids, phenolics, soluble sugars, starch, and chlorophyll content; nitric oxide localization via confocal microscopy. Vibro plants showed significantly higher photosynthetic rate ($p < 0.001$) and a significant Group×Week interaction for water-use efficiency ($p < 0.001$), indicating superior physiological regulation under drought. Chlorophyll fluorescence parameters (Fv/Fm, Fv'/Fm', ΦPSII, ETR) were higher in Vibro plants at peak stress (Week 5), indicating protection of the photosynthetic apparatus from drought-induced photoinhibition, despite comparable chlorophyll content between groups. A significant Group×Timepoint interaction was observed for free amino acids ($p = 0.044$), Control plants showed a significant FAA increase from T1 to T2 ($p = 0.012$), consistent with elevated proteolysis, whereas Vibro plants remained stable, indicating a more physiologically resilient state under sustained drought. These findings establish acoustic stimulation as a promising, sustainable strategy for improving olive drought resilience.

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Sciforum-208699: From Laboratory Exposure to Smart Agriculture: Radiofrequency Electromagnetic Field Effects on Wheat and Maize

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The rapid adoption of smart agriculture technologies has substantially increased the use of wireless sensor networks and Internet of Things (IoT) devices, resulting in a growing radiofrequency electromagnetic field (RF-EMF) background in agricultural environments and raising concerns regarding the potential impact of RF-EMFs on crop growth, physiology, and productivity. Maize (*Zea mays* L.) and wheat (*Triticum aestivum* L.) are important cereal food, feed, and industrial raw materials. The aim of this literature review was to analyze the relation between exposure conditions and registered effects on maize and wheat plants. It includes 26 studies on effects of RF-EMFs (800 MHz to 2.4 GHz) on wheat and maize found in scientific electronic databases, and 9 our papers, total 35 publications. These EM frequencies are mostly used in smart agriculture, with low output power – from ten to hundred(s) mW depending on system and country regulations, and short-duration transmissions separated by relatively long intervals; exposure continuing throughout the whole vegetation period. In contrast, the analyzed experiments were carried out in controlled laboratory conditions, at different stages of plants development. RF-EMF exposures lasted from few seconds to several hours – extended time periods; applied in single or multiple portions up to 30–60 days, at power levels exceeding those generated by devices used in smart agriculture. Intensity was given in different units – few to tens mW or tens to hundreds V/m, and were not always stated; SAR was rarely estimated. Often investigated plant characteristics were plant growth, biomass production, oxidative status and enzyme activity. The reported responses range from positive to adverse effects. Our analysis suggests that low intensity pulsed RF-EMF were more effective than continuous fields; young maize plants were more sensitive possibly due to their high tissue water content and greater RF energy absorption. These findings contribute to a better understanding of crop responses to RF-EMFs emitted by wireless technologies in smart agriculture.

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Sciforum-208736: Acoustic vibrations modulate grapevine phenology and physiology: first evidence from vineyard and controlled environment experiments

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The development of sustainable strategies capable of enhancing crop resilience while reducing external inputs is a major challenge for modern viticulture. Among emerging non-chemical approaches, acoustic vibrations have recently attracted interest as physical stimuli capable of influencing plant physiological processes. However, knowledge of grapevine responses to vibrational stimulation remains limited, particularly across field and controlled-environment conditions. This study presents the first results of an ongoing investigation evaluating the effects of acoustic vibrations on grapevine phenology and physiology in commercial vineyards and in potted vines grown under controlled conditions. Acoustic stimulation at 100–120 Hz was applied continuously (24 h day^{-1}), starting before bud break and continuing throughout the growing season. Vibrations were delivered through piezoelectric actuators connected to metallic wires along vineyard rows and by dedicated vibration systems under controlled conditions. The experiments involved Vitis vinifera L. cv. Sangiovese, with 15 treated and 15 control vines under vineyard conditions and 9 treated and 9 control vines under controlled conditions. Plant responses were assessed through phenological development, shoot growth dynamics, leaf gas exchange, stem water potential, chlorophyll fluorescence, photosynthetic pigment content, and, under controlled conditions, anatomical traits related to cuticle and xylem structure. Preliminary results revealed environment- and experiment-dependent responses to acoustic stimulation. Under vineyard conditions, no significant differences in phenological development were detected between treatments, although vibrated vines showed a trend towards greater shoot growth. Under controlled-environment conditions, control plants exhibited significantly faster phenological development, whereas vibrated plants showed a trend towards greater shoot elongation. Leaf-level physiological responses varied between experiments. No consistent treatment effect on stomatal conductance was detected, whereas transient and experiment-dependent trends were observed for effective PSII quantum yield (ΦPSII) and electron transport rate (ETR). Anatomical analyses under controlled conditions revealed a significantly lower inter-vessel distance in vibrated plants compared with controls (Wilcoxon test, $p = 0.012$), while xylem vessel area, vessel number, and cuticle thickness did not differ significantly between treatments. Overall, responses observed across vineyard and controlled-environment experiments suggest that acoustic stimulation may influence specific aspects of grapevine development, vegetative growth, and anatomy. Further measurements are required to establish the consistency and functional significance of these responses and to determine whether they may be associated with acclimation processes or interpreted within a plant-priming framework. Although the experiments are ongoing, these preliminary findings suggest the potential of acoustic vibrations as an innovative physical approach for modulating grapevine responses. The integration of field and controlled-environment experiments provides a framework for investigating vibration-induced plant responses and their possible agronomic relevance for climate-resilient viticulture.

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Sciforum-209997: Computational Agroecological Identity: A Multidimensional Data Framework Linking Precision Assessment and Product Valorization

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Agroecological systems combine environmental, biological, technical, territorial, socioeconomic, and cultural interactions. Digital agriculture generates heterogeneous data with fragmented representations. This study introduces Computational Agroecological Identity (CAI), a conceptual framework representing agroecosystems and products as related multidimensional entities. A structured, iterative conceptual-modelling process comprised three operations: delimiting agroecosystem and product entities; organizing candidate variables across established agroecological domains and the author's situated interdisciplinary expertise; and specifying relations, provenance, evidence states, and missing-data categories. The resulting preliminary structure covers geography, soil, climate, water, biodiversity, varietal genetic identity, practices, inputs, environmental performance, socioeconomic attributes, cultural knowledge, and product characteristics.The work does not yet constitute a formal machine-readable ontology, implemented database schema, or validated software prototype. Interoperability is a design target, not a demonstrated result; intended future mappings include FAO AGROVOC for agricultural terminology, W3C/OGC SOSA/SSN for observations, and GS1 EPCIS for traceability events.CAI's proposed contribution is an identity-and-provenance layer complementing assessment, traceability, digital-twin, and ontology approaches without requiring aggregation into a single score. An illustrative olive-oil use case, grounded in the author's situated knowledge of the Imperia production and labelling ecosystem, links cultivar identity, territory, practices, quality signs, and evidence provenance while preserving their distinct status. Product valorization means improving the legibility, traceability, and communicability of documented attributes; it does not imply demonstrated price, income, or market effects.CAI thus distinguishes the operational function of agricultural data—measurement, decision support, efficiency, and resilience—from its identity function—characterization, territorial recognition, and evidence-based product description. The next research stage will translate CAI into a machine-readable ontology, database schema, and software prototype, then evaluate technical validity, interoperability, and empirical applicability. This pathway will support evidence-qualified computational micro-certification research without presupposing validity before implementation and testing.



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Sciforum-210150: Study on the Storage Suitability of Promising Quince Varieties and Development of a New Preservation Method

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Quince (Cydonia oblonga Mill.) is a valuable fruit crop with high nutritional and medicinal value, but its storage is limited by quality deterioration and post-harvest disorders. This three-year study evaluated the effect of an environmentally friendly post-harvest treatment combining 2% calcium chloride ($CaCl_2$) and 2% methyl jasmonate on the storage quality and preservation of quince fruits under cold-storage conditions. Fruits of the 'Georgian Sour' variety were collected from a local farmer's plot in Dzevera village, Gori district, Georgia. Treated and untreated (control) fruits were stored at 0–1 °C and 85–90% relative humidity. Weight loss, soluble solids content (SSC), titratable acidity, amino acids, vitamin C, and post-harvest disorders were evaluated before and during storage. After one month, vitamin C content in treated fruits remained at 18.6–20.2 mg%, compared with 18.1–19.7 mg% in the control, while the initial content in fresh fruits was 18.9–21.4 mg%. SSC was retained at 11.4% in treated fruits, compared with 11.1% in the control, from an initial value of 12.3%. Amino acid content decreased from 5.1% initially to 4.2% in treated fruits, whereas it declined to 3.8% in the control. Regarding post-harvest disorders, superficial scald occurred at a rate of 6%; notably, no pathological development was observed in the treated fruits, whereas grey mold decay reached 15% in the control. The results demonstrate that the combined treatment significantly slowed quality deterioration, maintained the marketable condition of quince fruits, and reduced physiological and microbiological losses during storage. The proposed treatment therefore represents a promising sustainable approach for improving quince storage technology and may support practical application under commercial conditions in Georgia.

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Sciforum-210181: IMMAGO: Automated In-Field Classification of Tomato Phenological Stages Using Promptable Zero-Shot Detection

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Identification of crop phenological stages is essential for automating agronomic decision-support systems (DSSs) and improving the timing of crop-protection interventions. Direct field observations provide the reference standard for phenological assessment, but collecting them continuously across numerous fields is labour-intensive and impractical. Conventional detection and classification systems based on supervised neural networks also require extensive annotated datasets, remain limited to fixed sets of classes, and require retraining whenever new categories or defects are introduced.

The Terremerse IMMAGO project addresses these limitations by proposing an alternative approach based on AVT Physical AI Core, a promptable, RGB-based zero-shot detection system in which crops and BBCH stages are defined through textual and visual prompts rather than task-specific training. The resulting low-cost system automatically recognizes tomato phenological stages according to the standardized BBCH scale under real-world field conditions, including variable illumination, occlusions, overlapping fruit, foliage, debris, and camera movement.

Five-megapixel RGB images are acquired every three hours by fixed, solar-powered IoT cameras and transmitted via 4G to a central server. One representative image is selected automatically each day. Histogram-based criteria exclude underexposed or sun-glared images, while sharpness analysis rejects blurred or motion-affected acquisitions. Pre-processing includes region-of-interest definition, histogram equalization, colour correction, and normalization. The study was conducted using the tomato hybrid Fokker F1 (Nunhems). The experimental plot was micro-irrigated, and the planting density was 33,000 plants per hectare.

The selected image is analysed at multiple scales by AVT Physical AI Core, and the resulting predictions are aggregated to provide a daily phenological-stage estimate. Classes can be added or modified without rebuilding the dataset or retraining the model, while limited few-shot calibration can address ambiguous cases. On an independent field test set, the system achieved a precision = 0.73, recall = 0.81, accuracy = 0.71 e mAP = 0.83. These results indicate that promptable zero-shot vision can reduce annotation and retraining costs while supporting adaptable phenological monitoring and more timely targeted crop-protection interventions.

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Sciforum-212355: Physiological, Productive and Biodiversity Responses of *Vitis vinifera* L. cv. Primitivo under Agrivoltaic Conditions in a Mediterranean Vineyard

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Agrivoltaic (AV) systems represent an innovative approach to address climate-related challenges in Mediterranean climate viticulture while promoting the combined use of land for renewable energy production and crop cultivation. Nevertheless, cultivar-specific responses under rainfed conditions remain insufficiently explored. This study investigated the effects of photovoltaic-induced shading on *Vitis vinifera* L. cv. Primitivo during the 2024 growing season in southeastern Italy, comparing full sun conditions (FS) with two shading levels within an operational AV system: low shade (LS) and high shade (HS). Shading modified the vineyard microclimate, reducing air temperature by 0.5–1.0 °C, increasing relative humidity by 2–14%, and enhancing soil moisture availability under panels (+23%). Grapevines showed morphological acclimation to reduced radiation, including increased shoot length (+130%), greater leaf area, and higher stomatal density (+38–48%) and stomatal size under shaded conditions. Physiological responses included increased chlorophyll content (as SPAD values) and improved midday stem water potential under HS, indicating a more favorable plant water status. Yield per cane increased from 0.41 kg in FS to 1.36 kg in LS and 1.06 kg in HS, whereas total soluble solids decreased from 25.8 °Bx (FS) to 24.4 °Bx (LS) and 22.9 °Bx (HS). In addition, floristic surveys showed a two-fold increase in plant species richness beneath photovoltaic panels, suggesting a potential contribution of AV systems to vegetation diversity. Overall, these findings highlight the potential of AV systems to enhance grapevine growth and productivity while maintaining acceptable grape quality and also promoting biodiversity within Mediterranean agroecosystems. Further multi-year investigations are required to validate these responses under varying climatic conditions and with other grape varieties.



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Session 6. Economics of Regenerative and Sustainable Farming Systems

Sciforum-179676: Agricultural Payments and the Transition Towards Sustainable Farming Systems in Poland: A Regional Perspective

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The transition towards more sustainable agricultural systems has become a central objective of the Common Agricultural Policy (CAP), yet its actual effectiveness in reshaping farming practices remains highly contested. This study examines whether CAP payments contribute to the transition towards more sustainable agricultural systems in Poland, with a particular focus on regional variation and differences in production structures.

The analysis is based on a panel dataset covering Polish voivodeships over the period 2015–2024. A synthetic sustainability index was constructed using indicators of production intensity and structural characteristics, including fertiliser use, livestock density, crop structure, grassland share, and the share of organic farms. To ensure robustness, the index was also validated using principal component analysis (PCA), allowing for a comparison between a theory-driven and a data-driven measure of sustainability. The empirical approach employs regression models with year fixed effects, where sustainability is explained by environmental payments, direct income support, and key structural variables such as farm size and land-use composition.

The results reveal substantial regional variation in both agricultural sustainability and the structure of CAP support. Environmental payments are positively associated with sustainability outcomes, while direct income support does not show a consistent effect. However, structural variables, particularly the share of arable land, emerge as the strongest determinants. This suggests that CAP instruments operate within pre-existing production systems rather than fundamentally transforming them.

The findings indicate that the effectiveness of CAP environmental instruments is strongly conditioned by regional agricultural structures, pointing to the importance of better alignment between policy design and production characteristics in supporting a transition towards more sustainable and resilient farming systems.



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Sciforum-180760: Digital Agricultural Extension and Its Effect on Food Quality Assurance Practices in Local Grain and Legume Processing Enterprises in Southern Kebbi, Nigeria

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This study examined the effect of the digital agricultural extension on food quality assurance (FQA) practices among grain and legume processing enterprises in Southern Kebbi, Nigeria. A cross-sectional survey was conducted among 172 processors selected from four Local Government Areas (Sakaba, Ngaski, Yauri, and Zuru) using structured questionnaires. Descriptive statistics revealed high mobile phone ownership (96.0%) but moderate utilization of digital platforms for food quality information (34.0%), indicating a gap between access and effective, targeted use of digital advisory services among processors in the study area and beyond. Adoption of FQA practices was moderate overall (66.2%), with hygienic processing (74.4%) and personal hygiene (72.0%) showing the highest compliance, while regulatory compliance (57.8%) and traceability (56.0%) were lowest. Multiple regression analysis showed that digital extension exposure significantly predicted FQA adoption (β = 0.44), alongside education (β = 0.15), training received (β = 0.19), cooperative membership (β = 0.13), enterprise size (β = 0.12), access to credit (β = 0.11), household income (β = 0.08), gender (β = 0.09), and distance to extension office (β = -0.11), explaining 58% of the variance in FQA adoption (R^2 = 0.58, Adjusted R^2 = 0.55). Moderated regression analysis revealed that education (β = 0.12), training received (β = 0.16), cooperative membership (β = 0.10), enterprise size (β = 0.09), and access to credit (β = 0.08) strengthened the relationship between digital extension use and FQA compliance, while distance to the nearest extension office negatively moderated the relationship (β = -0.11). It is concluded that digital advisory services enhance adoption of food quality practices, but their effectiveness is conditioned by socio-economic and institutional factors. The study recommends integrating digital extension with training, cooperative strengthening, infrastructure support, and improved rural connectivity to enhance food safety, post-harvest quality, and overall market competitiveness among processors and smallholder agribusiness enterprises across diverse rural contexts globally today.



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Sciforum-182472: Resilience of Agroecological and Organic Markets: A Comparative Analysis of six case studies from Italy, Bolivia, Brazil, Spain and Colombia

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This study investigates the socioeconomic and environmental resilience of agroecological and organic markets through a comparative analysis of six case studies in Colombia, Bolivia, Italy, Brazil, and Spain. It addresses a gap in agrifood resilience research, which has mainly focused on production while giving limited attention to markets as spaces where disturbances, stresses, and adaptive strategies emerge. Using a qualitative multiple-case study approach, the research draws on semi-structured interviews with coordinators, producers, collaborators, and consumers, complemented by documentary review and participant observation. The cases include fairs, stores, and digital markets linked to small-scale agroecological or organic food systems with at least twelve years of operation.

The findings show that these markets have faced multiple disturbances and stresses over time. Economic pressures are the most frequent, including financial unsustainability, unstable producer income, limited consumer demand, logistical constraints, rising costs, and difficulties in accessing suitable market spaces. Social tensions are also relevant, especially those linked to participatory governance, collective decision-making, certification processes, and unequal distribution of responsibilities among participants. Environmental stresses, although less frequently reported, remain significant because climate variability, pests, and productive challenges affect supply stability.

Across the six cases, 131 practices were identified and classified according to resilience capacities: prevention, anticipation, absorption, adaptation, and transformation. Adaptation and absorption were the most common responses, while prevention, anticipation, and transformation were less frequent. The study shows that resilience is strongly rooted in the commitment of producers, consumers, and coordinators, but this commitment alone is insufficient to guarantee long-term sustainability. Supportive public policies, institutional recognition, access to public spaces, procurement opportunities, and investment in logistics, communication, and data systems are essential to strengthen these markets as strategic spaces for more resilient, inclusive, and sustainable agrifood systems.



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Sciforum-184403: Productivity, Agricultural Development, and the Governance of Sustainability: From the Green Revolution to AGRA

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This paper examines how productivity-centred agricultural development has been historically institutionalized, restructured, and reproduced from the Green Revolution to contemporary initiatives such as the Alliance for a Green Revolution in Africa (AGRA). Rather than treating these as distinct or disconnected policy moments, it analyzes them as linked episodes in the longer reorganization of agricultural governance around yield, efficiency, and market-oriented modernization. The paper argues that productivity metrics have been central to sustaining this trajectory over time because they translate complex social, ecological, and political processes into standardized indicators of success that appear objective, technical, and comparable across contexts.

Using a comparative historical political economy approach, the paper traces how the Green Revolution established a model of agricultural development centred on measurable increases in output, input intensification, and state-supported modernization. It then examines how structural adjustment reconfigured that model by shifting agricultural governance toward liberalization, privatization, and market discipline, while preserving the centrality of productivity as a development objective. Finally, the paper considers how AGRA has renewed and adapted these earlier logics within contemporary African agricultural policy through a continued emphasis on yield improvement, technology adoption, and commercialization.

The paper's central contribution is to show that productivity metrics do not merely measure agricultural change; they actively structure what counts as agricultural success, which institutions gain authority, and which development pathways are legitimized. In this sense, debates over sustainable farming systems are inseparable from the governance tools through which agricultural problems are defined, and policy priorities are organized. By foregrounding the politics of productivity, this paper contributes to discussions in agroecology and sustainable systems by asking how agricultural development might be evaluated differently when ecological resilience, distributive justice, and social reproduction are treated as central rather than secondary concerns.



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Sciforum-185554: Willow (Salix acmophylla Boiss.) irrigated with saline or treated waste water provides sustainable healthy feed supplements for goats, sheep and calves

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Salix acmophylla Boiss. (Brook willow, Leviticus 23:40) is native to the Middle East. We have identified three genotypes of S. acmophylla growing naturally in Jordan and Israel, all of which can grow easily with marginal irrigation sources (treated wastewater or natural saline (EC 4-6) sources), which cost the farmer up to 60% less than natural freshwater or desalinated seawater. Although there were few differences in nutritional value or salicylate content of the three S. acmophylla genotypes, one genotype was significantly more productive than the others, regardless of water quality. Silage made from Brook willow is a healthy alternative to synthetic nematicides or coccidiostatic compounds. Nematode exsheathment *in vitro* was reduced by as much as 95% in the presence of branch or leaf extracts from the three genotypes. Willow extracts also significantly inhibited Eimeria sporulation, with over 70% inhibition at concentrations as low as 750 ppm. Sporulation was inhibited by 80% and 90% respectively for branch or leaf extracts at concentrations above 1250 ppm. Both blood and milk markers of animal health were increased after feeding sheep and goats with 200 g/kg (DM basis) willow silage (an increase of 190g and 185g milk yield/head/day, respectively), regardless of the irrigation source. Feeding Awassi sheep with willow silage significantly improved the muscle tenderness score by 30% and the weight of the fatty tail, which is considered a delicacy, by 40%. With Holstein heifers, the willow diet improved plasma antioxidant capacity by 6% compared to the control diet, in addition to enhancing plasma oxidative status by 40% over the course of the experiment. Using marginal water to grow native willows for silage provides sustainable, natural, and healthy fodder for goats, sheep and calves.



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Sciforum-186623: Application of Regenerative Agriculture Practices across Central Europe: A bibliometric review

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Food insecurity remains a global challenge despite agricultural production advancement. The major causes relate to unsustainable farming methods like conventional farming, which gradually degrade the soil properties, significantly widening the gap between food demand and production. This review aimed at quantitatively mapping the trend and application of regenerative agriculture practices for crop production among Central European countries. A literature search was conducted using a Web of Science database covering the period 2000-2025 based on keywords “Regenerative agriculture” AND “Crop production” AND “Central Europe”. VOSviewer software was employed for bibliometric analysis and the Mann-Kendall to analyse the publication trends. The results showed a positive publication trend (P=0.001). The interest in regenerative approaches in central Europe was reflected in the number of scientific publications per country. The lowest number of publications was recorded in 2002 (01) while the highest was 2024 (16). Germany recorded the highest number of publications (92) followed by Hungary (21) while the lowest was Slovenia (01). The major regenerative practices applied in Central Europe during the study period included organic matter and farm-yard manure application, conventional tillage, zero tillage, minimum tillage, crop rotation, cover cropping, and conservation agriculture. These practices have been vital in yield improvement, soil fertility maintenance, improved soil biodiversity, mitigated adverse climate change effects, increased soil health, and microbial activity. However, while regenerative and conservation agriculture support sustainable crop production, they are not a stand-alone solution to mitigate food insecurity. The uneven distribution of research in this field highlights a critical gap in knowledge, particularly in under-represented countries. Therefore, there is a need for greater collaboration in the region to share resources, knowledge, and technologies.



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Sciforum-188861: The Biological Nutrient Cycle as an Economic Determinant: Soil – Food/Feed – Animal – Human and the Cost of Micronutrient Deficiency

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Paper's objective(s) and research background Conventional farm accounting records the consequences of micronutrient deficiency long after they have become unavoidable, while the upstream decisions that determine those consequences leave almost no trace in the ledger. This paper reframes the soil–food/feed–animal–human chain as a single asset whose condition is set at the lowest trophic level and inherited, with interest, at every level above it. The objective is to show that the economically relevant unit is not the individual deficiency event but the position of the limiting nutrient within the chain, and that the further upstream a shortfall originates, the larger and more diffuse its eventual cost. Rather than asking what a deficiency costs to treat, the paper asks what it costs to allow the deficiency to propagate, and who along the chain ultimately settles the account.

Data/Methods The argument proceeds by tracing a single limiting nutrient through successive transfer steps rather than by comparing prevention against treatment at one stage. Each transition—soil to plant, plant to animal feed, animal to human consumer—is modelled as a node at which concentration losses compound and at which the cost of correction rises sharply. The framework draws on documented Central European livestock evidence of soil-level deficits in zinc, copper and iron, and contrasts a plant-essential element applied below agronomic thresholds with one that plants do not require yet animals and humans depend upon. The economic structure is expressed through a cumulative-loss function across nodes and through the wedge between private and social marginal cost, allowing the point of cheapest intervention to be located analytically rather than assumed.

Results/Conclusions/Value added Locating intervention by trophic position rather than by symptom shows that the cheapest correction almost always lies at the soil and feed node, while the cost actually incurred accumulates downstream in veterinary spending, productivity loss and public-health burden carried by systems that never participated in the original fertilisation decision. The mismatch between where cost is generated and where it is borne is a textbook negative externality, but one whose magnitude grows with trophic distance—a feature absent from single-stage treatments of the problem. The contribution is conceptual: it offers a transferable way to price upstream under-supply and to identify the level at which internalisation is most efficient. Empirical calibration across multiple production systems remains the necessary next step.



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Sciforum-189606: Agroforestry Practices and Building Livelihood Resilience in Northwestern Ethiopia: Evidence from Three Districts in the Amhara Region

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Agroforestry is an effective land use strategy for improving livelihood resilience against socioeconomic and environmental challenges. However, few studies have investigated its impact in Ethiopia. This study aimed to: (i) assess agroforestry-based livelihood strategies among smallholder farmers; (ii) identify key factors influencing these strategies; and (iii) evaluate income and food security outcomes for smallholder farmers in three districts of northwestern Ethiopia. Data were collected through key informant interviews, in-depth interviews (27), household surveys (387), and focus group discussions (9). The analysis utilized descriptive statistics, factor analysis, propensity score matching, and zero-truncated negative binomial regression. Results indicated that the average livelihood resilience index (LRI) was 0.59 ± 0.18. Practitioners of agroforestry had a significantly higher average LRI (0.65) compared to non-practitioners (0.46, $p < 0.05$). Additionally, the financial, natural, social, and human capital of practitioners were 19%, 14%, 11%, and 8% higher, respectively. Among the districts, Lay Armachiho contributed the most to the LRI at 38%, while Bahir Dar Zuria contributed 17%. Agroforestry practices improved household well-being by generating income for education, agricultural inputs, asset creation, and enhancing food diversity. Propensity score matching revealed that practitioners experienced significantly higher total annual income (ATT = ETB 18,230) and food consumption scores (ATT = 1.84) compared to non-practitioners. The study concluded that agroforestry can enhance resilience to climate and socioeconomic threats.



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Sciforum-193735: Output Value impacts of micro-nutrient management scheme: Quasi-experimental evidence from an Indian state of Karnataka

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In this paper we examine causal impact of a soil test-based micronutrient management scheme, *Bhoochetna*, on value of output using Propensity score matching and Entropy Balancing methods to address selection bias arising from the non-random nature of policy adoption. Micronutrient deficiency in soils is a critical yet underappreciated constraint on agricultural productivity in India, and targeted interventions such as Bhoochetna represent an important policy instrument to address this challenge. To analsyse this , we use data from a primary survey of 4669 farmers, conducted across 10 districts of an Indian state of Karnataka, coming from different agro-climatic zones to ensure adequate geographic and ecological representativeness of our findings. Our results highlight significant positive impact of this scheme on the agricultural value of output, which increases by 15 too 27 percentage points for the entire sample underscoring the effectiveness of soil test-based nutrient management as a productivity-enhancing intervention. Further, we also observed heterogenous impacts of this scheme, based on land holding size which is even more striking. Our results suggests, that for the marginal farmers with landholding size of less than one acre of land, the program adoption led to a significant and large increases in the value of output, to the tune of nearly 78 percentage points, gesting that smaller and more resource-constrained farmers stand to benefit disproportionately from such targeted interventions. Our results stress on adequate targeting of the policy to marginal farmers alongside uniform spread of awareness about the program and its benefits by utilizing the services of Farmer Field Schools and other information netwroks (FFS).



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Sciforum-195935: What Drives Forage Adoption Intensity Among Smallholder Dairy Farmers? Evidence from Kenya

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Introduction

Smallholder dairy production is vital for sustainable livestock intensification in sub-Saharan Africa. In Kenya, smallholder farmers contribute 80% of national milk production, yet productivity is limited by inadequate feed resources. While most adoption studies treat technology uptake as a binary outcome, this study examines forage adoption intensity—measured as the proportion of total farmed land allocated to forages. This approach captures the depth of technology integration and reflects how farmers manage land trade-offs between forages and competing food and cash-crop demands.

Methods

Data were collected through a survey of 253 smallholder dairy households across five sites in Nakuru and Nyandarua counties, representing diverse high- and mid-altitude production systems. A fractional logit model, estimated via quasi-maximum likelihood, was employed to identify the structural, institutional, and technological determinants associated with cross-sectional variation in the share of land dedicated to forage crops.

Results

The analysis showed that forage adoption intensity is driven by farm management and institutional factors. Households with larger dairy herds, those utilizing artificial insemination (AI) services, and those participating in dairy cooperatives allocate a higher proportion of land to forage. By contrast households with more land tended to allocate a smaller share to forages, suggesting they may diversify into other enterprises rather than intensify forage production. The data also highlights significant spatial heterogeneity across study sites regarding institutional engagement and production systems.

Conclusions

Our findings suggest that forage intensification is closely tied to feeding practices, breeding choices, and cooperative participation. To promote forage intensification, policy interventions should move beyond simple technology transfer. Strategies could prioritise strengthening cooperative-based advisory systems, promoting "feed-breed" complementarity to align genetics with nutrition, and developing site-specific interventions that recognise the diverse land constraints facing smallholder households.



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Sciforum-195992: Economic Impact of Regenerative Farming Practices on Smallholder Wheat Farmers: A Propensity Score Matching Analysis in Ethiopia

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The shift to regenerative farming systems has drawn interest from all over the world as a financially feasible and ecologically sound substitute for traditional farming methods. Despite its potential advantages, there is still little empirical data on its microeconomic effects in Ethiopia, especially among smallholder wheat farmers. Using cross-sectional micro-level data from 368 smallholder farmers, this study investigates the financial effects of regenerative farming techniques on Ethiopian smallholder wheat producers. Crop rotation, reduced tillage, integrated soil fertility management, organic soil additives, and diverse cropping systems are among the regenerative techniques taken into consideration in the study. To mitigate self-selection bias and determine the causal impact of implementing regenerative techniques on farm revenue, yield performance, and cost efficiency, a Propensity Score Matching (PSM) method was utilized. Based on important farm and socioeconomic factors like age, education, land size, access to extension services, loan availability, and market access, the model matched adopters and non-adopters. The findings show that farmers who used regenerative approaches had far higher net income and more consistent yields than those who did not. This was mainly because of increased soil productivity, lower input costs, and better resistance to climate variability. The results also show that adoption is strongly influenced by education level, land tenure security, and access to extension help. According to the study's findings, smallholder incomes can be raised by regenerative wheat farming, which also promotes long-term soil and environmental sustainability. In order to grow regenerative agriculture in Ethiopia's wheat-based farming systems, policy implications highlight the necessity of focused extension programs, monetary incentives, and integrated land management support. Enhancing these initiatives can improve farmer well-being nationwide and hasten sustainable agricultural transition.



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Sciforum-198852: The Influence of Nitrate Derogation on Land Rental Market Participation: Evidence from Ireland

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The land rental market in Ireland is an important mechanism for improving land mobility and remains the most feasible means for dairy farmers to access farmland. However, reforms to the European Union Nitrates Directive, have placed additional pressures on farmers by reducing limits on organic manure per hectare. These restrictions induce farmers to seek additional land to maintain milk production while complying with regulatory requirements.

The nitrate derogation, a special permission under the Directive, allows eligible farmers to operate at higher stocking rates subject to strict environmental conditions. Despite its potential importance, evidence on the effects of dynamic environmental regulations on farmland rental markets remains limited. No previous study has specifically examined the impact of nitrate derogation on land rental market participation. This research addresses this gap by examining the determinants of dairy farmers' participation in the land rental market, with particular attention to the effects of nitrate derogation.

The study uses panel data from the Teagasc National Farm Survey covering the period from 2015–2024. A Heckman two-stage sample selection model is employed to account for potential sample selection bias arising from unobserved factors that jointly influence dairy farmers' decisions to rent-in land and the volume of land rented. Farm-specific unobserved heterogeneity is controlled for using fixed effects model.

Preliminary results indicate that nitrate derogation status has a statistically significant positive effect on dairy farmers' decisions to rent-in land, while its effect on the volume of land rented is statistically insignificant. Land ownership, organic nitrate production, total labour units, and farm net value added significantly influence participation decisions. A correlated random effects model is estimated as part of the robustness analysis.

The findings provide important insights for designing policies that enhance land mobility while supporting environmental sustainability and the competitiveness of Ireland's dairy sector.



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Sciforum-199383: Smart farming, data use and sustainability pathways in Australian agriculture: Evidence from farmers' survey

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The transition towards more sustainable agricultural systems is increasingly supported by digital technologies, farm data management, and environmental, social and governance (ESG) frameworks. However, the relationship between these factors remains poorly understood at the farm level. Therefore, this study presents findings from a survey of 200 Australian farmers conducted to investigate adoption of digital technology, sustainability practices, ESG perceptions, and the role of farm data in supporting sustainability. The findings show that 39% of the surveyed farmers are using smart farming technologies and its adoption was mainly influenced by economic capacity, infrastructure availability, and perceived benefits. Poor infrastructure (26%) and huge investment cost (25%) were identified as major barriers to adoption. While 91% farmers considered sustainability important and 82% reported using at least some sustainable farming practices, use of formal sustainability frameworks were relatively low (28%). ESG was familiar with around half responded and varied across farm types and enterprise characteristics. Further analysis showed that farmers adopting smart farming technologies used more sustainability practices and farm data to improve efficiency, monitoring, compliance, and reporting. Mediation analysis showed that about two-thirds of the relationship between smart farming adoption and sustainability practices was explained by increased data use. This suggests that data mobilisation is an important pathway through which digital technologies can support sustainability outcomes. Cluster analysis identified two different pathways among farmers: a digitally enabled sustainability integrator pathway and a low-digital emerging steward pathway. These findings suggest that there is no single pathway to sustainability in Australian agriculture. Instead, sustainability outcomes are influenced by data use, farm context, governance arrangements, and support systems. The study highlights the importance of developing practical, farmer-centred ESG tools to support decision-making and provide credible evidence of sustainability performance in Australia. Such use of technology and tools will benefit farmers globally to improve productivity and sustainability.



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Sciforum-199394: Farmer Readiness for Net-Zero Agriculture: Motivations, Barriers, and Digital Decision Support Systems

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Agriculture is central to achieving net-zero emissions because it is both a source of greenhouse gas (GHG) emissions and a sector with substantial mitigation potential through improved land management, carbon sequestration, digital monitoring, and climate-smart practices. However, progress toward low-emission agriculture depends not only on policy targets or technological innovation, but also on farmers' motivations, perceived barriers, digital readiness, and capacity to use emissions-related information in decision-making. This study draws on a survey of Australian farmers' readiness for low-emission agriculture, based on valid responses from 192 farmers for the net-zero practice analysis and 165 farmers for the digital readiness analysis. The analyses focused on two connected dimensions: (1) farmers' awareness, motivations, barriers, and adoption of net-zero related practices (2) use of digital tools and decision support systems (DSS) for greenhouse gas management. The findings show that awareness of net-zero emissions was high, with 93.2% of respondents reported awareness, and 73.3% had adopted at least one sustainable or GHG practice. Adoption was concentrated in practical land-based practices, biodiversity plantings, carbon sequestration, renewable energy use, and zero or no-tillage. Adoption decisions were shaped primarily by environmental concern, social responsibility, and perceived economic benefits. Key barriers included financial constraints, time limitations, technological challenges, and a lack of information. The digital-readiness findings reveal a related challenge. Although 72.1% of respondents reported using digital tools for routine farm management, use for emissions management remained limited. Digital tools were mainly used for record-keeping, financial management, production optimisation, and livestock tracking rather than emission management. Digital GHG record-keeping emerged as a critical bridge between general digital capability and DSS use. Findings highlight that progress towards net-zero agriculture depends on both farmer motivation and digital readiness. For this transition, it will require effective policy, and extension should prioritise farmer-centred support linking emissions reduction with farm benefits, simple digital record-keeping, and user-friendly DSS.



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Sciforum-199482: Economic Viability of Sustainable Livestock Production: A Financial Analysis of AIoT-Driven Precision Management Systems

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Transitioning toward sustainable farming systems raises key questions among producers regarding long-term financial viability. In intensive livestock production, endemic disease outbreaks and inefficient resource management significantly undermine economic sustainability. This study presents a comprehensive economic evaluation of an Artificial Intelligence of Things (AIoT)-driven precision management framework, integrating AI-based cough monitoring and automated environmental controls, implemented within smallholder contract swine farming communities in the Eastern Region of Thailand.

A thorough cost-benefit analysis was conducted across two distinct commercial pilot facilities, encompassing a total scale of 600 pigs over a 12-month production timeline. The platform utilized real-time sensor networks to monitor microclimatic parameters, including ammonia (NH_3) and carbon dioxide (CO_2) levels, executing automated climate adjustments to mitigate operational risks.

The quantitative financial and operational data revealed substantial economic returns, successfully addressing the reviewers' criteria for empirical evidence. Across the pilot sites, the implementation led to a drastic reduction in swine mortality rates by 57% to 83%, which subsequently boosted overall biomass production weight by 34% to 78%. In terms of cost efficiency, the automated system reduced labor-associated administrative expenses by 50% at both facilities, while optimizing energy expenditures, resulting in a 20% to 24% reduction in electricity costs and a 21% to 24% reduction in water usage. Furthermore, veterinary medicine and disease treatment costs dropped by 10.2% to 34.6%. These combined efficiencies generated exceptional financial performance, with the Net Return increasing by 11.72% to 21.58%, yielding a Return on Investment (ROI) ranging from 183.81% to 397.33%, and achieving rapid payback periods between 3 and 6.5 months.

In conclusion, this research provides robust empirical evidence that precision technology directly reinforces the economic pillars of sustainable farming systems, demonstrating that initial capital investments are rapidly offset by minimized production losses.



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Sciforum-199952: Oil Palm-Based Agroecological Potential and Characteristics of Smallholder Adopters: Evidence in Rural Democratic Republic of Congo (DRC)

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The oil palm agroecosystem (OPAES) offers significant potential for sustainable agriculture in rural areas such as Bulungu in the Democratic Republic of the Congo (DRC), where agriculture is the primary source of income. However, issues such as deforestation, pollution, and land grabbing in the oil palm sector often impede development. This study addresses the lack of empirical data on the adoption of oil palm-based agroecological practices by smallholders in the DRC, examining these practices, their accessibility, and the factors influencing their adoption for food crops and oil palm plantation renewal.

Data were collected from 192 households across approximately twenty villages in three key oil palm-growing zones in Bulungu territory. Household well-being was measured using multidimensional poverty indices. T-tests were used to analyze differences among adopters, and a binomial generalized linear regression model assessed the relationship between poverty and oil palm adoption.

Results indicate that agriculture is the primary source of income (60%). Smallholders underutilize the OPAES model, with palm oil extraction (34%) being the most common activity, followed by biomass use for cooking (32%), agroforestry (17%), and organic fertilizer recycling (8%), while livestock feed recycling remains low (4%). Socioeconomic disparities exist in agroforestry adoption, influenced by household head gender, household size, and location. The regression model shows that adopting oil palm as an alternative income source significantly reduces poverty, whereas dependence on it as a primary source may hinder poverty reduction due to low yields from aging plantations and poor oil quality, which limits market access.

In conclusion, policy interventions should promote a climate-resilient OPAES model that enhances income diversification, alleviates poverty, and improves food security by integrating social, ecological, and economic aspects of development.



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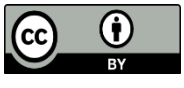
Sciforum-199996: Between perception and adoption: innovation attributes in the use of digital technologies in coffee farming

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The adoption of digital technologies in rural areas has advanced through the development of productive practices oriented toward data and connectivity, involving sensors, automation, connectivity, and decision-support systems. However, their incorporation still occurs unevenly among producers and productive contexts. This study analyzes the factors associated with the adoption of digital technologies by coffee growers in a territorial area of Southeastern Brazil, considering perceived innovation attributes, barriers, and socioeconomic and productive variables. The research is characterized as quantitative, descriptive, and causal. A structured survey was conducted, consisting of 46 questions based on scales validated in the literature, and applied to 274 coffee growers. Responses were measured using a five-point agreement scale. Data were analyzed using Partial Least Squares Structural Equation Modeling, with assessment of the measurement model, structural model, moderating effect of barriers, and importance-performance matrix. The results indicated that relative advantage, compatibility, and trialability positively influence the perceived results of digital technologies, with trialability showing the strongest effect. Perceived results, in turn, positively influenced adoption, indicating that technologies whose benefits are perceived more clearly tend to be incorporated by producers. The moderating effect of barriers showed borderline significance, suggesting that perceived limitations may condition the relationship between observability and adoption. The importance-performance analysis indicated that observability of results, financial performance, and planted area stand out as relevant factors for explaining technological adoption. As a managerial contribution, the findings indicate that rural producers, cooperatives, and technical assistance agents can expand adoption by making the benefits of technologies more visible, demonstrable, and compatible with the reality of farms. Theoretically, the study advances by articulating distinct explanatory perspectives to understand technological adoption in coffee farming, contributing to the debate on innovation, diffusion, and digitalization in specialized agricultural contexts.

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Sciforum-208644: GHG emissions and abatement potential in fisheries and aquaculture: evidence from Vietnam

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Despite the important contribution of aquatic food production to food security, nutrition, and livelihoods, concerns about its environmental impacts, particularly greenhouse gas (GHG) emissions are growing as aquaculture expands and pressure on capture fisheries resources intensifies. This paper examines the economics of GHG emissions in Vietnam's aquaculture and capture fisheries, focusing on heterogeneity in emissions intensity and profitability, the economic returns to emissions, and the potential effectiveness of carbon pricing in reducing emissions.

Using household-level data from the Vietnam Household Living Standards Surveys (VHLSS) for 2010, 2012, 2014, 2016, and 2018, we estimate GHG emissions and economic returns at the producer level. The detailed cost data allow us to identify key sources of emissions and examine variation in emissions intensity and profitability across producers. We also construct a bottom-up Marginal Abatement Cost Curve (MACC) to assess the potential and economic costs of emissions reduction and examine the effects of alternative carbon prices.

The results reveal distinct emissions profiles across production systems. Feed is the dominant source of GHG emissions in aquaculture, while fuel consumption is the primary source in capture fisheries. Average economic returns are estimated at USD 330 per tonne of GHG emissions in aquaculture and USD 278 per tonne in capture fisheries. More importantly, substantial heterogeneity in emissions intensity and economic returns across producers indicates considerable scope for emissions reduction through improvements in production efficiency. Our analysis further suggests that carbon pricing could reduce GHG emissions by discouraging emissions-intensive production, while having only a modest impact on fish output at moderate carbon prices.

The findings highlight the importance of accounting for producer heterogeneity when designing climate mitigation policies for aquatic food systems. While focused on Vietnam, the study offers broader insights into pathways for reducing emissions while maintaining the economic viability of aquaculture and capture fisheries in developing countries.

Author contributions: Conceptualization, Nhuong Tran and Long Chu; Methodology, Nhuong Tran and Long Chu; Formal analysis, Nhuong Tran, Long Chu, Anh Tran, Chin Yee Chan and Nhat-Mai Nguyen; Investigation, Nhuong Tran, Long Chu, Anh Tran, Chin Yee Chan and Nhat-Mai Nguyen; Data curation, Nhuong Tran, Long Chu and Anh Tran; Writing - original draft, Nhuong Tran, Long Chu, Anh Tran, Chin Yee Chan and Nhat-Mai Nguyen; Writing - review and editing, Nhuong Tran, Long Chu, Anh Tran, Chin Yee Chan and Nhat-Mai Nguyen; Visualization, Long Chu and Nhat-Mai Nguyen;



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Sciforum-208676: Farm Competitiveness and Climate-Smart Investment Portfolios: Post-Investment Evidence from the Serbia Competitive Agriculture Project

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Investment support for family farms is increasingly expected to strengthen competitiveness while also contributing to selected resource-use objectives. This study examines post-investment changes in competitiveness indicators among beneficiaries of the Serbia Competitive Agriculture Project (SCAP) and complements this analysis with a descriptive module on climate-smart agriculture (CSA) investments. The analysis draws on survey data from 203 beneficiary family farms, comprising 122 crop and 81 livestock farms, collected in 2025 under an observational before-and-after design without an external non-beneficiary control group. Paired changes were tested with the Wilcoxon signed-rank test, differences between crop and livestock farms with the Mann-Whitney test, and correlates of change with multiple regression using HC3-robust standard errors. In the post-investment period, median output rose by 12.5%, unit production cost fell by 8.6%, selling price rose by 13.3% and absolute margin increased by EUR 1,000, each change significant at $p < 0.001$. An aggregate decomposition indicates that 79.4% of the margin change is associated with the quantity component. In the descriptive CSA module, fuel-use intensity, calculated as the ratio of reported subgroup means, increased in both comparison groups but grew more moderately in portfolios containing a CSA component: by 9.4% with a CSA component versus 20.8% without one for raspberry, and by 3.7% versus 32.3% for plum. Because CSA selection was non-random and no external control group exists, these findings are observational associations rather than causal programme effects. The results are relevant for designing and monitoring investment support that considers both competitiveness and measurable resource-use outcomes, including farm-level collection of baseline and follow-up resource data in physical units. This research received no external funding; data collection was enabled by the institutional framework of SCAP.

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Author contributions: Conceptualization, Milan Nenad Stevanovic; Methodology, Milos Kolavcic; Software, Milos Kolavcic; Validation, Milan Nenad Stevanovic; Formal analysis, Milan Nenad Stevanovic; Investigation, Milos Kolavcic and Jakov Bozovic; Data curation, Jakov Bozovic; Writing - original draft, Milan Nenad Stevanovic; Writing - review and editing, Milos Kolavcic; Visualization, Milan Nenad Stevanovic; Supervision, Jakov Bozovic; Project administration, Jakov Bozovic;



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Sciforum-209294: Integrating Industry 4.0 and Mechanical Engineering Innovations for Next-Generation Sustainable Farming Equipment: Impacts on Input Costs, Yield Stability, and Farm-Level Economics

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The agricultural machinery industry is undergoing a significant transformation due to the application of Industry 4.0 technologies and mechanical engineering breakthroughs, which allow the intelligent monitoring, automation, precision control and more efficient functioning of agricultural machinery. But the contribution of their use in sustainable agriculture economy remains poorly quantified. A large number of studies already exist that assess the technical and/or production performance potential of smart agriculture technologies, only a few of which combine the potential for mechanic innovations enabled by Industry 4.0 with the reduction of input costs, yield stabilization and performance of the farm-level economies. The main target of this study is assessing the impact of Industry 4.0 and mechanical engineering innovations on the efficiency in using inputs, stability in production at farm level, and the performance of the farm. The performance of equipment and the farm economics indicators were used to set up a quantitative comparative framework. The four indicators of technological innovation (α), automation intensity (β), resource-use efficiency (γ) and digital monitoring capability (δ) were examined and analysed through descriptive statistics and multivariate regression. The findings reveal a positive effect of technological innovation on the economic performance of the farms (α = 0.43, $p<0.01$), as also did the variables of automation intensity (β = 0.31), resource-use efficiency (γ = 0.36), and digital monitoring (δ = 0.24) had a positive effect. The proposed equipment framework resulted in a reduction in the input cost of 18.7%, improved yield stability of 14.3% and improved estimated economic performance at farm-level by 21.5%. The model accounted for 72% (R^2 = 0.72) of the variance in observations. The synergy between Industry 4.0 and mechanical engineering can enhance sustainable farming by lowering input expenses, smoothing production, and boosting profitability.

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Sciforum-210110: Mechanical Engineering Pathways for Next-Generation Sustainable Net-Zero-Waste (NZW) Agriculture: Optimized Crop-Residue Gasification for Renewable Bio-Syngas Production

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Agricultural residues are a marginalized resource in most agroecological systems, and uncontrolled burning leads to air pollution, greenhouse gas emissions, and loss of resources. This study proposes and tests a continuous feed downdraft gasifier to develop renewable bio-syngas fuel and promote sustainable and net-zero waste agriculture. In order to study the structural strength, internal gas flow, and temperature behavior of a (3-D) gasifier, a three-dimensional (3-D) gasifier model was developed on SolidWorks, and its structural strength, internal gas flow, and temperature behavior were studied by using SolidWorks simulation and SolidWorks flow simulation software. Considering the thickness of the reactor wall, pressure in the reactor, and velocity of air being taken into the reactor, the best design was optimized to ensure the safe and efficient operation of the reactor. The optimized gasifier had an 8.50 mm thickness and a working pressure of 1.50 MPa with a maximum von Mises stress of 112 MPa and a factor of safety of 2.80. When the air-intake velocity was 2.20 m/s, the peak temperature of the combustion process was 985°C, and the pressure drop was 320 Pa. The defined operating conditions for the producer gas suggested a higher heating value of about 5.40 MJ/Nm^3. Based on these results, it can be concluded that the proposed gasifier is a technically viable system to produce renewable energy from crop residues, ensuring structural security and operating parameter management. The proposed approach can contribute to positive improvements in crop-residue management, diminish the amount of open field burning, facilitate decentralized renewable-energy generation, enhance a circular use of agricultural resources, and boost rural energy resilience. The technical and economic feasibility assessments of the project, site, and concept level and the farmer-level assessments require further work before implementation. In conclusion, the study is a solid mechanical-engineering basis for the development of sustainable crop-residue-to-energy systems within a net-zero-waste agriculture paradigm.

Author contributions: Conceptualization, Helal Uddin, Soham Biren Katlariwala and Md Sohag Ahasan; Methodology, Helal Uddin and Soham Biren Katlariwala; Software, Helal Uddin and Soham Biren Katlariwala; Validation, Helal Uddin and Soham Biren Katlariwala; Formal analysis, Helal Uddin, Soham Biren Katlariwala and Md Sohag Ahasan; Investigation, Helal Uddin and Md Sohag Ahasan; Resources, Sharif Ibne Mizan Al Mahmud and Ziyoda Kobilbekova; Data curation, Helal Uddin, Md. Rasel Ahmed, Md. Alamgir Hossain, Zaryab Basharat and Ziyoda Kobilbekova; Writing - original draft, Helal Uddin, Soham Biren Katlariwala, Md Sohag Ahasan, Sharif Ibne Mizan Al Mahmud and Ziyoda Kobilbekova; Writing - review and editing, Md. Rasel Ahmed, Md. Alamgir Hossain and Zaryab Basharat; Visualization, Helal Uddin; Supervision, Md. Rasel Ahmed and Md. Alamgir Hossain; Project administration, Md. Rasel Ahmed, Md. Alamgir Hossain, Zaryab Basharat, Soham Biren Katlariwala, Md Sohag Ahasan, Sharif Ibne Mizan Al Mahmud and Ziyoda

Kobilbekova; Funding acquisition, Md. Rasel Ahmed, Md. Alamgir Hossain, Zaryab Basharat, Soham Biren Katlariwala, Md Sohag Ahasan, Sharif Ibne Mizan Al Mahmud and Ziyoda Kobilbekova;



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Session 7. Agroecological Approaches to Soil Management

Sciforum-180229: Regenerative soil and crop management in organic agriculture; a strategy to maintain fertile soils, heathy crops, food quality and human health?

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The benefits of integrated soil and crop management practices used in organic farming systems on soil biological activity, structural stability and fertility, above and below ground biodiversity, and the environmental impact and long-term sustainability of agricultural crop production are increasingly recognized. In contrast, there has been controversy about whether, to what extent and how organic soil and crop management may affect the nutritional quality of food crops.

However, a range of recent studies has provided substantial, new evidence which supports the main hypothesis of early organic farming pioneers which is that "*healthy soils result in healthy crops and healthy livestock and humans* (Rempelos et al. 2021; Hasanaliyeva et al. 2023).

This review will describe results from recent long-term factorial field experiment which provided strong evidence that the same agronomic practices (e.g. the non-use of synthetic pesticides and the use of manure and legume fertility building crops instead of mineral NPK fertilizers in organic production) are responsible for both soil health and nutritional quality improvements in organic cropping systems. In addition, supporting evidence from (i) systematic reviews/meta-analyses of data from studies that compared concentrations of nutritionally relevant compounds (e.g. antioxidants, vitamins, minerals, toxic chemicals) in organic and conventional crops and (ii) dietary intervention and observational studies that compared health-related physiological markers and the incidence of non-communicable diseases (e.g. obesity, metabolic syndrome, cancer, pre-eclampsia and neurological disorders including autism) in animal models and humans, will be described.

The review aims to critically the currently available information, discuss the interactions between diet and food type (organic versus conventional) that may have confounded the results of observational studies into health impacts of organic foods and identify important knowledge gaps.

Reference

Rempelos et al. Integrated Soil and Crop Management in Organic Agriculture: A Logical Framework to Ensure Food Quality and Human Health? *Agronomy* **2021**, 11, 2494.



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Sciforum-183091: Country, Collaboration, and Soil: Integrating Indigenous Knowledge in Transdisciplinary Agroecology

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This transdisciplinary (TDR) study examines collaborative approaches to agroecological soil management through integrating natural and social sciences with Indigenous knowledge systems in Australian agriculture. Focusing on the Transformative Aboriginal Agricultural Methods – Maaman Marra Boodjar (TAAM) pilot project (2024–2025), the research brings together soil scientists, social scientists, farmers, and an Aboriginal traditional lore-man with the objective to build drought resilience on adjoining farms in Western Australia. While TDR emphasizes co-production and long-term engagement, the practical mechanisms enabling these processes remain underexplored.

The study identifies key operational strategies, including sustained multi-directional communication, respectful integration of diverse epistemologies, and negotiation of differing temporal frameworks between research processes and stakeholder expectations. TAAM outputs were intentionally varied—written reports, documentary storytelling, and webinars—to reflect multiple modes of knowledge engagement. Beyond tangible outputs, less visible outcomes were critical, including strengthened relationships, increased participant confidence, and shared learning influencing future decision-making.

Challenges emerged during the project's middle phase, including balancing different ways of knowing, maintaining engagement over time, and resisting default technical solutions under uncertainty, revisiting shared project goals and the mismatch between funding, reporting deadlines and on Country needs. Yarning circles played a central role in addressing these challenges by creating space for storytelling, lived experience, and cultural knowledge, enabling collective meaning-making despite non-linear dialogue.

Findings highlight that effective TDR begins with relationships rather than methods, requires early and meaningful involvement of Aboriginal communities, and embraces ambiguity and multiple ways of knowing. Trust, reciprocity, learning, and empowerment emerge as essential outcomes. Soil moisture measures showed improvement and carbon sequestration changes. The study demonstrates how inclusive, culturally grounded collaboration can strengthen soil resilience and adaptive capacity under increasing climatic variability.



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Sciforum-186020: Integrated Biochar-Based Strategies for Sustainable Crop Production in the Drylands of Saudi Arabia

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Water scarcity, climate change, extreme temperatures, decreased rainfall and deteriorating irrigation water quality pose serious risks for agricultural sustainability in Saudi Arabia. Biochar could be an effective solution to address all these concerns simultaneously. Results from our research demonstrate the effectiveness of biochar application in enhancing water use efficiency, morpho-physiological traits of crops, and yield under both drought and salinity conditions. In our greenhouse study evaluating 16 combinations of water quality (fresh: 0.9 dSm^{1}; saline: 2.3 dSm^{1}), deficit irrigation regimes (40-100% ETc), and 5% date palm biochar application showed that salinity and water deficit resulted 42.48% yield reduction at 40%ETc compared to fully irrigated controls. However, significant amelioration of yield reductions was observed with biochar application in interaction with freshwater irrigation, providing improvement of growth indices, leaf water content and photosynthetic pigments, and water use efficiency. In another field experiment on wheat, a biochar from poultry litter applied at 10 and 20 t ha^{1} in conjunction with chemical fertilizers showed a significant enhancement of soil microbial biomass of C, N and P (by 27, 58, 61%), and bacterial and arbuscular mycorrhizal fungi populations (by 70% and 49%, respectively). In another study we demonstrated the climate projections for the Al-Baha region using a landscape scale, SALTMED-based model, which showed that groundwater salinity increasing from 1.44 dS m^{-1} to 4.67 dS m^{-1}, leading to increases in soil salinity as high as 675%. It was predicted that the pomegranate tree productivity may decrease up to 41.6% in the Al-Baha region if the deterioration of groundwater quality continues. Further, 1995–2019 climate trends observed in the region indicated a temperature increase of 1.1–1.6℃ and a rainfall decrease of 24-41%. Therefore, introduction of biochar-based soil management and precision deficit-irrigation in drylands of Saudi Arabia could lead to sustainable crop production in the region.



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Sciforum-197203: Nitrogen accumulation in field peas (*Pisum sativum* L.) under different tillage systems

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The sowing area of peas in Latvia has increased from 1.2 thousand ha in 2010 to 46.6 thousand ha in 2025, highlighting the growing importance of legumes in sustainable crop production. Optimizing agronomic practices, including tillage, is therefore essential for achieving stable and high yields.

This study evaluated the effects of conventional and reduced tillage on nitrogen accumulation, biological nitrogen fixation, and soil C and N dynamics in peas (*Pisum sativum* L.).

A long-term field experiment established in 2006 at the LBTU Research and Study Farm "Pēterlauki" compared conventional tillage (ploughing) and reduced tillage (10 cm disc harrowing) systems.

Total N and C contents and $\delta^{15}N$ values were determined in plant biomass and soil samples using an EA3000 elemental analyzer coupled with isotope ratio mass spectrometry.

Soil total N and C content increased slightly from spring to autumn under reduced tillage, suggesting more favorable conditions for organic matter accumulation. During flowering and at maturity, total nitrogen content in plant biomass was under reduced tillage, indicating enhanced nitrogen uptake and accumulation.

$\delta^{15}N$ values differed between tillage systems. Root $\delta^{15}N$ was 0.58‰ under reduced tillage and 2.05‰ under conventional tillage, while seed $\delta^{15}N$ values were 0.06‰ and 0.95‰, respectively. Higher $\delta^{15}N$ values under conventional tillage suggest a greater contribution of soil-derived nitrogen, whereas lower $\delta^{15}N$ values under reduced tillage indicate a greater contribution of atmospheric nitrogen through biological fixation.

Overall, reduced tillage promoted nitrogen accumulation in pea biomass and was associated with lower $\delta^{15}N$ values, suggesting a greater contribution of biologically fixed nitrogen, while also supporting higher soil total C and N contents.

This research was supported by the project "The potential impact of increasing pea cultivation areas in Latvia on the spread of pests and other harmful organisms, as well as on potential yield in other crop groups".



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Sciforum-197227: Compost-Based Soil Management Improves Soil Health and Turfgrass Performance in Construction-Disturbed Sandy Soils

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Construction-disturbed sandy soils in urban and residential developments are typically low in organic matter, have poor nutrient retention, low water-holding capacity, and limited biological activity, often resulting in increased fertilizer and irrigation requirements during turfgrass establishment. Compost amendments offer a potential strategy to improve soil function and support more sustainable soil management in these degraded systems. This study evaluated the effects of compost incorporation and repeated compost topdressing on soil health and turfgrass performance in builder sand. A field experiment was conducted from 2024 to 2026 in Citra, Florida, USA, using 'Floratam' St. Augustinegrass established on builder sand. Two soil systems were evaluated: compost-amended and non-amended builder sand. Compost-amended plots received compost incorporated at 329.2 m^3 ha^{-1} into the top 15.2 cm of soil prior to sod establishment. Within each soil system, six treatments were compared: compost topdressing applied once per year (C1X), twice per year (C2X), C1X plus fertilizer, C2X plus fertilizer, fertilizer alone, and a non-treated control. Turfgrass performance, soil moisture, and soil physical, chemical, and biological properties were monitored throughout the study. Compost incorporation improved turfgrass performance and soil quality relative to non-amended builder sand, increasing soil moisture retention, organic matter, water-holding capacity, microbial activity, and plant-available nutrient concentrations while reducing bulk density and soil pH. Across both soil systems, C2X and C2X + fertilizer consistently produced the greatest turfgrass performance, canopy vigor, soil moisture, and nutrient availability. Treatment effects were generally more pronounced in non-amended soils, indicating greater reliance on external nutrient inputs where baseline soil quality was limited. These results demonstrate that compost-based soil management enhances soil health, improves turfgrass performance, and increases nutrient and water retention in construction-disturbed sandy soils. Repeated compost applications provide a sustainable strategy for restoring soil function while reducing dependence on synthetic fertilizer inputs in urban landscapes.



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Sciforum-198884: Surface-Enhanced Raman Spectroscopy (SERS) of Deep Soil as a Tool for Cropping System Sustainability Evaluation

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Assessing the sustainability of agricultural cropping systems requires evaluating soil processes throughout the whole soil profile, including deep horizons that are often neglected in conventional studies. Surface soils are commonly used to monitor soil health and soil organic matter (SOM) dynamics, but deep soil layers represent important reservoirs of soil organic carbon (SOC) and play a key role in carbon sequestration, nutrient cycling, and ecosystem resilience.

This study evaluates the sustainability of a long-term agricultural cropping system in the Dél-Alföld (Hungary) using Surface-Enhanced Raman Spectroscopy (SERS) at 532 nm and 785 nm to characterize SOM composition and carbon dynamics along a soil profile extending to 150 cm depth. The site, cultivated since the Early Middle Ages, has undergone intensive agricultural exploitation since the 1950s, including extensive use of fertilizers and pesticides. Despite its historically high soil quality, prolonged overuse and recurrent drought conditions have resulted in declining crop productivity and quality.

The investigated soil showed no major physical limitations, as indicated by bulk density measurements and field observations of texture and porosity, which allowed adequate root growth and drainage. SOC analyses revealed substantial carbon depletion throughout the soil profile. However, the relatively uniform $\delta^{13}C$ values with depth suggest limited transformation of SOM. In contrast, SERS spectra identified variations in SOM-associated molecular signatures along the profile, indicating altered carbon dynamics and reduced soil functional capacity. The SOM findings highlight the unsustainability of the current cropping system in Dél-Alföld, justifying thus the decline in crop productivity and quality. Moreover, SERS proved to be a rapid, sensitive, and minimally invasive analytical tool for characterizing SOM quality and monitoring the sustainability of agricultural management systems.



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Sciforum-199376: Kokogel: A novel microbially enriched hydrogel-containing fertilizer derived from poultry manure for improving soil quality and supporting wheat productivity

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Introduction

Sustainable management of livestock by-products and the development of environmentally friendly fertilisers are important challenges in modern agriculture. Poultry manure represents a valuable source of nutrients and organic matter that can be recycled into value-added products. This study evaluated the effects of Kokogel, a novel hydrogel-containing organo-mineral fertiliser derived from poultry manure and biologically enriched with beneficial soil microorganisms, on soil properties, microbial activity, and wheat productivity.

Methods

Pot experiments were conducted under controlled conditions using sandy soil and spring wheat (*Triticum aestivum* L.). Three fertiliser variants differing in hydrogel content (H30, H60, and H100) were compared with a mineral control (MC) and an unfertilised control (C). Kokogel and MC treatments were applied at an equivalent nitrogen rate of 150 mg N kg^{-1} dry soil. Plants were grown under optimal water supply (60% water holding capacity). Soil chemical properties, microbial activity, physiological parameters, yield components and grain quality traits were determined after harvest.

Results

Kokogel significantly improved soil quality compared with both controls. The H60 treatment resulted in the highest pH, calcium content, cation exchange capacity (15.2 cmol kg^{-1}) and base saturation (82.1%), indicating enhanced nutrient retention and improved soil fertility. Fertilised treatments stimulated microbial activity, increasing the abundance of diazotrophic, nitrifying, ammonifying and proteolytic bacteria. Grain yield reached 20.17, 18.67 and 19.50 g pot^{-1} in H30, H60 and H100 treatments, respectively, compared with 11.77 g pot^{-1} in the C and values comparable to MC (20.70 g pot^{-1}). In addition, the grain protein and gluten contents were higher relative to the C group.

Conclusions

Kokogel improved soil fertility, stimulated beneficial microbial communities, and maintained wheat productivity comparable to that under mineral fertilisation. The developed fertiliser represents a promising agroecological approach for sustainable soil management and circular utilisation of poultry manure, with the potential to reduce dependence on mineral fertilisers and improve soil quality.



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Sciforum-199645: Particle size influence in water absorption capacity of a commercial biochar for agricultural applications

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Increasing water scarcity and more frequent drought events associated with climate change are placing increasing pressure on agricultural production, highlighting the need for sustainable soil management strategies that improve water use efficiency. Biochar has emerged as a promising soil amendment due to its potential to enhance soil water availability and crop resilience. Although considerable attention has been given to the influence of feedstock and pyrolysis conditions on biochar properties, the effect of particle size on its intrinsic hydrological behaviour remains poorly understood, despite granulometry being a readily adjustable parameter before soil application. This study evaluated the influence of particle size on the water absorption capacity (WAC) of a commercial-grade biochar. Four granulometric fractions (1 mm, 250 µm, 63 µm and integral material) were assessed under controlled laboratory conditions. Water absorption capacity was determined gravimetrically and expressed as grams of water absorbed per gram of dry biochar (g g^{-1}). Data were analysed using one-way ANOVA followed by Tukey's multiple comparison test ($\alpha = 0.05$). Particle size significantly affected WAC ($F = 48.20$, $p < 0.001$). The 250 µm fraction exhibited the highest WAC (2.61 ± 0.21 g g^{-1}), followed by the 63 µm fraction (2.12 ± 0.14 g g^{-1}), whereas the 1 mm (1.46 ± 0.09 g g^{-1}) and integral fractions (1.47 ± 0.08 g g^{-1}) showed significantly lower values. The finest fraction did not exhibit the greatest water absorption, suggesting that maximum WAC is achieved at an intermediate particle size rather than progressively increasing with decreasing particle size. These findings demonstrate that particle size is a key factor influencing the hydrological performance of commercial biochar and should be considered before soil application. This laboratory study represents the first stage of an ongoing research programme on biochar incorporation into vineyard soils. Future work will evaluate whether the observed differences in WAC translate into improved soil water retention, water availability and vine performance under field conditions.



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Sciforum-199803: Influence of hedgerows on soil quality and macrofauna in three agricultural systems in the chalky Champagne region (France)

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Hedgerows are more and more considered as key elements for agroecology, promoting biodiversity and soil functioning, but the spatial extent of their influence in the adjacent cultivated plots is insufficiently quantified. We address this question by a field study in the chalky Champagne region (NE France) combining a gradient distance approach and a comparison between agricultural systems, depending on soil tillage intensity.

The sampling was realized in the fall 2025 and spring 2026 on 14 plots divided into 3 systems (conventional, soil conservation, and organic farming) along transects perpendicular to the hedgerows (from the base of hedgerows, i.e. 0 m, to 20 m into the cultivated surface). Three indicators were studied: soil physicochemical properties, earthworm communities (abundance, biomass, and diversity) and ground beetle abundance (*Carabidae*).

Soil Organic Matter (SOM) and Soil Organic Carbon (SOC) content presents a decreasing gradient with increasing distance from the hedgerow to the center of the plot. Earthworms follow the same pattern, decreasing in abundance and biomass with increasing distance from the hedgerow, accompanying a change in their diversity. Benefits from the presence of hedgerows are higher in soil conservation farming.

The abundance of ground beetles (*Carabidae*) shows a different pattern, ground beetles being more numerous in the adjacent cultivated plots than near the hedgerow.

These contrasting responses suggest that the effect of hedgerows varies between organism groups and is influenced by the agricultural system. These observations confirm the relevance of including the hedgerows in the agroecological practices of soil management. Future studies will extend this framework to include soil microbial communities (biomass and diversity).



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Sciforum-199848: Bacterial inoculation effect on nickel concentrations in *Medicago sativa*: Bioaccumulation potential

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Introduction

Soils with increased nickel (Ni) concentrations are widely spread, particularly among alluvial soils, which are generally suitable for alfalfa growth, but with a risk of Ni accumulation in the above-ground plant part. Rhizobial bacteria that live in symbiosis with alfalfa, in addition to nitrogen supply, can promote plant growth in stressful conditions (including increased content of heavy metals).

Material and methods

The influence of different rhizobial strains (*Ensifer meliloti* 218, 224, 217k, G-nov, 4193cs and 252) on alfalfa growth and Ni bioaccumulation in the first year of cultivation was analysed (first cut). The plants were grown on Fluvisol, in two fields with increased content of total Ni, 52.69 and 195.00 mg/kg. The Ni content in plant and soil was determined by ICP-OES and data were subject of analysis of variance and Duncan's test.

Results

The results showed that soil Ni influenced the Ni in the alfalfa shoots, which was in average for all treatments 2.51 mg/kg (soil with lower Ni), and 6.08 mg/kg (soil with higher Ni). Most of the strains reduced the Ni content in the alfalfa shoots, but the differences were not significant. The bioaccumulation factor (the ratio of Ni concentration in the above-ground part and total Ni content in soil) is very low, 0.036-0.147. Some strains positively influenced alfalfa biomass compared to non-inoculated control plants. In soil with higher Ni content, the total absorption of Ni in treatments with strains 4193cs, 218 and 217k was significantly lower compared to the control.

Conclusion

The effect of inoculation depends on the strains and soil properties, and further research will provide more detailed data.

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Sciforum-199984: Qualitative Systems Model for Compost-Based Growing Media: Oxygen Demand, Salinity, and Nitrogen Immobilisation Risk

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Compost in growing media can improve water holding and nutrient supply, but if it is not fully stabilised it can continue to decompose after mixing, which increases microbial oxygen demand and can reduce oxygen available to young roots. This oxygen drawdown risk is most important in plugs and seedlings because the root zone is small and often kept wet, so oxygen diffusion is limited. At the same time, high soluble salts (EC) and unsuitable pH can stress seedlings directly, and low air-filled porosity can intensify the effects of microbial respiration.

Using R-programming, an elastic-net signed Qualitative Systems Model (QSM) approach was established. Using mix composition parameters (ingredient percentages and amendments such as lime, gypsum, and fertiliser N) as predictors, the model simultaneously estimates six distinct agronomic targets: (1) oxygen uptake rate (OUR), (2) EC, (3) pH, (4) organic matter, (5) air–water structural indices, and (6) an N immobilisation risk value. Model adequacy was checked using holdout RMSE, and robustness was explored with stability and transient amplification diagnostics of the inferred operator.

OUR provided a sensitive measure of biological activity that can indicate whether a mix is likely to consume oxygen rapidly after potting. The QSM results highlighted formulation trade-offs, including cases where reduced OUR occurred alongside increased EC (suggesting apparent stability due to salt inhibition), and cases where high OUR combined with low N supply and low air-fraction increased N immobilisation risk. Driver rankings and profile plots identified the most influential ingredients and amendments for shifting these outcomes.

The combined measurement-and-model framework supports practical decisions on compost inclusion rate, aeration management, and starter fertiliser strategy for seedling-safe growing media. It also reinforces that respiration alone is not sufficient for agronomic suitability, and that EC, pH, and air-space should be evaluated together with OUR when approving compost-based mixes for crops.



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Sciforum-201675: Ecological Indicators of Earthworm Effects on Soil Microbial Biodiversity

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Earthworms residing in the plant root zone contribute to the horizontal and vertical distribution of microbial taxonomic units in the soil by ingesting and excreting soil along with soil microorganisms. Additionally, numerous studies conducted on this topic have demonstrated that earthworms enrich the soil with new microbial taxonomic units, proving that this soil animal can also act as a donor of new OTUs (or ASVs) in its habitat, thereby enhancing microbial interactions, nutrient cycling, functional diversity, ecosystem resilience, and the overall stability of soil ecological processes.The ecosystem functions of earthworms in agricultural soil can manifest as the proliferation of both beneficial and pathogenic microorganisms relative to crops. The literature lacks a synthetic indicator describing the impact of earthworms on overall soil microbial biodiversity after passing through their digestive tract. Moreover, this impact is highly likely dependent on the earthworm species, making it justifiable to establish an indicator that will facilitate efficient comparison between earthworm species and habitats. This earthworm functionality in the soil can be measured, among other things, through the proposed ecological indices: IETAM, IETAB, EESB, and EESBE. The first two express the impact of earthworm trophic activity on the biodiversity of major microbial symbionts and those remaining in the minority ($<$ 0.99%). The latter two refer to scenarios where the soil is enriched with new earthworm endosymbionts, with the earthworm acting as a donor of new microbial units and communities.

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Sciforum-207537: Characterization of Microbial Communities Dynamics in a Manure Solid-Liquid Separation System: A Shotgun Metagenomics Approach

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Manure management strongly influences dairy farm greenhouse gas emissions, especially methane and nitrous oxide. In addition, manure-derived products are commonly used as organic amendments, making their microbial characteristics relevant to downstream soil applications. However, the underlying microbial communities and their metabolic contributions remain insufficiently characterized. This study applied shotgun metagenomics to characterize taxonomic and functional shifts associated with solid–liquid fractionation in a dairy manure management system. Samples were collected in October 2024 from three sources: raw manure from the manure pit (MP, ~363 m^3), solid fraction (SF) of the composting pile, and liquid fractions (LF) of the first sedimentation lagoon (n = 2 per fraction). SF was composted, agitated, and humidified weekly. LF, on the other hand, flows through a series of three lagoons that sequentially decant the residual solids. 300 mg of sample was used for the DNA extraction using a ZymoBIOMICS DNA Miniprep kit (ZymoResearch, USA). Sequencing was performed using the Illumina's NovaSeqX platform. 270 Gb of data was obtained with an average of 60 million Raw Reads per sample. Sequencing reads were quality-filtered and host-depleted, taxonomically profiled with MetaPhlAn4, functionally annotated using Prodigal, InterProScan, HUMAnN3, UniRef90, and KEGG, and analyzed to quantify microbial diversity and methanogenesis-related pathways. Manure fractionation was associated with a clear decline in microbial diversity, with Shannon indices decreasing from 4.56 (MP) to 3.91 (SF) and 3.44 (LF), accompanied by a 47% reduction in observed species richness from MP to LF. Distinct microbial communities emerged across fractions. Bacteria dominated MP (90%) and SF (97%), whereas LF exhibited nearly equal representation of bacteria (50.2%) and archaea (49.8%), indicating selective enrichment of methanogenic archaea in the liquid phase. Each fraction exhibited distinct, functionally specialized microbial consortia. MP was enriched in fermentative *Bifidobacterium* (7.8%), reflecting its gut-derived origin. SF had a high abundance of thermophilic *Actinobacteria* (47%), taxa associated with fiber-degradation and nitrogen-cycling. In contrast, LF was enriched in acetate-producing bacteria, including *Corynebacterium pollutisoli* (0.65%), *Dietzia aerolata* (0.49%), and *Corynebacterium xerosis* (0.41%). Archaeal composition further reflected fraction-specific methanogenic potential. LF showed strong enrichment of acetoclastic methanogens, particularly *Methanotrix soehngenii*, increasing from 0.63% in MP to 31.5% in LF, suggesting enhanced methane-production potential under lagoon conditions. SF uniquely hosted ammonia-oxidizing archaea (*Candidatus Nitrosocosmicus* [1.33%]) and thermophilic methanogens (*Methanosarcina thermophila* [1.01%] and *Methanosarcina* sp. MSH10X1 [0.004%]), indicating the coexistence of nitrogen- and carbon-transforming potential in SF. Solid-liquid separation was associated with substantial restructuring of the manure microbiome and its functional potential, providing biological insights into the microbial processes that may contribute to the greenhouse gas emission reductions commonly reported in manure management systems equipped with solid-liquid separation. These findings improve our understanding of the microbial ecology underlying manure fractionation and highlight how management practices shape microbial communities involved in carbon and nitrogen transformations. This framework can support the development of strategies to optimize

composting and lagoon management, mitigate greenhouse gas emissions, and enhance the utilization of manure-derived fractions for soil application.



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Sciforum-208275: Temperate agroforestry systems increase abundance and functional diversity of earthworm communities

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Agroforestry is a promising multifunctional land-use system that integrates woody perennials with crops and/or livestock. In alley cropping systems, where tree strips alternate with crop alleys, soil biological activity is often enhanced compared to open croplands. For instance, earthworms, which are considered ecosystem engineers that regulate key soil functions, are typically more abundant within and near trees than in open croplands. However, multi-year studies in differently managed agroforestry systems are currently lacking. Therefore, we investigated how modern alley cropping systems affect earthworm abundance and functional diversity while considering spatio-temporal dynamics.

Earthworms were sampled biannually at six differently managed paired alley cropping and open cropland systems over two consecutive years. To account for spatial heterogeneity within alley cropping systems, earthworms were chemically extracted along point transects, spanning from the tree strip to the middle of the adjacent crop alley, using allyl isothiocyanate. Overall, earthworms were promoted underneath trees and were able to recover more quickly in tree strips following dry periods. Moreover, agroforestry enhanced the functional diversity of earthworm communities at certain study sites, as litter-dwelling species were particularly prevalent within and close to tree strips compared to open cropland. The positive effects of agroforestry on earthworms were attributed to more favorable microclimatic conditions, the absence of soil management under the trees, and the accumulation of leaf litter. However, earthworm communities were also influenced by site-specific differences in crop rotation and soil management, as well as by seasonal dynamics.

Our results highlight that tree strips can promote the abundance and functional diversity of earthworm communities and facilitate recovery following dry periods compared to crop alleys and open cropland. However, earthworm communities were strongly shaped by management and local climatic conditions. Our data emphasize the importance of spatio-temporal dynamics when assessing the impact of agroforestry on soil communities.

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Sciforum-208435: Satellite-based monitoring of crop residues: assessing NDTI reliability at the regional scale in Friuli Venezia Giulia

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Crop residue retention and reduced soil disturbance are key agroecological practices for soil health and long-term fertility, yet adoption is difficult to verify beyond farmer declarations.

This study assessed whether the Normalized Difference Tillage Index (NDTI), from Sentinel-2 bands B11/B12, can detect crop residues and characterize tillage conditions across the agricultural plain of Friuli-Venezia Giulia, Italy. Biweekly NDTI and NDVI time series were generated for 2023 over 200,000 parcels representing 15 crop types. After cloud masking and median compositing, parcel-level values were compared among conventional, minimum-tillage and no-till practices declared under the EU CAP.

Across crops, NDTI closely tracked NDVI throughout the year, and this association persisted after removing plot-level seasonal trends. Both dry residues and vegetation water content can alter B11/B12 reflectance, causing NDTI to reflect overall organic cover and moisture rather than residues specifically. This interpretation is consistent with Daughtry et al. (2006), who found that broadband NDTI explained only a limited proportion of residue-cover variation.

After regressing out the NDVI component, a post-harvest residual signal remained only for some crops. Crop-specific stratification (Kruskal-Wallis and Cliff's delta) confirmed sunflower as the clearest case, with large effect sizes (delta up to 0.82) between no-till and conventional practices, while soybean and barley showed moderate effects and most cereals negligible ones. Crop phenology thus often obscured the soil-surface signal required for residue detection.

We also tested whether hedgerows biased parcel-level estimates: excluding hedgerow pixels produced detectable but negligible changes in median NDTI/NDVI, confirming that median-based zonal statistics are robust to field-boundary contamination.

Overall, NDTI alone cannot be considered a residue-specific indicator across heterogeneous regional cropping systems. Reliable satellite-based monitoring requires narrow, crop-specific post-harvest windows and complementary indices or data able to separate residue signals from phenology and moisture.

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Sciforum-208719: Machine Learning Reveals Soil-Type-Specific Drivers of Soil Health Change in Czechia

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Agroecological recommendations require evidence that accounts for management practices and inherent soil differences. We analysed 358 six-year changes in three soil health indicators—calcium (Ca), glomalin, and oxidizable organic carbon (Cox)—using paired soil samples collected between 2014 and 2022 from the nationwide Agrochemical Testing of Agricultural Soils database administered by the Czech Central Institute for Supervising and Testing in Agriculture.

Changes were related to more than 30 predictors covering farm characteristics (production type, Farm Accountancy Data Network (FADN) classification, size, change in field number), soil characteristics (erosion potential, water retention capacity, texture, pH), agricultural production regions integrating climate and geography, terrain, and crop history. Relationships were analysed separately for five major soil groups using an ensemble of Random Forest, Elastic Net, generalized additive models, and Bayesian regularized regression.

Changes in pH were positively associated with changes in Ca across all soil groups, reflecting liming, acidification, and base-cation processes. Larger farm area was consistently associated with increasing glomalin in Cambisols, with weaker evidence in Chernozems. Although farm size is not a direct driver, it may indicate greater access to capital, technical expertise, and precision agriculture. This interpretation is supported by Žáková Kroupová et al. (2026), who found that large Czech farms were 9 percentage points more likely to adopt precision agriculture than small farms. More frequent maize cultivation was associated with significant Cox decline only in Chernozems, identifying maize-grown Chernozems as a priority for carbon conservation. In contrast, Cox decline was not associated with erosion potential, possibly reflecting the effectiveness of anti-erosion measures in Czechia.

National soil databases still lack important management information. Future studies would benefit from records of tillage, residue management, organic amendments, cover crops, liming and fertilizing. Integrating these variables into long-term monitoring would improve interpretation of soil health trends and support more targeted, soil-specific management recommendations.

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Sciforum-209182: Soil organic matter and its impact on apple postharvest quality

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Soil organic matter plays a key role in maintaining soil fertility, improving nutrient availability, water retention, and overall orchard sustainability. The use of livestock effluents as organic fertilizers has emerged as a promising strategy to enhance soil organic matter while promoting circular resource management. However, their effects on apple fruit quality and postharvest performance remain insufficiently understood. This study evaluated the effect of partially replacing mineral fertilization with organic matter derived from livestock effluents, namely slurry and farmyard manure, on the postharvest performance of apples. Four field treatments (0%, 25%, and 50% replacement of inorganic fertilization with organic matter) were evaluated in five commercial orchards over three consecutive growing seasons. After harvest, the fruit were stored under dynamic controlled atmosphere (DCA) conditions for seven months. Fruit quality was assessed after five and seven months of storage by measuring skin colour, fruit size, firmness, total soluble solids, titratable acidity, as well as the incidence of physiological disorders and decay. Overall, the results suggest a cumulative positive effect of increasing soil organic matter on fruit quality. During storage, apples from the treatment with a 50% reduction in inorganic fertilization showed lower firmness loss than the control. This treatment also exhibited the highest eating quality index (EQI) both at harvest and after seven months of storage. In contrast, treatments in which farmyard manure was used as the organic amendment generally showed a higher incidence of postharvest decay.

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