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*Matching Agri-Food Systems
and Ecosystems via AI:
Aligning Digital Innovation
with Sustainability and Policy Goals*

Book of abstracts

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Oral Presentations

Predicting Water Quality Changes from the Implementation of Agricultural Conservation Practices Using a Machine Learning Approach

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Investments in agricultural conservation programs are expected to improve the sustainability of agri-food systems. However, policymakers often lack timely and spatially explicit evidence on how conservation practice implementation translates into measurable ecosystem improvements, including changes in water quality [1]. Existing empirical studies often focus on a few watersheds or rely on field experiments, making it difficult to generalize findings for regional or national conservation targeting [2]. We integrate nationwide datasets and advanced Machine Learning (ML) methods to improve the targeting of agricultural conservation for water quality improvements in the U.S. agricultural systems. The primary objective is to predict changes in water quality outcomes, including dissolved oxygen, total nitrogen, and total phosphorus, at the watershed level (Hydrologic Unit Code 10 digit), in response to changes in surrounding conservation practice implementation. We then use the predicted changes in water quality outcomes in ex-ante benefits–cost analysis for major agricultural conservation investments in the U.S., in particular the Partnerships for Climate-Smart Commodities. The specific research steps are as follows. First, we compile and harmonize national watershed-level datasets at the Hydrologic Unit Code 10-digit scale, including (i) observed water quality measurements from the USGS Water Quality Portal, (ii) spatially explicit conservation practice and land-use measures from the Agricultural Census, the Cropland Data Layer, and the National Land Cover Database, and (iii) climate and hydrologic features constructed from PRISM and the National Hydrology Dataset. Second, we link watersheds to their upstream contributing watersheds and summarize hydrologic characteristics, land use, and conservation practice adoption in upstream watersheds. Third, Random Forest and Gradient Boosting models are trained to compare alternative ML algorithms and evaluate predictive performance. Model interpretation tools, including SHAP values and mutual information, are used to evaluate the relative predictive contribution of each variable and examine complex feature interactions. Finally, the selected ML model is used to predict expected water quality changes under additional adoption of conservation practices. Preliminary results indicate that the share of cropland under conservation practices has strong nonlinear relationships with water quality and provides greater predictive power than other agricultural features, including land use patterns and livestock densities. In addition, upstream conservation measures improve predictive performance relative to within-watershed measures. Our model predicts meaningful changes in water quality measures from projects under the Partnerships for Climate-Smart Commodities. Our study demonstrates how an ML-based predictive framework can link agricultural conservation investments with water quality outcomes, providing scalable, location-specific estimates for ex-ante conservation targeting and agri-environmental program evaluation — even in settings where conservation practices have been adopted but water quality monitoring data remain sparse.

Enhancing Water Productivity of 'Picual' Olive Using Aloe vera Biostimulant under Different Irrigation Systems in Arid Regions

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Water shortage constitutes a serious challenge in achieving sustainability in olive production in arid and semi-arid environments. The study sought to answer three essential questions, which include: (i) Can aloe vera as a biostimulant increase olive yield, oil production and fruit quality under different irrigation systems? (ii) Which irrigation system yields the highest irrigation water productivity without compromising on high-quality fruits? and (iii) Does the integration of natural biostimulant techniques and modern irrigation systems help increase profitability? This paper examines the impacts of using aloe vera biostimulation and irrigation systems on the agronomic performance, fruit characteristics, irrigation water productivity, and economic returns of 'Picual' olive trees grown under an arid environment. Three irrigation systems (drip, micro-sprinkler, and bubbler) were tested with two aloe vera application techniques: extract fertigation and soil application of sliced leaves. Parameters measured included vegetative growth, fruit yield, oil production, fruit quality characteristics, fruit coloring pattern, irrigation water productivity, and economic returns. Fruit color was objectively evaluated using the CIELAB color system (L*, a*, b*) combined with digital image analysis to quantify changes in fruit appearance and market quality. Positive effects were observed with the use of aloe vera with respect to growth, fruit quality, ripening, and irrigation water productivity. Optimal performances were obtained when bubbler irrigation was used with soil application of aloe vera, where fruit yield (30.66 kg tree⁻¹), oil yield (7.82 kg tree⁻¹), irrigation water productivity (0.75 kg m⁻³), and net return (175,390 EGP feddan⁻¹) were maximized. Irrigation with micro-sprinkler had average efficiency, whereas surface drip irrigation gave the lowest efficiency values under similar biostimulant applications. In conclusion, it can be observed that a combination of bubbler irrigation system and aloe vera soil applications may be an effective climate-smart water management technique. Therefore, it may be applicable to improve olive growing under dry climates.

Aligning Digital Innovation with Economic Reality: Quantifying the Economic Value of Prediction Accuracy in Crop Disease Decision Support Tools

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Objectives and Research Questions Digital innovation and artificial intelligence offer great opportunities to create data-driven decision-support tools (DSTs) that reduce uncertainty in farm decision-making. In crop disease management, where traditional monitoring is largely inefficient, these approaches could help reduce economic and environmental losses. However, a common yet rarely examined assumption in DST development is that greater prediction accuracy inherently yields a superior decision-support tool. This study challenges this assumption from an economic perspective, arguing that a DST is valuable only if it leads to better outcomes than decisions made without it. Precision agriculture research lacks a framework for determining when and by how much increased prediction accuracy enhances decision quality. This paper introduces a Bayesian Value of Information (VOI) approach for decision-making under imperfect information, quantifying the economic value of DSTs. The empirical analysis focuses on in-season recognition of *Cercospora* Leaf Spot in sugar beet. The research questions are: (1) How does forecast VoI change with bias and uncertainty? (2) How do risk preferences and prior beliefs affect this relationship? **Theory & Methodology** Grounded in Value of Information (VOI) and decision analysis, this study constructs a fully probabilistic agronomic-economic decision model. Biological and economic parameter distributions are estimated using probabilistic programming based on field trials and secondary data. Seasonal disease severity is characterized by a historical distribution, and decision-making is modeled at the seasonal level, with each season represented by a single draw from this distribution. The analysis distinguishes between the perfect information case, which assumes the farmer knows seasonal severity with certainty, and the imperfect information case, under which the farmer relies on prior knowledge or DST predictions. Instead of implementing a specific prediction model, seasonal predictions are generated synthetically: for each simulated season, the DST signal is created by introducing bias and uncertainty to the drawn severity value. Consistent with Bayesian decision theory, the farmer updates prior beliefs upon observing the DST signal, and the posterior distribution informs optimal action selection. The value of imperfect information (EVII) is quantified as the utility difference between prediction-informed and prior-informed decisions, expressed in certainty equivalents and averaged across simulated seasons. Expected Results EVII curves are anticipated to demonstrate diminishing returns to uncertainty reduction. Under high bias, improvements in uncertainty may even worsen outcomes, as farmers act more confidently on a systematically wrong prediction. Comparing EVII change rates against the value of perfect information (EVPI) helps identify which accuracy improvements yield the greatest value and establishes thresholds beyond which further enhancements are unnecessary. Presenting economic value in certainty equivalents, averaged across simulated seasons and farmer contexts, yields concrete monetary estimates that can be directly communicated to farmers, supporting informed adoption decisions and linking data-driven innovation to measurable economic outcomes. Beyond economic value, sensitivity analyses of risk preferences and prior beliefs reveal whether farmers will alter spraying behavior in response to DST information. This analysis provides insights into the potential for DSTs to reduce unnecessary fungicide applications and informs sustainable disease management policy.

Governing AI for Resilient Agri-Food Systems: An Agricultural Economics Perspective on Climate Adaptation and Policy Coherence in Europe and Beyond

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This paper investigates the positioning of Artificial Intelligence (AI) and digital innovation within international and European policy frameworks aimed at enhancing the adaptability of agri-food systems to climate change and external shocks. The analysis is situated within agricultural economics, considering not only whether digital tools increase technical efficiency but also whether they improve risk management, resource allocation, environmental performance, and welfare outcomes throughout the food chain. Droughts, floods, heat stress, biodiversity loss, input price volatility, and supply chain disruptions affect farm incomes, output stability, factor productivity, and food price transmission. In this context, the paper explores how AI can be integrated into policy mixes that promote productivity, resilience, ecosystem stewardship, and food security, while remaining consistent with sustainability objectives. This paper pursues two primary objectives. First, it analyzes the conceptualization of food systems' adaptability to climate change, external shocks, and AI-enabled digital innovation within international and European policy documents. Second, it evaluates whether these frameworks establish coherent incentives and governance mechanisms that align adoption decisions with climate resilience, rural viability, ecosystem protection, and value-chain stability. The analysis is structured around three research questions: how adaptability is framed in policy discourse; which economic and governance functions are attributed to AI and digital technologies; and the extent to which existing frameworks foster coherence across agricultural, climate, environmental, and innovation policy domains. The theoretical framework integrates resilience theory, multi-level governance, and policy coherence from an agricultural economics perspective. Resilience theory differentiates among absorptive, adaptive, and transformative capacities, clarifying whether policies address short-term shocks or facilitate long-term structural adjustment toward sustainable production systems. Multi-level governance elucidates the distribution of competences, resources, and policy learning across international organizations, the European Union, and implementation contexts, thereby shaping incentives and coordination outcomes. Policy coherence serves as the integrative dimension, recognizing that adaptation is ineffective when agricultural support, climate policy, environmental regulation, innovation policy, and social protection generate conflicting signals or fragmented investment priorities. Within this framework, AI is conceptualized as a policy-conditioned asset whose value is contingent upon data infrastructures, transaction costs, and market failures related to information asymmetries and environmental externalities. Methodologically, this study employs a comparative policy analysis of international and European documents addressing climate adaptation, agriculture, food systems, and digital transition. At the international level, the analysis covers FAO frameworks and United Nations food-systems initiatives. At the European level, it focuses on the EU adaptation framework, the Common Agricultural Policy 2023–2027, and associated sustainability strategies. Documents are systematically coded for references to risk, resilience, AI, data governance, ecosystem services, coordination mechanisms, and incentive design. The anticipated finding is that governance levels increasingly recognise AI as a tool to enhance productivity and resilience, though its policy integration remains partial and inconsistent. Current approaches tend to prioritize technical optimization over distributive effects, labor conditions, food access, and crisis preparedness. The argument advanced is that AI can enhance the alignment between agri-food systems and ecosystems only when integrated within coherent policy architectures that internalize environmental externalities, lower transaction costs, strengthen adaptive capacity, and align digital innovation with economic efficiency, sustainability, and value objectives.

Uniform Incentives, Heterogeneous Landscapes: Within-Farm Allocation of Biodiversity Areas under Agri-Environmental Schemes

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The ecological effectiveness of agri-environmental schemes (AES) depends not only on participation rates but also on the spatial placement of biodiversity measures within agricultural landscapes. While previous research has mainly focused on farmers' participation in AES, less attention has been paid to how farmers allocate biodiversity areas across parcels within farms under real policy conditions. This study examines within-farm allocation decisions under Austria's agri-environmental programme ÖPUL, specifically the measure "environmentally and biodiversity-enhancing management" (UBB), which requires participating farms to allocate at least five percent of their utilized agricultural area to biodiversity areas while allowing flexibility in spatial placement. The paper addresses three research questions: (1) Which parcel characteristics influence the allocation of biodiversity areas within farms? (2) Do farmers differ systematically in their sensitivity to these parcel characteristics? (3) How do decentralized allocation decisions aggregate into landscape-level spatial patterns? The analysis builds on a random utility framework in which biodiversity area designation is conceptualized as a constrained spatial allocation problem. Farmers are assumed to allocate biodiversity areas to parcels that maximize utility under a minimum-area requirement. Parcel-level utility differences are primarily interpreted through opportunity costs associated with agricultural production. The study further incorporates behavioral heterogeneity through a latent-class approach, allowing farms to differ in their responses to parcel characteristics. Empirically, the study uses linked parcel- and farm-level data from the Integrated Administration and Control System (IACS) for approximately 5,600 farms and more than 210,000 arable parcels located in Austria's North-Eastern Plain and Hill region. A latent-class logit model exploiting within-farm variation in parcel characteristics is estimated to identify allocation behavior. Parcel characteristics include soil quality, terrain roughness, parcel size and compactness, distance to the farmstead, and environmental context variables such as adjacency to landscape elements or floodplains. The results indicate systematic within-farm sorting along opportunity-cost gradients. Biodiversity areas are more likely to be allocated to parcels with lower productivity, greater operational constraints, and lower expected agricultural returns. At the same time, the findings reveal substantial heterogeneity in allocation responses across farms, resulting in distinct allocation regimes. Aggregated at the landscape level, these decentralized decisions generate uneven spatial patterns, with biodiversity areas clustering disproportionately in less productive locations. We conclude that uniform per-hectare AES payments are not spatially neutral. Even without explicit spatial targeting, decentralized within-farm allocation decisions shape landscape patterns and may create spatial mismatches between ecological priorities and policy outcomes. The findings highlight the importance of considering within-farm allocation behavior and behavioral heterogeneity when designing and evaluating agri-environmental policies.

Attitudes of Olive Growers toward Climate Change and Nature-Based Solutions: Evidence from the Region of Eastern Macedonia and Thrace, Greece

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Climate change is increasingly recognized as one of the most significant challenges facing Mediterranean agricultural systems and food sector, particularly olive cultivation, which is highly vulnerable to increasing temperatures, prolonged droughts, water scarcity, extreme weather events, biodiversity loss, and emerging pest pressures. At the same time, Nature-Based Solutions (NbS) have emerged as promising approaches for enhancing climate resilience, improving ecosystem services, and supporting the long-term sustainability of agricultural production systems. Understanding farmers' perceptions, attitudes, and adaptation readiness is therefore essential for the successful design and implementation of climate adaptation policies and sustainable rural development strategies. This study investigates the attitudes of olive growers from different generational groups toward climate change and Nature-Based Solutions (NbS) in the Region of Eastern Macedonia and Thrace (EMT), Greece. As one of the most important agricultural regions of Northern Greece, Eastern Macedonia and Thrace faces increasing climate-related challenges – even in less degree than other regions in the country- that directly affect agricultural productivity, quality, natural resources, and rural livelihoods. Data were collected through a structured questionnaire administered to 213 olive producers. The survey included questions related to climate change awareness, adaptation attitudes, knowledge and perceptions of Nature-Based Solutions, information sources, and socio-demographic characteristics. A combination of multivariate statistical techniques was employed to analyze the data. Principal Component Analysis (PCA) was used to identify the underlying dimensions of farmers' attitudes toward climate change and adaptation. Cluster Analysis was subsequently applied to classify respondents into homogeneous groups according to their attitudinal profiles. Chi-square tests were used to examine associations between cluster membership and socio-demographic characteristics, while Quadratic Discriminant Analysis (QDA) assessed the discriminatory power of the extracted factors. Furthermore, Multinomial Logistic Regression was employed to investigate the influence of knowledge, awareness, and information-related variables on cluster membership. The results revealed the existence of distinct attitudinal profiles among olive growers, reflecting differences in climate change perceptions, adaptation readiness, and support for sustainable agricultural practices. The findings also highlight the importance of knowledge, awareness, and communication channels in shaping farmers' responses to climate-related challenges and their acceptance of Nature-Based Solutions. In addition, demographic and farm-related characteristics were found to contribute to the observed differences among producer groups. The study contributes to the growing body of research on agricultural adaptation to climate change by providing empirical evidence from the olive sector in Eastern Macedonia and Thrace. The findings offer valuable insights for policymakers, agricultural advisory services, cooperatives, and rural development organizations seeking to strengthen adaptive capacity, enhance climate resilience, and promote the wider adoption of Nature-Based Solutions within Mediterranean agricultural landscapes. Keywords: climate change, olive growers, Nature-Based Solutions, climate adaptation, sustainability, Eastern Macedonia and Thrace, Greece, principal component analysis, cluster analysis, discriminant analysis, logistic regression.

From Recognition to Adoption: Stakeholder Perceptions of Legumes in European Agri-Food Systems

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Legumes hold a distinctive position in the debate on the transition of European agri-food systems towards sustainability, resilience, and food security. Their contribution to biological nitrogen fixation, reduced dependence on synthetic inputs, diversification of cropping systems, and stronger protein self-sufficiency is well documented. Yet their integration into production, markets, and everyday dietary practices remains limited. This contradiction suggests that the issue is not merely technical or agronomic, but also profoundly social, economic, and institutional. The present study examines the factors shaping the acceptance, adoption, and utilization of legumes in European agri-food systems. Its objective is to understand how different groups of actors — consumers, experts, and agri-food value chain practitioners — perceive the value of legumes, and under what conditions this positive assessment can be translated into practice. The research questions concern the relationship between knowledge, attitudes, and behavior; the interaction among social, economic, environmental, and political parameters; and the differences emerging across regions, institutional roles, and consumer profiles. Within this framework, the theoretical basis of the study draws on approaches from agri-food systems, participatory governance, and multi-actor innovation systems. Its central premise is that the transition towards sustainable dietary and production practices depends not only on scientific evidence and policy incentives, but also on social meaning-making, trust, market functionality, and the capacity of institutions to generate coherent and implementable policy signals. Methodologically, the research adopts a participatory mixed-method design, centered on focus groups involving 44 participants from across Europe. The discussions were organized around five thematic axes: social perceptions, the economic and market dimension, environmental value, the political and institutional framework, and future development opportunities. The qualitative analysis was complemented by structured questionnaires, leading to a comparative mapping between Northern and Southern Europe, a distinction between experts and consumers, and cluster analysis for identifying different profiles of attitudes and intentions. The results show that the core problem is not the absence of a positive evaluation of legumes, but the difficulty of translating this evaluation into stable production, market, and consumption practices. The main barriers relate to convenience, availability, the limited variety of attractive products, and gaps in the value chain. At the same time, perceptions differ substantially across groups and regions. In Northern Europe, legumes are more strongly associated with functional, plant-based, and sustainable alternatives, whereas in Southern Europe they are understood through tradition, locality, and cultural familiarity. Similarly, experts focus mainly on institutional frameworks, value chains, and coordination, while consumers evaluate legumes in terms of convenience, price, and everyday usability. Consequently, strengthening their role requires simultaneous policy and managerial interventions. These include more coherent policy signals, stronger links between production, markets, and consumption, clear information, context-sensitive strategies, and deeper cooperation along the value chain. In practical terms, the adoption of legumes requires products better adapted to everyday use, the translation of their environmental value into real market terms, and closer alignment with consumer needs. In this way, legumes can move from being an undervalued potential to a substantive driver of agri-food transition in Europe.

How stakeholders assess the compatibility of digital technologies and agroecology in Europe

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Over the coming decades, agriculture is expected to undergo significant digital transformation, fundamentally changing how food is produced and distributed. Growing pressures on food safety and sustainability have simultaneously placed agroecology, a framework for sustainable food systems, at the centre of policy debates. Whether digitalisation and agroecology are compatible, however, remains underexplored. This study examines how stakeholders across Europe perceive the compatibility of digital tools with agroecological principles. Specifically, we ask: what is the perceived impact of selected digital technologies on agroecology, how do impacts vary across the FAO's 10 elements of agroecology, and to what extent do perceptions differ among stakeholders with different backgrounds? Our analysis is grounded in the FAO's 10 elements of agroecology, a comprehensive, practice-oriented framework. The FAO's framing ensures that social and cultural dimensions are evaluated alongside efficiency and environmental principles, enabling a holistic assessment of digitalisation's implications across Europe. We conducted 11 technology-specific workshops in six European countries (Denmark, Finland, Germany, Greece, Portugal, and the United Kingdom), each focused on a different digital tool. Workshops combined group discussions structured around indicators for each FAO element, followed by a survey measuring the perceived impacts of individual participants on a five-point Likert scale. Survey data were analysed using ordinal regression models while the discussions were summarised using AI. Our results indicate a slightly positive perceived compatibility between digitalisation and agroecology, with variation across elements. Efficiency, co-creation and sharing of knowledge, and resilience were most consistently rated positively. Recycling, culture and food traditions, and responsible governance were rated less favourably, as stakeholders noted that broader social and cultural implications are often overlooked by technology producers. To address these concerns, we recommend that policymakers prioritise affordability, data protection, and digital infrastructure in rural areas to support an inclusive agroecological transition.

Behavioral Barriers to Crop Diversification in Türkiye

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Crop diversification becomes a vital yet complex component of sustainable agricultural production. While the agronomic, financial, and structural constraints keeping adoption rates persistently low among Turkish farmers are well documented, the behavioral perspectives behind these decisions remain largely unexplored in existing regional research. To address this gap, this study conducted a narrative review of peer-reviewed crop diversification literature published between 2015 and 2025, specifically focusing on intercropping, crop rotation, and agroforestry. The aim of the narrative review was to synthesize the documented constraints hindering these practices across Türkiye's farming landscapes and then re-examine them through a behavioral insights lens. This approach helped to identify potential behavioral barriers and proposed a research agenda to guide future empirical investigations into farmer decision-making. This study is part of the EU Horizon-funded project Crop-MATCHING, which aims to accelerate the adoption of sustainable cropping practices among smallholder farmers across Europe.

Understanding food security drivers in the face of climate change and biodiversity loss: a resilience framework from EU Living Labs

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Food security is a complex and evolving challenge shaped by climate change, biodiversity loss, and the nexus among biophysical, technological, economic, political, supply chain, and socio-demographic drivers. Addressing these challenges requires system-level approaches that go beyond analysing individual sectors. This study aims to develop and apply a structured, resilience-oriented framework to systematically classify and analyse food security drivers across European food systems. The analysis is based on a structured integrative literature review, complemented by participatory insights from ten EU Living Labs, to categorise food system risks into six thematic domains. Using the Global Food Security Index, this framework maps drivers across four pillars: availability, affordability, quality and safety, and sustainability and adaptation, linking them to absorptive, adaptive, and transformative resilience capacities. The results indicate that biophysical and environmental, economic and market, and food supply chain drivers are pervasive across all Living Labs. In contrast, institutional, technological, and socio-cultural drivers are context-specific. The findings further show that the availability and sustainability pillars of food security are particularly vulnerable where climate-induced shocks, biodiversity loss, and market volatility overlap. Mapping of drivers through resilience capacities identifies strategic leverage points for intervention, including governance coordination, supply-chain diversification, and investments that enhance adaptive and transformative capacity to manage trade-offs within food systems. By integrating food security drivers, resilience capacities, and GFSI pillars within a single analytical framework, this study offers a pragmatic tool for policymakers to design targeted, cross-sectoral interventions to strengthen resilience in the European food system, for practitioners to develop resilience strategies through collaborative problem-solving, and for researchers to analyse systemic food security risks.

AI-Enabled Circular Transitions in Agri-Food Systems: Linking Behaviour, Ecosystem Goals and Regional Resilience

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Agri-food systems face increasing pressures from climate change, biodiversity loss, resource scarcity, market volatility, and growing societal expectations regarding sustainability and food quality. These challenges are particularly significant in rural regions where economic vulnerability, infrastructure limitations, and environmental sensitivities intersect. In this context, circular economy approaches are increasingly recognised as important pathways for improving resource efficiency, reducing waste, strengthening regional resilience, and aligning food systems more closely with ecosystem capacities and long-term sustainability goals. Concurrently, advances in artificial intelligence (AI) and digital technologies are creating new opportunities to support more adaptive, data-driven, and system-oriented approaches to agri-food transitions. This paper explores how AI-enabled approaches can support circular economy transitions in agri-food systems by linking ecosystem objectives, behavioural change, and regional resilience. Rather than viewing AI solely as a technological optimisation tool, the paper adopts a broader sociotechnical perspective that considers interactions between digital innovation, human behaviour, governance structures, and place-based development processes. Particular attention is given to AI role in supporting circular decisionmaking across production, consumption, redistribution, and waste management systems. The paper combines systems thinking, behavioural insights, and exploratory system dynamics modelling to examine how AI-enabled interventions may influence circular economy transitions. A conceptual system dynamics framework is developed to capture interactions between resource flows, behavioural adaptation, policy incentives, local collaboration, and ecosystem outcomes. Illustrative scenarios are used to explore how AI-supported forecasting, adaptive decisionmaking, and behavioural targeting mechanisms may affect food waste reduction, circular adoption rates, local value retention, and regional resilience under transition pathways. AI technologies can contribute to circular agri-food transitions in several ways. Machine learning and predictive analytics can support more efficient logistics, inventory management, and demand forecasting, helping reduce food loss and waste while improving supply chain coordination. AI can also improve the monitoring of material and resource flows, enabling better identification of inefficiencies, waste hotspots, and opportunities for reuse, redistribution, or valorisation of by-products. In addition, AI-enabled behavioural tools may support more targeted interventions, feedback, and adaptive communication strategies aimed at encouraging circular consumption and waste prevention behaviours. The paper further argues that the effectiveness of AI-enabled circular economy strategies depends on their integration within broader systems-based and place-sensitive approaches. Circular transitions are shaped by feedback loops, institutional dynamics, infrastructure availability, economic incentives, and social acceptance, which vary significantly across regions. Drawing on examples from rural and island contexts, including circular food system initiatives and waste reduction strategies, the paper discusses how AI can contribute to regional resilience by supporting diversification, local value retention, adaptive capacity, and more integrated circular ecosystems. The paper highlights important limitations and challenges associated with AI-driven transitions, including uneven access to digital infrastructure and skills, limited data availability and interoperability, governance and privacy concerns, risks of technological dependency, and the potential exclusion of smaller rural actors with limited technical capacity. The paper also recognises the uncertainty associated with modelling complex socio-ecological systems, arguing that system dynamics approaches are valuable not for precise prediction, but for exploring feedbacks, tradeoffs, and transition pathways under uncertainty.

Administrative Complexity Bias in AI-Driven Agriculture: Evidence from the CAP

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Administrative Complexity Bias in AI-Driven Agriculture: Evidence from the CAP Artificial intelligence (AI), autonomous machinery, and data-intensive farm management are expected to accelerate the transition towards more diverse, adaptive, and environmentally sustainable agri-food systems. However, realizing these benefits requires governance systems capable of accommodating the increasing production complexity associated with AI-enabled farming. This paper argues that the successful adoption of AI depends not only on technological progress but also on administrative systems capable of scaling with increasing production complexity. The paper introduces the concept of Administrative Complexity Bias, a theoretical framework explaining why administrative requirements increase disproportionately as production systems become more diverse and information-intensive. Drawing on research in digital agriculture, public administration, and agricultural policy, the framework argues that administrative complexity may become a structural barrier to the diversified production systems promoted by sustainability policies and increasingly enabled by AI. To operationalize this concept empirically, the paper develops a novel Administrative Frictions Index. The framework identifies three mechanisms. First, combinatorial data growth arises because additional crops, parcels, management practices, sensors, and autonomous operations generate rapidly growing reporting and compliance requirements. Second, rule collisions emerge as regulatory frameworks designed for standardized production systems encounter increasingly heterogeneous farming realities. Third, asymmetric compliance risk increases audit exposure and regulatory uncertainty, encouraging over-documentation and risk-averse management. These mechanisms intensify in AI-enabled agriculture, where sensor networks, autonomous machinery, and real-time decision systems substantially increase administrative data complexity. The empirical analysis exploits differences in CAP implementation across two German federal states and one neighbouring country. A cross-border discontinuity design compares farms operating under similar agronomic conditions but different administrative regimes. The Administrative Frictions Index captures eligibility complexity, reporting requirements, control intensity, and regulatory fragmentation across successive CAP instruments, including Greening, Agri-Environment-Climate Measures (AECMs), and Eco-Schemes. The index is linked to measures of production complexity derived from Integrated Administration and Control System (IACS) data, including crop diversity, crop rotation complexity, landscape diversification, and field fragmentation. The analysis tests three hypotheses: administrative frictions reduce observed production complexity (H1); the negative effects of administrative frictions increase disproportionately with production system complexity (H2); and digital administrative infrastructures mitigate these effects by reducing transaction costs and compliance burdens (H3). Administrative frictions are expected to reduce crop and landscape diversification, with the strongest effects among farms exhibiting the highest production complexity and weaker effects where digital administrative infrastructures are more advanced. The analysis therefore examines whether administrative design, rather than technological capability alone, shapes the diffusion of diversified and data-intensive production systems. The CAP illustrates a broader governance challenge associated with AI-enabled agriculture. If administrative complexity already constrains diversified farming under current governance arrangements, these constraints are likely to intensify as production systems become increasingly dynamic, heterogeneous, and data-intensive. Realizing the sustainability potential of AI therefore requires governance systems capable of scaling alongside production complexity. This calls for the continued digital transformation of public administration through interoperable data standards, machine-readable regulations, automated data exchange, digital compliance infrastructures, and AI-assisted administrative processes.

Digital Agriculture for What Transition? An AI-Augmented Structural Analysis of Research Trajectories and Contextual Alignment

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Digital technologies are increasingly promoted as critical enablers of agricultural transformation. Precision agriculture, smart farming, sensing systems, artificial intelligence, robotics, and decision-support tools are expected to contribute to objectives ranging from productivity growth and resource efficiency to climate adaptation and environmental sustainability. However, despite the rapid expansion of digital agriculture research, it remains unclear whether the technological directions pursued by the scientific community are aligned with the capabilities required by contemporary agricultural transition agendas. This paper investigates a simple but important question: digital agriculture for what transition? Rather than examining individual technologies or applications, the study analyzes the overall structure of digital agriculture research and evaluates its alignment with the priorities promoted by major international transition frameworks. These include objectives related to sustainable resource management, resilience, biodiversity conservation, productivity, knowledge support, and farm-level decision-making. The study employs a large-scale evidence-mapping approach based on more than 140,000 peer-reviewed journal articles indexed in Scopus. A dedicated search strategy was developed to capture operational digital agriculture research, including precision agriculture, smart farming, sensing technologies, robotics, farm management systems, advisory services, and decision-support applications. Using natural language processing, machine learning, and bibliometric techniques, the study identifies dominant technological trajectories, maps their evolution over time, and examines their relationship with transition-oriented capabilities. The analysis aims to determine which technological pathways receive the greatest research attention, which transition capabilities are most strongly represented, whether technological trajectories exhibit systematic associations with particular farming scales and production contexts, and where potential mismatches emerge between research activity and broader agricultural transformation objectives. Particular attention is given to the balance between monitoring technologies, automation systems, advisory tools, and integrative decision-support approaches, as well as to the extent to which these trajectories are associated with different farming scales and production contexts. Expected results include a comprehensive structural map of digital agriculture research, the identification of dominant and neglected capability areas, and a reproducible analytical framework for assessing the alignment of technological innovation with agricultural transition goals. By shifting attention from individual technologies to the overall direction of the research landscape, the study seeks to provide evidence that can support researchers, policymakers, funding bodies, and innovation initiatives in shaping future digital agriculture agendas.

PHENOTYPOS - A whole-plant high throughput phenotyping platform to improve plant productivity, agricultural sustainability, and resilience to climate change. “The cereal case study”

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Within the framework of the PHENOTYPOS project, a state-of-the-art High Throughput Plant Phenotyping Strategic Infrastructure has been established incorporating advanced technologies that enable accurate phenotyping. The core of the infrastructure is the PlantArray high-throughput, multi-sensor physiological gravimetric system. An Unmanned Ground Vehicle carrying RGB and thermal cameras has been developed for capturing images at frequent intervals. Machine learning models are applied for assessing morphological traits through image analysis and growth forecasting modules. Data can be visualized through two cloud-based systems, the Plant-Ditech's SPAC (Soil-Plant-Atmosphere-Continuum) Analytics and the Phenotypos software designed by the project team with the scope to collect, store, and visualize high throughput and manual measurements. Three pilot projects have been designed to feature the PHENOTYPOS usefulness to produce data in an integrated approach by the complemented production and introgression of data based on the existing knowledge and infrastructure capacity of the partners. Cereal fodder pilot aimed to screen and select genotypes combining high productivity and drought resistance. An experiment was established on PHENOTYPOS in spring 2026 where twenty triticale and bread wheat genotypes were evaluated under two water treatments for physiological and agronomical traits. The experimental set up followed the split plot design. Main plots were repeated six times. Plants were sown on 4-L pots on 11th December 2025. Turface was used as the growth substrate. One plant was established per pot. Prior transferring to the Phenotypos platform, plants were grown under greenhouse conditions and irrigated using a drip irrigation system. Fertilization was applied once per week throughout the vegetative growth period. A balanced water-soluble fertilizer (Nutrileaf) was applied on alternate weeks, while mono-potassium phosphate (MKP, KH_2PO_4) and calcium nitrate ($\text{Ca}(\text{NO}_3)_2$) were applied during the intervening weeks. The pots were transferred to Phenotypos platform when most genotypes were on booting stage. The plants were irrigated every night depending on their daily transpiration, which was calculated by the system. Severe stress was applied when genotypes reached the anthesis stage. Most precisely, well-watered plants were daily irrigated to cover transpiration requirements. Stressed plant reserved no irrigation after anthesis. The latter resulted to progressive severe stress at early stages of grain filling. Plants were harvested when plants reached milk stage. Several physiological traits were automatically calculated during the experiment on frequent intervals. The following will be presented: daily transpiration, transpiration rate, plant growth, plant weight, plant net weight. At the end of the experiment fresh and dry weight from each pot/array was measured. Our results showed the existence of significant differences between the two water regimes, between two species and between genotypes for most physiological and agronomical traits. The cereal pilot project demonstrates the ability of high throughput advanced technologies to produce scientific data that can be useful to sustain productivity under water limited environments and ultimately to adapt to climate change.

Are farmers' myopically loss-averse?

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Decision support tools (DST) help farmers optimize decision-making under uncertainty. AI- based DST allow for improved recommendations including better prediction accuracy or precise real-time feedback on management decisions. In other decision-making context, there is empirical evidence that higher feedback frequency comes along with individuals making less risky decisions – a phenomenon termed myopic loss aversion (MLA) and rooted in choice bracketing theory, i.e. in how far decisions are made in isolation (narrow-bracketing) or by taking other decisions into account (broad-bracketing). However, little is known about farmers' choice bracketing or the role of MLA in agricultural decision-making. In the context of crop production, MLA might lead to deviations from optimal input use like pesticides or fertilizer due to frequent feedback from AI-DST. Therefore, our objective is to investigate MLA in the agricultural domain within the cumulative prospect theory (CPT) framework, which has been found to well reflect farmers' decision-making under risk and uncertainty. Concretely, we address the following research questions: 1) Are farmers myopically loss-averse? 2) To what extent do farmers overweight small loss probabilities? We replicate a non-contextualized experimental design based on Gneezy and Potters (1997). In a between-subject setup, participants are assigned to either a narrow- (nine separate investment decisions) or broad-bracketed (one decision per three-round block) treatment. In each round, participants receive an endowment and choose how much to invest in a lottery that results either in a gain (the invested amount plus 2.5 times that amount) or a loss (the invested amount). Additionally, we include a within-subject design with two series of lotteries featuring different loss probabilities ($\frac{2}{3}$ and $\frac{1}{10}$), which allows studying the probability distortion effect. The order of these probability sets is randomized. We also collect farm and farmer characteristics to help explain treatment effects. Survey design and analysis follow a Bayesian probabilistic programming workflow, which allows us to (1) make distributional and relational assumptions explicit, (2) test models using synthetic data and simulations, and (3) transparently quantify uncertainty. The experiment was conducted online in early 2026 with 132 German farmers. Preliminary results show, that farmers in the narrow-bracketed treatment group invest statistically significantly less, hinting towards MLA. Probability distortion seems to vary between treatment groups. Fifteen participants were randomly selected to receive vouchers worth a fraction of their experimental earnings. Our contribution is threefold. First, we provide early evidence on MLA and choice bracketing in agriculture, examining sensitivity to evaluation and decision frequency as a potential consequence of increasing use of AI-DST. Second, we extend MLA research within a CPT framework by explicitly analysing probability weighting. Third, we demonstrate the value of probabilistic programming for experimental research, offering a transparent and flexible approach to modelling complex decisions and uncertainty.

Crop yield stability in organic and conventional farming systems

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Organic farming is widely promoted for its environmental benefits, yet concerns remain regarding its economic viability due to potentially higher yield variability. While existing literature has extensively examined yield gaps between organic and conventional systems, much less is known about the determinants of yield stability, particularly when accounting for spatial interactions and structural heterogeneity. This paper analyses yield stability across organic and conventional farming systems in the European Union using a geolocated panel dataset from the Farm Accountancy Data Network (FADN) covering the period 2011–2021. Yield stability is measured using the coefficient of variation (CV) of crop yields at the farm level. To address spatial dependence and potential endogeneity in organic adoption, the study employs an Instrumental Variable Spatial Durbin Model (IV-SDM), allowing for the identification of both direct effects and spatial spillovers arising from neighboring farms. The analysis focuses on a set of major crops with significant organic production, including cereals, fruits, vegetables, and olives, and explicitly distinguishes between farms fully operating under organic standards and those in conversion. Results show that conventional systems generally exhibit lower yield variability, while organic conversion is often associated with higher instability, reflecting transitional adjustment costs and learning processes. However, once structural characteristics, environmental controls, and spatial clustering are accounted for, many differences in yield stability across systems diminish. Moreover, fully organic systems outperform conventional ones in terms of stability for certain crops, such as olives and barley. Overall, the findings highlight the importance of regional context, peer effects, farm structure, and spatial spillovers in shaping yield stability, suggesting that organic farming is not inherently more unstable but highly conditional on spatial, structural, and institutional environments.

A typology of “good farmers” - exploring viewpoints of a good farmer identity with Austrian dairy farmers in the context of GHG Emissions

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Agri-environmental policies typically try to incentivise farmers to change their behaviour towards environmental-friendly farming practices. To be effective, they must account for the diversity of farmers' perspectives and decision-making. The “good farmer” concept provides a useful framework to study farmers subjective viewpoints on good farmer ideals. Utilising this concept, we address the following question: Which viewpoints exist among Austrian dairy farmers on what constitutes a good farmer? To answer this, we applied Q methodology and analysed 36 Q-Sorts, derived from 29 semi-structured interviews with farm decision-makers participating in the Farm Accountancy Data Network (FADN) in northern Austria. This approach enables the systematic identification and comparison of subjective viewpoints. Our preliminary results reveal three distinct viewpoints. The first viewpoint emphasises a stewardship-oriented good farmer habitus, in which ensuring healthy soils and focus on livestock, e.g., noticing changes early on, are considered important, while economically oriented objectives, e.g., aiming to maximise profits or achieving high yields, were ranked as less important. The second viewpoint highlights diligence, hard work, and a long-term orientation as central for a good farmer. The third viewpoint, the “business oriented” good farmer, prioritises time for their family and future generations, as well as economic thinking and maximising profits, more than the other viewpoints. Environmental considerations, such as reducing greenhouse gas emissions or participating in agri-environmental schemes, are comparatively less important. The findings demonstrate that substantially different understandings of a “good farmer” coexist, even within a quite narrow sample of Austrian dairy farmers. This study shall contribute to a deeper understanding of farmer identities, viewpoints and their attitude towards GHG-emissions. In doing so, we provide insights relevant for agricultural policy, advisory services, and the promotion of climate-adapted and sustainable transitions.

Impact of Local Government Agricultural Support on Rural Development: Evidence from the İzmir Region, Türkiye

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Abstract The increasing involvement of local governments in agricultural policy has introduced a new governance dimension to rural development, particularly in countries where municipalities have assumed broader responsibilities for supporting agricultural production and rural livelihoods. Despite this growing role, empirical evidence on the effectiveness of local government agricultural support remains limited. This study evaluates the impacts of agricultural support programmes implemented by the İzmir Metropolitan Municipality on rural development outcomes in the İzmir Region of Türkiye. The research adopts a mixed-methods approach combining quantitative and qualitative analyses. Primary data were collected through structured face-to-face surveys with farmers benefiting from municipal agricultural support programmes across different rural districts of İzmir, complemented by in-depth interviews with cooperative representatives, local authorities, and other stakeholders. Secondary data were obtained from municipal reports, official statistics, and policy documents. The analysis focuses on four major categories of agricultural support: livestock support, crop production support, machinery and equipment support, and cooperative-based interventions. Descriptive statistics, factor analysis, and binary logistic regression models were employed to identify the socio-economic and institutional factors influencing farmers' perceptions of programme effectiveness and local government performance. The findings indicate that local government agricultural support contributes positively to agricultural productivity, farm income, and rural resilience while strengthening producer organizations and encouraging collective action through cooperatives. Support programmes also improve farmers' access to agricultural technologies, increase production capacity, and enhance social capital within rural communities. Environmental support measures promote more sustainable production practices, although their effectiveness varies according to farm characteristics and regional conditions. Logistic regression results reveal that educational level, cooperative membership, frequency of contact with municipal agricultural services, and perceived transparency of support allocation significantly influence farmers' satisfaction with local government interventions. Furthermore, the findings suggest that cooperative-based support programmes generate stronger and more sustainable impacts than direct support provided to individual farmers. Farmers participating in cooperative-oriented interventions reported higher levels of productivity improvement, market integration, knowledge exchange, and long-term economic resilience. These findings underline the importance of strengthening farmer organizations as an effective mechanism for delivering public agricultural support and enhancing the overall effectiveness of local rural development policies. The study demonstrates that local governments can complement national agricultural policies by designing place-based and participatory support mechanisms tailored to local needs. However, the effectiveness and long-term sustainability of these programmes depend on transparent beneficiary selection, continuous monitoring and evaluation, stronger stakeholder participation, and improved coordination between local and central government institutions. The research contributes to the agricultural economics literature by providing one of the first comprehensive empirical evaluations of municipal agricultural support policies in Türkiye. It also offers practical policy recommendations for improving decentralized rural development strategies and strengthening the role of local governments in achieving sustainable and inclusive rural transformation. **Keywords:** Rural development; local governments; agricultural support; impact assessment; cooperatives; sustainable agriculture; Türkiye; İzmir.

Economic and Environmental Performance of Organic and Conventional Farms in Austria: A Multi-Indicator Analysis

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Objectives & Research Questions Austria is a frontrunner in organic agriculture, with 25% of utilized agricultural area (UAA) already under organic management and a national target of 35% by 2030 — among the most ambitious in the EU. There is general consensus that organic farming systems often have better environmental outcomes compared to conventional systems, however robust farm-level evidence on whether organic farms perform better on economic outcomes as well as trade offs between the two remains limited in the Austrian context. This study asks: (1) Do organic farms outperform their conventional counterparts across both economic and environmental dimensions? (2) What structural farm characteristics determine performance outcomes within each production system? **Conceptual Framework** The study adopts a sustainability assessment perspective rooted in multi-criteria analysis. Multi-criteria analysis enlists an indicator-based approach that operationalizes the multi-dimensionality of farm sustainability, capturing these potential trade-offs across economic and environmental outcomes, producing transparent and actionable results for agricultural policy and governance. **Methodology** Building on Martín-García et al. (2024), we will construct a set of (composite) economic and environmental indicators to be compared across organic and conventional farms. To deal with selection bias and create comparable groups of organic and conventional farms, propensity score matching (PSM) will be applied to develop the sample for comparison. Regression analysis then identifies the structural determinants - farm size, subsidies, disadvantaged areas - of each dimension. Data used includes Austrian farm accountancy data, agricultural census, and our own data on GHG footprints of accountancy farms. **Expected Results** We expect to find that organic farms achieve better environmental performance per hectare, but with heterogeneous outcomes for economic indicators. Structural factors such as farm size and subsidy dependency are expected to be significant moderators for both environmental and economic outcomes.

Training agricultural advisors for responsible AI and digital farming: A modular capacity-building framework from the DigiFarm project

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AI, Earth Observation (EO), sensors, farm management information systems (FIMS) and decision-support tools are often presented as key enablers of more productive and climate-resilient agroecosystems. Yet, a persistent gap exists between the availability of digital tools and their translation into trusted, economically realistic and sustainability-oriented farm-level decisions. Agricultural advisors occupy a critical position in this gap as mediators between technology providers, policy, scientific knowledge and farmers' situated experience. However, advisory capacity is not always sufficiently developed to support the responsible use of AI- and data-driven tools in agriculture. We present the development of an online training framework through DigiFarm, an Erasmus+ project focused on advancing digital skills of European farmer advisors. Our work is based on a needs assessment of advisors in Cyprus, Greece, Italy and Ireland, a review of existing digital-agriculture training initiatives, and a synthesis of technology adoption and responsible innovation literature. We ask: what competences do agricultural advisors need in order to support responsible digital farming? How can these competences be translated into a practical online training structure? And how can advisor training address not only technical knowledge, but also trust, data governance, sustainability communication and economic viability? The proposed framework is organised around four interconnected modules. The first module introduces EO as a practical advisory tool for crop monitoring, phenology, crop stress and climate-related decision support. The second module focuses on the role of AI, sensors, FIMS and Decision Support Systems (DSS) in data-driven advice, and highlights how different data sources can be organised, interpreted and transformed into advice, while also introducing basic AI concepts (e.g., prediction, classification, bias and transparency). The third module links digital evidence to sustainability communication, climate adaptation, resource efficiency, ESG-related concepts and circular-economy principles. The fourth module supports advisors in assessing whether digital tools are useful, affordable, understandable and appropriate for specific farm contexts, using cost-benefit thinking, return-on-investment logic, and SWOT analysis. An innovative feature of the framework is the integration of ethics, trust and data governance as a cross-cutting theme. Advisors are trained to recognise that EO products are indicators rather than ground truth; that FMIS, DSS and AI outputs depend on data quality and transparency; that digital tools should support sustainability rather than only productivity or compliance; and that technology should not be recommended if it is economically unrealistic or inaccessible for the farmer. Our approach does not frame spatial and digital intelligence as merely a technical competence, but as a socially accountable advisory practice. The expected contribution of the paper is twofold. First, it offers a practical capacity-building model for aligning AI and digital innovation with sustainability and policy goals in European agriculture. Second, it argues that agricultural advisors should be understood as part of the enabling infrastructure for responsible digital transformation. Digital tools can support more sustainable agri-food systems only when they are embedded in advisory relationships that account for local knowledge, farmer trust, economic feasibility and policy requirements.

Artificial intelligence chatbot adoption in Mediterranean agrifood SMEs: A Q-methodology study

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Artificial intelligence (AI) is rapidly reshaping how firms operate, yet small and medium-sized enterprises (SMEs) continue to lag in adoption, constrained by limited capital, scarce technical expertise, and resistance to change [1]. In particular, how AI is perceived and adopted within Mediterranean agrifood SMEs remains under-explored, as research on this traditionally low-tech sector has so far privileged technical applications over managerial uptake [2]. As accessible content-generation tools such as AI chatbots (e.g., ChatGPT, Gemini, Copilot) lower the barrier to entry, their uptake becomes not merely a technical matter but also an organizational and perceptual one. In this context, the present study aims to explore the subjective perspectives of Mediterranean agrifood SME leaders regarding the integration of AI chatbots into their daily operations. Theoretically, the study adopts the Technology-Organization-Environment (TOE) framework [3] as its primary structure. The TOE was selected because it conceptualizes technology adoption as the joint outcome of a firm's technological context, its internal organizational characteristics, and the external environment in which it operates. This integrated lens is particularly suited to the resource-constrained, tradition-bound, and institutionally heterogeneous setting of Mediterranean agrifood SMEs, where adoption cannot be fully explained by technical or economic factors alone. Methodologically, it employs Q methodology [4], a quali-quantitative approach to human subjectivity [5]. A 36-item Q-set built on a TOE design matrix, in which each of the three dimensions (technological, organizational, and environmental) was articulated into four thematic subgroups of three statements each, spanning perceived drivers and barriers. A purposive sample of 22 agrifood business owners and managers familiar with AI chatbots, drawn from 13 Mediterranean-bordering countries, sorted the statements along a forced quasi-normal grid (−5 to +5) under the common stem “In my opinion, AI chatbots in my business...”. Post-sort questions and a socio-demographic survey support the final interpretation. Preliminary analysis suggests four distinct leader perspectives, namely (i) Regulatory innovators, (ii) Pragmatic efficiency adopters, (iii) Governance skeptics, and (iv) Context-constrained adopters. Adoption is expected to hinge less on the usefulness of AI chatbots than on what legitimizes them in each leader's eyes, reflecting institutional, organizational, and infrastructural conditions rather than technical or economic merit alone. This would carry context-sensitive implications for policymakers and SME leaders pursuing digital transformation.

Skills and Sustainable Futures: Building Competence Frameworks for Twin Transitions in European Agrifood Systems

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Twin transitions require agri-food actors to pursue sustainability targets through digital innovations. However, a significant skills gap hinders the deployment of advanced technology. This paper describes the development of a comprehensive competence framework that maps green, digital, and entrepreneurial skills and operationalizes it by identifying specific future-related training needs. Our study sought to answer three research questions: which core competences are required by diverse agri-food actors to navigate twin transitions; what main systemic skills gaps prevent transitioning from basic literacy to advanced technology exploitation; and how these gaps vary contextually across Mediterranean agricultural systems. To answer these questions, the research adopted a mixed methodological approach. First, a Unified Competence Framework was developed by integrating four major European competence frameworks (DigComp, GreenComp, EntreComp, and LifeComp) and two new frameworks referring to Deep Tech Proficiency and Resilience Competence. The framework was further cross-referenced with the ESCO taxonomy and CEDEFOP classifications to ensure policy and labour-market alignment. Second, the framework was field-tested through a normative scenario analysis and foresight methodology involving multi-stakeholder workshops in Italy, Greece, and Spain, to identify desirable sustainable digital futures and related training needs. Grounded in social and technological transition theories and emphasizing how uncertainty and indeterminacy shape twin transitional processes, our framework conceptualizes digitally enabled pathways toward sustainability driven by directionality and reflexivity. The workshop findings revealed that future agrifood systems require hybrid professional profiles that combine AI-supported decision-making, systems thinking, adaptive learning, and collaborative governance. Moreover, our study highlights persistent structural barriers linked to rural digital divides and socio-cultural constraints. Aligning education and training systems with a rapidly transforming technological reality is critical to supporting these transitions and bridging the current lack of knowledge-generating mechanisms in agrifood systems. Finally, our work contributes to the debate on how digital innovation can support ecosystem-oriented and socially inclusive agrifood policies.

Digital Maturity and Transformation of the Agricultural Sector: Developing an Assessment Tool Based on the Digital Maturity Assessment Framework

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Background Digital transformation is reshaping agri-food chains and farms, affecting production, data management, decision-making, supply-chain relations and sustainability (Wolfert et al., 2017; Klerkx et al., 2019). Digital maturity has therefore become a key analytical category, capturing not only technology adoption but also organisational capacity, human factors, data governance and the integration of innovation with environmental goals. Despite the widespread use of maturity models, the literature still lacks operational tools designed for a first assessment of agricultural enterprises (Hein-Pensel et al., 2023). **Objectives** The study develops a structured, sector-specific tool for assessing the digital maturity of farms, addressing two questions: (i) how can a consolidated digital maturity framework be effectively adapted to the agricultural sector? (ii) what is the current level of digital maturity of Italian farms and how does it vary across firm profiles? **Theoretical framework** The work builds on the European Digital Maturity Assessment (DMA) framework, developed by the Joint Research Centre with DG CNECT (Kalpaka, 2023) and articulated in six dimensions: digital strategy, digital readiness, human-centric digitalisation, data management, automation and artificial intelligence, and green digitalisation. **Methodology** Within the project Polo Innovazione Agricoltura Digitale, the DMA was adapted to the primary sector by reformulating items, introducing a branching logic in the questionnaire and adding variables on farm profile (hectares, LSU), connected activities, inhibiting factors and carbon farming, while preserving the 0–100 scoring scale to ensure comparability across heterogeneous farm types. **Results** The descriptive analysis on 8,906 farms returns a mean score of 10.02 (s.d. 10.01), with 71% of firms below 12.5 points and 91% below 25, and limited variability across age classes and regions. The findings confirm an early-stage digital transition and support the need for targeted, structured assessment tools to guide tailored accompaniment policies.

AI-Enabled Food Security: Matching Agri-Food Systems, Ecosystems, and Policy Responses in Times of Disruption

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Rising global food demand, coupled with the escalating pressures of climate volatility, biodiversity loss, resource scarcity, and geopolitical instability, has rendered traditional agri-food management models increasingly inadequate. Recent crises have shown that European agri-food systems are exposed not only to environmental pressures, but also to food supply chain disruptions, strategic dependencies, trade volatility, energy and fertiliser shocks, and wider geoeconomic risks. As these systems face increasingly interconnected disruptions, there is an urgent need to transition from reactive management to proactive, adaptive, and anticipatory governance. This paper explores the potential of Artificial Intelligence (AI) to function as critical infrastructure for informed, interpretable, and timely decision-making. By leveraging data-driven surveillance, predictive analytics, and early warning systems, AI can harmonise agricultural productivity with ecological boundaries, offering a pathway toward more resilient and sustainable food systems. Methodologically, this study combines a qualitative analysis of emerging AI applications with a critical review of European food security and crisis-preparedness mechanisms, including early-warning and monitoring instruments within the Common Agricultural Policy and the EU's Sustainable Food System Framework. Grounded in this approach, we present a conceptual framework that links digital innovation, ecosystem health, and regulatory alignment. The framework also situates AI adoption across the agri-food supply chain within the EU's broader geoeconomic turn, where food supply chains are increasingly understood as strategically significant systems exposed to external shocks and dependencies. We examine how AI-driven insights can be systematically translated into actionable policy recommendations supporting key European objectives, including the European Green Deal and the Farm to Fork Strategy. By fostering a dialogue between scientists, industry stakeholders, and policymakers, this study argues that aligning AI capabilities with ecosystem needs and food-security priorities (and embedding them within EU early-warning and monitoring mechanisms) is a prerequisite for strengthening the resilience of European agri-food systems to climate extremes, supply chain disruptions, and geopolitical shocks. By connecting digital tools with evidence-based policy evaluation, we provide a roadmap for creating food systems that are not only technologically advanced but also socially inclusive and ecologically aligned.

Cognitive Distance between Science, Business and the Public: A Comparative Analysis of Mastic

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This work aims to investigate the alignment among science, business and the public regarding the unique commodity of mastic and opportunities for research and development in this area. Chios Mastic is a European agricultural product that is certified as a protected designation of origin (PDO). Recently, it has become popular worldwide due to its cardioprotective properties and therapeutic indications for skin inflammation and mild dyspeptic disorders. Yet, recent literature notes that businesses and universities often exhibit cognitive distance and different objectives, while search interest and social media content may reflect public attention and commercial orientation toward products and topics (Commission Regulation (EC) No. 123/97, 1997; Pachi et al., 2020; Nasirov and Joshi, 2023; Shams et al., 2025). Therefore, this work investigates differences in scientific, business, and public attention to mastic through a comparative analysis of scientific publications, advertisements and search interest. Relative search interest and related topics of mastic were obtained from Google Trends for the last five years revealing public interest in mastic. Moreover, scientific production and authors' keywords from articles related to mastic were derived from Scopus reflecting scientific interest in mastic. Furthermore, text from advertisements related to mastic in Greek and English on Instagram and Facebook was obtained through the Meta Ads Library for the last five years reflecting business interest in mastic. Results from bibliometric analysis, text mining and search trend analysis were compared. Mediterranean and Middle Eastern countries show high search interest in mastic despite relatively limited scientific output, with Greece representing an exception. Scientific publications mainly focus on plant taxonomy, functional ingredients, diseases, chemical, and biological mechanisms. In contrast, searches emphasize plants, supplements, digestive health, culinary uses, beverages and personal care products. In addition, advertisements emphasize culinary, sensory qualities, oral health, cultural, and promotional aspects. Overall, the findings suggest that research activity is primarily science-oriented, public interest is consumption-oriented, and business activity is market-oriented. The study highlights opportunities for academia and businesses to better align with the public interest and emerging sustainable market demands. Findings indicate potential opportunities for mastic beverages and supplements. Finally, the study suggests that researchers could further investigate the usage of mastic in commercial products, while businesses could expand the development and promotion of beverage and health-related applications.

Consumer Behaviour Towards Traceability Information: Evidence from Digital Wine Labelling

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The rapid digital transformation of the agri-food sector, reinforced by new EU wine-specific Regulation 2021/2117 (effective 12/2023) supporting the digital provision of nutritional information, has made QR-code-enabled digital labels increasingly prevalent in the wine industry. Despite this regulatory shift, consumer behavioural responses to the traceability information conveyed through digital labels remain largely unexplored, particularly in small Mediterranean markets. This study addresses this gap by investigating consumer behaviour towards the purchase of wine products carrying a digital label that provides traceability information, using Cypriot consumers as a case study. The study is grounded in the Theory of Planned Behaviour (TPB), which posits that consumer behaviour is shaped by attitudes, subjective norms, and perceived behavioural control, mediated through behavioural intentions. The original TPB framework was extended in two ways: first, by incorporating demographic characteristics and wine purchase frequency as additional explanatory variables; and second, by substituting behavioural intentions with willingness to pay (WTP). A secondary objective was to identify consumer preferences regarding which types of traceability information they prefer to receive through physical labels, digital labels, or neither. Primary data were collected via a structured questionnaire survey administered to 369 adult wine consumers in Cyprus. The data were firstly analysed using descriptive statistics, Exploratory and Confirmatory Factor Analyses. Subsequently, three Structural Equation Models were estimated. Model 1 tested the standard TPB with actual behaviour as the outcome. Model 2 augmented Model 1 with demographic variables and purchase frequency, while Model 3 replaced behavioural intentions with WTP. Descriptive results revealed moderate-to-favourable mean scores across all TPB constructs: attitudes ($M=3.76$), perceived behavioural control ($M=3.70$), subjective norms ($M=3.06$), and behavioural intentions ($M=3.30$), while actual behaviour was lower ($M=2.58$), suggesting an intention-behaviour gap. Model 1 demonstrated good overall fit and confirmed that attitudes and subjective norms significantly and positively influence behavioural intentions towards purchasing digitally labelled wine, while behavioural intentions and perceived behavioural control significantly predicted actual purchasing behaviour. Model 2 showed that the inclusion of demographic variables and purchase frequency did not improve model fit—evidenced by a deterioration in key indices ($CFI=0.933$ from 0.949 ; $AIC=13,470$ from $12,690$; $SRMR=0.063$ from 0.048)—indicating that the core TPB constructs are sufficient to explain consumer behaviour. Model 3 showed that when intention becomes financial, attitude collapses, while Model 1 revealed that when intention is psychological, attitude dominates ($\beta=0.021$ vs. $\beta=0.485$). Social norms stay consistently strong in both Models ($\beta\approx 0.33$), while perceived behavioural control doubles its direct effect on behaviour (from 0.219 to 0.527) when WTP replaces intention. These findings indicate that consumers can hold a positive attitude towards a behaviour, but that positive attitude does not map onto a higher WTP. Regarding information preferences, consumers strongly preferred essential product attributes (alcohol content, origin, grape variety, ingredients, nutritional information) on physical labels, while more detailed traceability content—including production processes, vineyard details, and sustainability information—was preferred digitally. These findings offer actionable insights for wine producers, marketers, and policymakers developing effective hybrid labelling strategies that balance regulatory compliance with consumer engagement in digitally evolving food markets.

Farmers' Position in the Food Supply Chain: Marketing Margin Evidence from 26 Fruits and Vegetables in Cyprus

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Recent farmer mobilizations across Europe have brought chronic imbalances in the food supply chain (FSC) to the forefront of policy debate. Producers increasingly operate as price-takers, absorbing market volatility, while intermediaries capture a disproportionate share of value added. In Cyprus, structural weaknesses, such as weak producer organization, small market size, and limited transparency, are expected to amplify these disparities, yet empirical evidence covering the full breadth of domestic fresh produce markets remains scarce. This study addresses this gap by providing the first comprehensive analysis of the price gap between producer prices (PP) and consumer prices (CP) for 26 fresh fruits and vegetables in the Cypriot market over 2020–2022; a period of heightened interest due to the COVID-19 pandemic and the Russia–Ukraine war, which exposed structural fragilities in FSCs globally. The 26 products span five categories defined by the Statistical Service of Cyprus (Cystat): vegetables, leafy vegetables, melons, fresh fruits, and citrus. The analysis draws on monthly data from the Cystat and annual Eurostat data for EU-level comparisons. For each product, the following indicators were computed: • Producer Price (PP) (EUR/kg): The average farm-gate price. • Consumer Price (CP) (EUR/kg): The average retail price. • Marketing Margin (MM): The absolute difference between CP and PP. • Farmer Share (FS): The share of PP in CP. • Percentage Marketing Margin (PMM): The share of MM in CP. Measures of price volatility (mean, standard deviation, coefficient of variation) were calculated, and correlation analysis was applied to assess the relationship between PP and CP. Results reveal marketing margins ranging from 18% (lettuce) to 75% (oranges), with the majority of products exceeding 50%, which is hard to justify for unprocessed produce in a geographically compact island economy. The highest margins are observed for oranges, mandarins, and artichokes, while the lowest occur in perishable leafy vegetables. Consequently, most producers receive less than half the CP, underscoring their precarious position in the FSC. Producer price volatility consistently exceeds consumer price volatility, suggesting that intermediaries absorb and buffer price fluctuations downstream. Notably, parsley and chards display low and similar volatility at both price levels, indicating efficient price transmission with minimal intermediary interference—a pattern that fosters market stability and planning confidence for all actors. Strong, statistically significant correlations between PP and CP were found for most vegetables and some fruits, an indication of price transmission. Lettuce stands out as the only product simultaneously exhibiting low marketing margins, relatively stable prices, and a strong positive PP–CP correlation, pointing to a well-functioning and efficient market segment. Conversely, several fruit products, such as apples, pears, and oranges display weak or negative correlations, suggesting asymmetric or limited price pass-through. The EU comparison confirms that Cyprus exhibits higher marketing margins and lower farmer shares than most peer countries, approaching patterns found in structurally weaker markets. These findings highlight the need for targeted policy interventions to strengthen producer organizations, improve market transparency, promote short FSCs and contract farming, and enforce legislation against unfair trading practices, thereby contributing to more resilient and equitable agri-food systems.

From Terroir to Algorithms: Technology Transfer and Digital Innovation Adoption in Greek PDO Viticulture

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Small-scale vineyards are central to Greek wine regions, yet their capacity to adopt digital and data-driven technologies remains uneven, particularly where family labour, fragmented landholdings and PDO regulations shape production decisions. This paper examines technology transfer and innovation adoption among grape growers in the Peloponnese, focusing on the PDO regions of Nemea and Mantinea and comparable non-PDO vineyard areas. Particular attention is given to the adoption of agricultural technologies and digital innovations that support vineyard management, productivity, quality improvement and overall farm performance. Drawing on Rogers' Diffusion of Innovations theory, the study analyses how growers receive, evaluate and utilise innovations, with emphasis on perceived relative advantage, compatibility, complexity, trialability and observability. Empirically, the research is based on a quantitative survey of small-scale vineyard enterprises and is supplemented by a review of policy and institutional frameworks influencing agricultural innovation. The survey captures adoption levels, communication channels, perceived productivity and quality effects, investment capacity, digital skills and structural constraints. The policy review examines how EU, national and regional initiatives, particularly CAP 2023–2027, AKIS, advisory services and rural development measures, support or constrain technology transfer processes and the uptake of agricultural innovations in small-scale viticulture. The paper contributes to debates on agricultural innovation and rural digitalisation by linking farm-level adoption behaviour with the broader institutional environment in which technology transfer occurs. The study investigates whether adoption is associated with perceived economic benefits, trusted advisory networks, access to technical support and training, and the characteristics of vineyard enterprises. The analysis also explores the extent to which investment costs, advisory coordination, digital skills, farm size, land fragmentation and administrative complexity influence adoption decisions. PDO regions may exhibit a dual effect: stronger quality orientation and collective reputation may encourage innovation uptake, while stricter production requirements may reduce flexibility for experimentation. The study concludes with recommendations for strengthening technology transfer mechanisms, improving advisory support and enhancing innovation uptake among small-scale vineyard enterprises in Mediterranean regions.

The future of blockchain adoption in agricultural cooperatives: Drivers, barriers and application prospects.

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Blockchain technology is widely theorized as a transformative governance mechanism capable of reshaping how transactions and information are coordinated within supply chains. A limited yet growing number of use cases are currently observable across sectors, with the agri-food domain emerging as a particularly active field of early experimentation. Agricultural cooperatives, with their distinctive governance structures and reliance on mutual trust, represent a theoretically rich but empirically neglected context for examining blockchain adoption. This research investigates the perceived facilitators and barriers influencing agricultural cooperatives' adoption intentions for blockchain technology, with a particular focus on the Greek cooperative ecosystem, where implementation remains at a nascent stage. Drawing on the Technology-Organization-Environment (TOE) framework, the study employs a qualitative research design comprising semi-structured, in-depth interviews with academic experts, cooperative executives, and blockchain specialists. Thematic and content analysis are deployed as the primary data analysis techniques to systematically identify and categorize the adoption determinants, while simultaneously uncovering blockchain-enabled solutions perceived as capable of addressing key operational and strategic challenges within cooperative organizations. To further complement the thematic findings, a structured prioritization exercise is also utilized, enabling the experts to comparatively assess and rank the relative importance of the identified facilitators and barriers to blockchain adoption. The findings suggest that blockchain adoption within agricultural cooperatives is closely tied to the technology's anticipated ability to deliver tangible value, with traceability and transparency, trust reinforcement, and business performance gains emerging as the most salient facilitators. Conversely, high implementation costs, technological complexity and digital illiteracy constitute the most influential barriers. Beyond adoption determinants, the results indicate that blockchain is perceived as a promising solution to persistent cooperative challenges, including opportunism, weak governance mechanisms and limited intra-organizational trust, primarily through the design and deployment of blockchain-based traceability systems and smart contract-enabled coordination and incentive tools. Notably, the study also reveals a discernible gap between stated willingness and actionable adoption intent: while cooperatives exhibited a generally favourable predisposition toward blockchain, this orientation seldom translated into concrete implementation timelines. Only a small number of studies to date have explicitly explored the intersection of blockchain technology and agricultural cooperatives. The present work advances that line of inquiry by shifting the focus on adoption perceptions and intentions within an emergent, pre-diffusion implementation setting. Theoretically, it extends the TOE framework by providing a sector-specific, empirically grounded understanding of early-stage blockchain adoption, while also reconceptualizing trust as a transversal construct operating across technological, organizational, and environmental dimensions. In practice, the findings offer actionable insights for cooperatives, policymakers, and technology providers by clarifying where blockchain can deliver tangible value, which constraints must be addressed first, and how specific use cases can be prioritized to align with cooperative operational realities. The field's ongoing evolution affords ample avenues for future inquiry.

Assessing System-Level Impacts of Agricultural Digitalisation: A Participatory Multi-Criteria Analysis across Living Labs

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Digitalisation is increasingly promoted as a key lever for enhancing the sustainability and resilience of agricultural systems. However, its impacts extend beyond individual technologies or farms, reshaping socio-ecological systems through changes in coordination, governance, decision-making, and resource management. This paper presents and applies a participatory Multi-Criteria Analysis (MCA) framework designed to assess the system-level economic, environmental, and social impacts of agricultural digitalisation within Living Labs. The analysis adopts a scenario-based perspective that distinguishes between three stylised digitalisation pathways—minimal, partial, and fully integrated—representing alternative transition trajectories rather than technological forecasts. Stakeholders evaluate how each pathway affects economic performance, environmental sustainability, and social outcomes at territorial or value-chain level. This approach explicitly recognises digitalisation as a structural change process that alters coordination mechanisms, governance arrangements, learning dynamics, and power relations within agricultural innovation systems. A core contribution of the paper lies in highlighting the role of participatory assessment in evaluating long-term transformations characterised by deep uncertainty and path dependency. Digitalisation generates impacts that are uncertain, unevenly distributed, and highly context-dependent, making ex post evaluation or purely model-based approaches insufficient. Participatory exercises allow these uncertainties to be surfaced explicitly, enabling stakeholders to articulate assumptions, expectations, and concerns that would otherwise remain implicit. By integrating diverse perspectives, participatory MCA helps reduce uncertainty, reveal contested impacts, and identify critical enabling conditions. Results highlight that stronger digital integration is generally associated with improvements in productivity, resource efficiency, and data-driven decision-making, supporting policy narratives that link digitalisation to competitiveness and environmental performance. However, the assessment also reveals important trade-offs and areas of uncertainty, particularly related to inclusiveness, affordability, dependency on digital infrastructures, and governance capacity. These findings challenge linear assumptions of technological progress and underline that sustainability transitions driven by digitalisation are neither automatic nor uniformly beneficial. From a policy evaluation perspective, the framework demonstrates how participatory MCA can support ex ante assessment of digitalisation by making explicit the conditions under which benefits materialise, the distribution of impacts across actors, and the risks of lock-in or exclusion. By integrating stakeholder perceptions, uncertainty levels, and scenario analysis, the method complements appraisal with the reflexivity space. The paper argues that effective digital transition policies must move beyond technology promotion toward system-oriented interventions that address skills, interoperability, governance, and institutional coordination. Moreover, inclusive deliberation supports procedural legitimacy and policy learning, which are essential for steering sustainability transitions in complex socio-technical systems.

BPMN-CBA for Evaluating Environmental and Social Trade-offs in Vineyard Digitalisation: Evidence from CODECS Living Labs in Italy and Slovenia

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Digitalisation in viticulture is transforming the balance between environmental sustainability, economic viability, and social well-being. Within the Horizon Europe CODECS Living Labs, we applied the BPMN-CBA (Business Process Modelling for Cost–Benefit Analysis) framework—an approach we developed to link process modelling and adaptive cost–benefit reasoning—to examine these trade-offs in two contrasting contexts: an Italian vineyard testing an autonomous robotic platform for mechanical weed control, and a Slovenian vineyard from the Smart Villages Network Living Lab adopting an IoT-based Decision Support System (DSS) for precision management. The BPMN-CBA methodology integrates BPMN 2.0 process modelling with iterative cost–benefit assessment, incorporating actor feedback, contextual adaptation, and system-level interpretation typical of Living Lab environments. It extends traditional cost–benefit analysis by enabling dynamic reasoning over technological, environmental, and social dimensions of digital innovation. In the Italian case, robotic automation reduces CO₂ emissions by about 80% and enhances operator safety by limiting chemical exposure. However, high CAPEX, short equipment lifespan, and a break-even threshold only beyond 50 ha constrain adoption to large estates. Socially, while automation might appear labour-substituting, the current scarcity of skilled operators reframes it as an opportunity to create new professional roles in digital vineyard management and maintenance, contributing to occupational renewal and rural attractiveness. The Slovenian case illustrates a more inclusive digitalisation path. IoT sensors monitor soil and weather conditions (moisture, rainfall, temperature), transmitting data to a shared platform that supports irrigation and spraying decisions. BPMN-CBA mapping shows lower investment requirements, moderate training costs, and clear environmental gains from reduced water and chemical use. Social benefits arise from greater decision autonomy, collective learning, and alignment with organic and small-farm practices. Across both contexts, BPMN-CBA acts as a decision-support and dialogue framework, translating process complexity into readable cost–benefit maps that facilitate multi-actor validation and participatory learning—overcoming the static, top-down limits of conventional CBA (Hanley & Barbier, 2009; Boardman et al., 2018). This work demonstrates how BPMN-CBA can guide context-sensitive and socially responsive digital transitions in viticulture, integrating environmental efficiency with human-centred innovation in Living Lab ecosystems.

Assessing Stakeholder Readiness for IoT Adoption in the Greek Agri-Food Supply Chain

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This study examines the adoption dynamics of the Internet of Things (IoT) within the Greek agrifood supply chain. Moving beyond traditional approaches that treat the sector uniformly, the research introduces a comparative framework analyzing 217 professionals: farmers, agronomists, and logistics managers. Empirical data from 2026 indicates that while theoretical familiarity remains moderate, practical field usage is independent of demographic factors such as age. In contrast, adoption barriers are highly sector-specific: logistics managers focus on cybersecurity and financial costs, agronomists on rural network deficits, and farmers on managing complex data. The Ordinal Logistic Regression model demonstrates that long-term strategic value and daily usefulness are the true drivers of investment willingness, absorbing the negative impact of operational barriers. Remarkably, farmers exhibit the highest readiness to invest, viewing IoT as a vital tool for modernization. These findings suggest that technology providers and policymakers must shift from selling standalone hardware toward delivering integrated service packages that combine equipment subsidies with targeted digital training.

Cross-European Mapping of Crop Matching Practices

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Crop Matching, a HORIZON EUROPE project, is an agroecological approach that connects farming systems, stakeholders, resources, practices, and local conditions by applying ecological principles and identifying complementary needs and opportunities. The approach aims to support small-scale farmers and foresters in adopting environmentally sustainable practices while strengthening rural communities, enhancing agrobiodiversity, and contributing to broader environmental and economic objectives. This study presents a comparative mapping of crop matching practices across ten European countries. Each participating country identified and documented ten examples of good practice, resulting in a database of 100 cases. The analysis offers a structured overview of both established and emerging practices, highlights underutilized knowledge, and generates insights to support the development of tailored expertise for small-scale farmers and foresters. To further explore similarities and differences among practices, a cluster analysis was conducted, identifying four groups of practices with shared characteristics. The findings demonstrate that crop matching is not a single standardized model, but rather a flexible and adaptable approach capable of responding to diverse objectives, territorial contexts, and stakeholder needs. Across the identified clusters, benefits emerged at environmental, farm, economic, and territorial levels, including enhanced biodiversity, improved soil health and resource efficiency, stronger cooperation and knowledge exchange, reduced dependence on external inputs, production diversification, local value creation, and more resilient rural networks. At the same time, the analysis revealed recurring challenges, particularly the need for effective facilitation, trust-building, long-term coordination, institutional support, and adaptation to local conditions. Overall, the mapping and clustering of practices across diverse European contexts contribute to a more comprehensive understanding of crop matching as a practical, adaptable, and context-sensitive approach for small-scale farming and forestry systems.

Using machine learning to forecast consumers' uptake of branded potatoes

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There have been significant structural changes in the UK fresh potato sector. First, the production has been declining as diets have changed and other products have been introduced (e.g., pasta). Second, the planted area has also been falling, however, this has been accompanied with higher yields due to improvements in irrigation, soil management, and better seedbed preparation. The consequence is that the average production has continue growing despite the smaller area. Third, the industry has become more consolidated due to higher capital investment, with far fewer growers with small holdings in even just the past 20 years. Thus, potato production is now in the hands of fewer but more specialised growers who must meet ever-increasing demands for high-quality product, especially for blemish-free, pre-pack potatoes for retail. Fourth, it has become important to distinguish between fresh and processed potatoes. While fresh potatoes have had significant decline in the per-capita consumption, this have been partially offset by processed potato products, which also have steadily grown in importance as a proportion of all potato sales. Fifth, imported potatoes have become a much larger part of the picture. The conclusion is that the challenges for the fresh-potato segment of the UK potato producers are: first, growers need to stay focused on profitability, keeping a close eye on yields and costs. Second, to make products more attractive by looking out for marketing opportunities to differentiate what they sell. A strategy followed by some potato growers has been to brand their produce as opposed to selling them as private label products. Examples of this are Albert Bartlett's Rooster potato, Greenvale's Farm Fresh and Heritage potatoes. Thus, the purposes of this paper are: first, to analyse the aggregated uptake of branded potatoes as opposite to private label ones, and second, to explore the uptake of branded potatoes by retailer. For the analysis, time series were created using the Scottish Numerator Worldpanel dataset. The choice of Scotland was due to the importance of potatoes on the Scottish production and consumption, and because it allows to create a lengthy consistent dataset from 2006 until 2024 with data broken by retailer, branded and private labels. In terms of methods, the analysis uses supervised learning algorithms, in particular regression algorithms, part of artificial intelligence, to build mathematical models of the dataset. Through iterative optimisation of an objective function, supervised learning algorithms were used to predict how much branded versus non-branded potatoes will be purchased in future periods and predict the probability of consumers switching to branded potatoes. The methodology allows it to revise the forecasts as the consumers' and retailers' behaviour related to potatoes change over time. The preliminary results indicate the possibilities of branding as a strategy for farmers to capture a greater share of the total generated value, as well as, to improve their resilience through diversification. In addition, the paper also shows the usefulness of machine learning for capturing dynamic behaviour and forecast the demand for branded and private label potatoes, a factor that is useful for retailing.

Bridging the Macro-Micro Divide: A State-of-the-Art Review on Integrating Big Data and Eye-Tracking to Understand Consumer Food Choice

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Our global food system nowadays is facing challenges like never before. About 700 million people faced hunger in 2024 [1], more than 1 billion individuals worldwide are living with obesity[2], which increases the risk of multiple diseases [3]. Simultaneously, food production drives climate change, land degradation, and biodiversity by causing major global environmental risks [4]. At the intersection of these crises lies a critical problem: we lack a wholesome understanding of “how” and “why” consumers make the food choices they do, as the latter connects directly and indirectly to the above-mentioned challenges and more. Without a systemic understanding of the whole decision-making processes and the ability to predict individual’s behavior at population scales, interventions remain inefficient, costly, and often ineffective [5]. Current research on consumer food choices is characterized by a deep methodological divide. On one hand, approaches that focus on the population level -which we will name “macro” level approaches-, these methods have become increasingly sophisticated with in the emergence of “big data”, Machine Learning (ML), and Artificial Intelligence (AI). The presence of data sources like large-scale scanner data, retail analytics, and ML algorithms can now map effectively with high precision map population level trends, giving insights on which products sell best, where, when and to whom [6], [7]. E-commerce platforms is a big source of food purchasing transactions. Daily, billions of data is captured, creating a huge, and unprecedented datasets about consumer preferences [8]. As important these data are, they can be used to answer different questions when it comes to consumers food choices, but they rarely answer the “why”. On the other hand, “micro” approaches that have made extraordinary advances in detailing the neurobiological and cognitive bases of food choice. Functional neuroimaging brings to the surface brain regions that are responsible for processing food value, taste, and health information [9]. Eye-tracking studies could reveal how consumers allocate cognitive resources when deciding by -objectively- measuring visual attention during product evaluation [10], [11], [12]. Multiple behavioral experiments have identified factors like food salience, decision framing, and cognitive load influence choice independently of stated preferences [13], [14], [15]. As strong as these studies seem, the sample size limitation (n= 50 to 200), the controlled environments (disconnected from real shopping), and the limited diversity in participants’ population presents weakness that prevents the generalization of findings [16], [17], [18], [19]. Combining computational models that synthesize individual-level neuro-cognitive data with population-level purchasing behavior, surely will bridge this gap of understanding and predicting -on different levels- how specific consumers will respond to targeted interventions. A state-of-the-art review was conducted to address this specific gap, by analyzing data sources and methodologies used, key limitations to present emerging integration pathways such as creating “digital twins” which is becoming an important and emerging trend in many applications. This technology is now feasible on the inputs, processing, and outputs level due to the advances in ML, eye-tracking and its mobility, wearable biometric sensors, and high-powered computational modeling. The findings will help to shape new strategies that will help bridging the how and why parts in consumers food choices.

Online Grocery Environments and Their Impact on Dietary Management

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Background Diabetes is a major health concern, projected to rise by 46% by 2045 (Sun et al., 2022), with significant economic and quality-of-life impacts (Busili et al., 2024). Dietary choices play a significant role in managing the disease (Szczerba et al., 2023); therefore, understanding consumers' food purchase decisions is crucial. However, stress and information overload may affect their purchasing behaviour (Martins, 2025). Decision Support Systems may assist consumers in making more informed grocery purchasing decisions, especially when purchasing online (Tasar et al., 2024). Nevertheless, limited research exists on these systems that address diverse dietary needs, such as disease-related or lifestyle diets, as studies often focus on individual food groups or nutrients (Harnack et al., 2021; Vanwinkelen et al., 2026). Aim and Objectives The present systematic literature review (SLR) aims to identify effective interventions implemented in online grocery environments to support dietary and health management. In particular, the SLR will: 1. Identify and categorise personalisation tools used in online grocery shopping based on intervention type and level of personalisation in targeting dietary behaviour and health management. 2. Evaluate the effectiveness of these tools in improving dietary behaviour and health-related outcomes. Methodology The SLR follows the PRISMA protocol and conducts searches in the key databases: SCOPUS, PubMed, ScienceDirect, and Web of Science. Key words used for the searches are: "online grocery environments", "personalised digital interventions", and "dietary behaviour". Articles will be screened for titles, abstracts, and keywords, and their eligibility will be evaluated using predefined inclusion criteria related to the online food environment, personalised digital intervention, and dietary or health-related outcome. Research published until June 2026 will be incorporated. The review is currently in the screening process. Expected Results This research is expected to identify key personalised digital interventions in online grocery shopping systems, assess their effectiveness in improving dietary behaviour and health, and inform future research on the optimisation of persuasive technologies.

A Systematic Review of the Adoption of Artificial Intelligence (AI) for Sustainable Food Choices

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Acute challenges in global food systems have brought sustainable food consumption into sharper focus in recent years. Global food demand is expected to rise by 35% to 56% by 2050 compared to 2010. Additionally, the UK government is aiming to make a food system that is more resilient, environmentally sustainable and supports healthier diets. With the emergence of artificial intelligence (AI) tools in food recommendation and personalized nutrition, consumers can identify trade-offs between environmentally sustainable and healthier diets, which are more economical, with real-time dietary guidance and insights that aid consumer food choices. Hence, AI tools provide a potential solution for improved sustainability in food consumption. The effectiveness of AI in encouraging individuals to adopt healthier and more sustainable diets requires more than access to information. It demands a deeper understanding of how attitudes, values, and social norms shape food-related behaviour. However, there is a lack of research providing a systematic overview of what AI tools are used regarding sustainable diets and what factors are barriers or motivations to their usage. This systematic review examines the existing AI recommendation tools that aid consumers' food decisions and identifies its effects on motivations to make sustainable dietary decisions. The review focuses on - assessing the application of AI in consumers sustainable food choices, the use of AI to make sustainable food more accessible to consumers and factors influencing AI usage. We conduct a pre-registered systematic literature review in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and synthesise insights from 29 studies. A combination of four electronic databases, PubMed (MEDLINE), Embase, Scopus, Web of Science were used with eligible studies including experimental, observational, pilot, or mixed-methods studies reporting on AI effectiveness. Primary outcomes will focus on how AI affects food related outcomes including changes in food purchasing, dietary behaviour, and sustainable consumption practices. Secondary outcomes will focus on barriers and drivers of AI use and include consumer perceptions, trust, accessibility, perceived usefulness and motivations specifically, environmental, economic and nutritional health. The findings of the review will contribute to future research, policy development, and stakeholder engagement regarding the integration of AI into sustainable food systems and consumer nutrition strategies. The full systematic review, including the findings and analysis, will be completed in summer 2026 with results available to present at the workshop.

Can Artificial Intelligence Support Sustainable Gastronomy? Exploring Chefs' Adoption, Perceived Benefits, and Future Expectations

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Artificial Intelligence for Sustainable Gastronomy: Exploring Chefs' Adoption, Perceptions, and Future Expectations The transition toward more sustainable food systems requires innovative digital solutions capable of improving efficiency, supporting decision-making, reducing food waste, and enhancing resource utilization across the food value chain. Artificial Intelligence (AI) has emerged as one of the most transformative technologies in this context, offering new opportunities for food production, distribution, and consumption. While AI adoption has gained increasing attention in agriculture and food manufacturing, its role within professional gastronomy remains relatively underexplored. As culinary professionals are key actors influencing menu design, ingredient selection, operational efficiency, and food waste management, understanding their perceptions and adoption of AI technologies is critical for the future of sustainable gastronomy. This study aims to investigate the awareness, adoption patterns, perceived benefits, perceived risks, and future expectations of gastronomy professionals regarding AI technologies. A quantitative survey was developed and administered to chefs, sous chefs, executive chefs, culinary instructors, restaurant managers, and other foodservice professionals. The survey examines demographic characteristics, AI awareness levels, frequency of use, preferred AI tools, application areas, perceived usefulness, perceived risks, and future adoption intentions. The study explores a broad range of AI applications in gastronomy, including recipe development, menu planning, menu description generation, cost control, purchasing decisions, social media content creation, food waste reduction, educational activities, visual presentation design, and nutritional analysis. In addition, respondents evaluate the extent to which AI contributes to operational efficiency, creativity, innovation, sustainability, and professional development. Based on preliminary observations and recent developments in the hospitality industry, it is expected that AI adoption among gastronomy professionals will be concentrated primarily around content generation, recipe development, menu planning, and educational support. Tools such as ChatGPT, Gemini, Copilot, Canva AI, and image-generation platforms are anticipated to be among the most frequently used technologies. The findings are also expected to reveal that culinary professionals perceive AI as a supportive rather than substitutive technology, emphasizing its role in enhancing productivity, reducing repetitive tasks, and facilitating creative processes. At the same time, concerns related to information reliability, authenticity, professional ethics, creativity loss, and excessive technological dependence are expected to emerge as significant barriers to adoption. Differences in adoption behavior may also be observed across age groups, professional positions, and years of experience, with younger professionals and educators potentially demonstrating higher acceptance levels. The study contributes to the growing literature on digital transformation in gastronomy by providing empirical evidence regarding how culinary professionals position AI within their professional practices. Furthermore, it expands discussions on sustainable gastronomy by examining whether AI can support more efficient resource management, informed decision-making, and waste reduction within foodservice operations. The findings offer practical implications for gastronomy education, hospitality businesses, technology developers, and policymakers seeking to align digital innovation with sustainability goals. Ultimately, the study highlights the evolving relationship between human creativity and artificial intelligence in shaping the future of sustainable food systems. **Keywords:** Artificial Intelligence, Sustainable Gastronomy, Culinary Professionals, Digital Transformation, Food Waste Reduction, Hospitality Innovation.

Assessing economic consequences of an animal health enhancing policy. The case of the "Claw Coin" animal welfare reimbursement scheme in Sweden.

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This paper investigates the impact of a preventive claw health policy on dairy farm economic outcomes in Sweden. Farmers who adopted the policy were reimbursed to implement (or uphold) a strategic management scheme involving a claw health plan and biannual routine claw trimming. The aim of the study is to assess the impact of a preventive health management policy on farm economic outcomes. We use matching method for time-series cross-sectional data followed by a staggered difference-in-difference design to account for dynamic and heterogeneous effects due to differences in policy adoption between farms. We fail to reject the null hypothesis that the policy affected the farm economic outcome, using two different farm accountancy measures: The net value added per annual working unit and the share of net value added out of total income. However, when estimating the energy corrected milk yield per cow and year we find an increase an average increase of 97kg/cow/year one year after treatment. The findings suggest that preventive claw management, on average, is not associated with effects on the farm-level economic outcomes, despite a small increase in milk yield. This result is likely due to initial high claw health standards in the Swedish dairy farm sector. Therefore, additional animal health enhancing policy, while upholding animal health standards, is thus unlikely to positively affect the competitiveness of the dairy sector.

Assessing the impact of stringency in animal welfare regulation on farm performance: Evidence from sow housing regulation

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This study examines the impact of stringency in Animal Welfare (AW) regulations on farm economic performance, using regulation on sow housing during gestation as a case study. While the European Union (EU) established minimum welfare standards for gestating sows, the Netherlands has implemented stricter national regulations that go beyond these requirements. This regulatory difference provides an opportunity to evaluate the economic implications of more stringent AW policies. We exploit the variation in stringency in regulation for sows during the gestation period, represented by Netherlands and apply a synthetic control method that constructs a counterfactual Netherlands from a weighted combination of other countries in the Farm Accountancy Data Network (FADN) dataset. To estimate the causal effect of stricter regulation, we apply Matching and Synthetic Control (MASC) (Kellogg et al., 2020). Compared with the standard synthetic control approach, MASC improves comparability between treated and control units while reducing estimation bias. Preliminary results do not provide evidence that regulatory stringency in sow housing gestation affects economic performance. In addition to regular placebo-tests, we further assess the robustness of these findings using two other recent methodological advancements from the synthetic control literature, *scpi* by Cattaneo et al., (2025) and *scinference* by Chernozhukov et al., (2017), both of which produce consistent results. This paper contributes to the literature in two ways. First, it provides new empirical evidence on the economic effects of stringency in animal welfare regulation in pig production. Second, it demonstrates a novel application of recent advancements in causal inference and machine learning within the synthetic control framework.

Decomposing and explaining greenhouse gas emission efficiency of Austrian dairy farms

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Decomposing and explaining greenhouse gas emission efficiency of Austrian dairy farms Eder, Andreas; Landon, Tess M.; Salhofer, Klaus; Seiringer, Martin In 2023, Austrian agriculture emitted greenhouse gas (GHG) emissions of 7,477 kt CO₂ equivalent, accounting for 11% of national emissions (Anderl et al., 2025). Besides agricultural soils (24%), the two main sources are enteric fermentation (57%) and manure management (17%), both tied to livestock. Dairy is Austria's single most important agricultural activity generating roughly 20% of the sector's output value (BMLUK, 2025). Given dairy farms' weight in farm income and in the national GHG inventory, it is crucial to understand how gross value added (GVA) is generated relative to GHG emissions, and how this relationship can be improved. Utilizing FADN and agricultural census data and based on the IPCC (2006, 2019) method, we calculate GHG emissions for a sample of 501 dairy farms in Austria in 2020. Following the multi-equation modelling of pollution generating technologies (Førsund, 2009; Murty et al., 2012), we propose a measure of GHG emission efficiency (GEE) that is multiplicatively decomposed into economic (i.e. the ability to generate value added from given inputs) and environmental efficiency (i.e., input emission efficiency). In the first stage, we apply Data Envelopment Analysis (DEA) to estimate economic (ECE) and environmental ENE efficiency. In the second stage, we explain GEE, ECE and ENE with different determinants. We derive the following results: GEE is strongly driven by ECE while the contribution of ENE to GEE is less important. We find a positive correlation between GEE/EEC and farm size, natural and economic production conditions, milk yields and organic certification. Moreover, negative correlations are observed between GEE/EEC and specialization in milk production and external input dependency.

Exploring Responsible Decision Support Systems Adoption in Dairy Farming through Q Methodology

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The digitalisation of livestock farming is central to European agricultural policy agendas, particularly in relation to sustainable agriculture and data-driven innovation. Within this context, Decision Support Systems (DSS) are increasingly promoted to improve farm efficiency, environmental performance, and managerial decision-making in dairy production systems. However, DSS are complex data-driven technologies that connect multiple actors involved in dairy supply chains (Brugler et al., 2024; Nsabiyeze et al., 2025). By integrating data across animal, managerial, environmental, and economic dimensions, DSS should be considered not only as a technical tool but also as a socio-technical structure able to reshape decision-making processes among different actors. Therefore, assessing livestock sustainability performance cannot be separated from the responsibility pathways through which these technologies are designed and governed (Vecchio et al., 2022). DSS adoption fits particularly well with a networked responsibility approach, which understands responsibility as distributed across socio-technical relationships (Timmermans et al., 2017). This perspective is consistent with Responsible Research and Innovation (RRI), which frames innovation as shaped by actors, norms, and responsible innovation activities (Stahl, 2013; Charatsari et al., 2022). The present research is developed within the SustMilk4IT – Stalla Modello project (CUP: J79I21000130001) which aims to improve sustainability of the dairy supply chain. Within this context, “responsible innovation space” refers to the interaction field where different actors (e.g., farmers, advisors, technology providers) construct different interpretations of sustainability and responsibility. This study investigates how actors perceive the responsible integration of DSS through Q methodology. The analytical framework combines Sustainability Assessment of Food and Agriculture systems (SAFA) (FAO, 2014) and RRI to capture both sustainability performance and governance principles. Expected outcomes identify shared viewpoints and divergent narratives on DSS adoption. Brugler, S., Gardezi, M., Dadkhah, A., Rizzo, D. M., Zia, A., & Clay, S. A. (2024). Improving decision support systems with machine learning: Identifying barriers to adoption.

Prompting sustainability-driven ventures in the Spanish dairy industry

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It is widely recognized that the dairy industry faces momentous challenges to make progress toward major environmental goals in balance with economic and social sustainability. This study contributes to addressing this concern from the business management angle, examining the contemporary processes of sustainability transition in a purposeful selection of Spanish dairy companies taken as illustrative case studies. In particular, we analyze the process of propelling sustainable business transition in terms of shifting from the strictly economic-driven business models toward more sustainable business models accounting for social and environmental values. Empirically, we adapt and test the Triple-Layered Business Model Canvas (TLBMC) in the specific contexts of the study companies, and find out the potential of this model to uncover appropriate factors and business areas for innovations in terms of sustainable value creation and delivery. We assume that conducting a novel analysis based on the TLBMC model in different dairy companies can provide a better understanding of the extent to which business modelling is adopted to accommodate new sustainability priorities. The use of a multi-case study design is motivated by the scarcity of both theory and empirical evidence on how dairy companies leverage sustainability drivers, and the efforts they make to overcome barriers to achieve sustainable outcomes. It is also due to the fact that relative to a single-case study, the evidence generated from a multiple case study often is stronger and more reliable as it is more intensely grounded in different empirical contexts. Primary data have been collected through structured questionnaires addressed to the study companies, and subsequently triangulated with secondary data. Findings suggest that sustainability goals can be appropriately represented through the proposed approach, facilitating the generation of new sustainability-driven ventures by innovating strategically in a series of variables including materials, cleaner technologies, partners, customers, distribution channels, and the value proposition.

Consumer Perceptions of Fish Raised in Treated Wastewater-Based Aquaponics Through the Human–Animal–Environment Nexus

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Growing population, accelerating climate change, increasing urbanization, and rising global demand for protein necessitate a transformation of food systems toward more sustainable and circular production models (de Boer & Aiking, 2021; Webb et al., 2020). In this context, recirculating aquaponic systems, integrating aquaculture and hydroponics within a closed-loop structure, have emerged as a promising innovation to improve resource efficiency and reduce environmental impacts (Goddek et al., 2019; Horn et al., 2023). To further strengthen circularity, the integration of treated wastewater (TWW) as a water source offers substantial potential through freshwater conservation and nutrient recovery (Cifuentes-Torres et al., 2021; Qadir et al., 2020). However, despite its technical and environmental promise, the social acceptance of fish raised in TWW-based aquaponics remains largely overlooked. This study examines consumer perceptions of fish raised in TWW-based aquaponic systems through the human–animal–environment nexus. Drawing on the Health Belief Model, the study conceptualizes consumer perceptions through three dimensions: concerns, perceived benefits, and acceptance-enhancing measures. A structured online survey was conducted in Germany and Italy between November and December 2025. The findings reveal limited public familiarity with TWW use in food production in both countries. Consumer perceptions consistently clustered around three dimensions: human-centered risk perception, environmental and system-level evaluation, and trust and governance mechanisms. While concerns related to human health risks emerged as particularly salient, perceived environmental benefits and governance-related measures, including transparency, certification, and monitoring, appeared as important elements shaping consumer acceptance. Cross-country differences suggest variations in the relative importance assigned to these dimensions. The study contributes to the emerging literature on circular aquaculture by highlighting how consumer perceptions may shape the social viability of digitally monitored and traceable food production systems. The findings further underline the importance of transparency, monitoring, and trust-building mechanisms in supporting the societal acceptance of emerging sustainable aquaculture innovations.

Aggregate or Detailed? How Eco-Label Design Shapes Trust and Sustainable Food Choices

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Abstract Understanding how consumers respond to different label formats is critical for designing eco-labeling systems that are both usable and effective in promoting sustainable consumption. In this study, we examine the effectiveness of a pro-environmental food label that includes multidimensional sustainability indicators compared with a pro-environmental label that presents only an aggregate Eco-Score. Drawing on a consumer survey that is currently being conducted with approximately 3,000 respondents from Italy, Germany, and Denmark, we investigate which label format is more effective in increasing purchase intentions and recommendations, while reducing information avoidance. The study includes three experimental conditions. In Condition 1, respondents are presented with an olive oil bottle displaying an Eco-Score label rated at Level B. In Condition 2, respondents view the same olive oil bottle and Eco-Score label (Level B), but the label additionally provides Level B ratings for specific sustainability dimensions, including agroecology, soil health, circularity, and biodiversity. In Condition 3 (control condition), respondents are presented with the olive oil bottle without any Eco-Score label. We hypothesize that the multidimensional food label increases consumer trust relative to the aggregate label, which in turn drives higher purchase intentions and recommendations, and reduces information avoidance. Eco-labels function as credence cues for which trust is of paramount importance. More specifically, credence attributes serve as integral elements in shaping consumer perceptions and choices by conveying unobservable characteristics that influence quality assessments. Our study contributes to the food marketing literature by examining which food label format is more effective in promoting sustainable consumer behaviors and fostering trust. This question is particularly relevant for policymakers and standard-setting organizations, as label design involves a trade-off between cognitive simplicity and information provision. **Keywords:** consumer preferences, sustainability, credence attributes, food claims. **Acknowledgements:** This research received funding from the Environmental Food Label (EFL) project, supported by EIT Food.

Bridging the Intention – Action Behaviour Gap in the Promotion of PDO-certified Cheese in Greece

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Geographical Indications (GI) represent a strong tool in the food market, as they are connected to a specific geographical area, traditional production processes, and high-quality standards. Even though consumers report positive intentions towards these products, the transition of purchasing intention into actual purchasing behaviour is not guaranteed. That's why the intention-action behaviour gap has gained high research interest, specifically for the products certified with the Protected Designation of Origin (PDO) label. The present survey examined the intention-action behaviour gap in the purchase of the Greek PDO Kasseri cheese. The aim was to investigate the effects of PDO certification, price, and producer brand in consumers' choices in a real purchasing environment. Data were collected from Greek consumers (N=55) through an online questionnaire that included a Discrete Choice Experiment (DCE). This methodology allows the assessment of trade-offs that consumers make between different product attributes in their decision-making process. Results indicated that the PDO-certified Kasseri cheese was the most preferable choice, at 56.2% level, in total choices of experimental scenarios. Their preference confirms that there are positive views for the attributes of quality, authenticity, and geographical origin, directly connected to the PDO products. Nonetheless, the price difference increase between the PDO Kasseri cheese and the conventional yellow cheese, decreased the probability of choice for the PDO product, which highlights that the price variable operates as the most limiting factor of the purchasing behaviour. Logistic regression results confirmed that the probability of choice for the PDO product decreases, as the price difference increases, implying that there is a high sensitivity to economic cost. It was also found that the producer's brand in combination with the PDO certification enhanced the consumers' preference and eliminated the negative influence of the price variable. Consequently, credibility, trust, and brand awareness work as strong attributes for a high quality brand. In other words, these characteristics strengthen the perceived quality of a product and increase its purchasing intention, even in cases of a higher price. In conclusion, the survey demonstrates that, even though consumers value the distinctive attributes of the PDO products, economic constraints operate as an obstacle to translate the positive intention into actual purchasing behaviour. Findings confirm the existence of an intention-action behaviour gap and highlight the importance of certification and producer brand as mechanisms that are able to bridge the intention-action behaviour gap of PDO products' purchasing. Keywords: Protected Designation of Origin (PDO), Kasseri, consumer behaviour, intention-action behaviour gap, Theory of Planned Behaviour (TPB), Discrete Choice Experiment (DCE), Willingness to Pay (WTP)

Sustainability in Mediterranean Dairy Farming Systems: A Consumer-Based Study

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Dairy livestock farming is currently facing multiple challenges related to environmental sustainability, system resilience, digitalisation, and the transition towards more circular agricultural models (Schreefel et al., 2022; Berckmans, 2026). Within this context, the SUPREM-MILK project (PRIMA programme) aims to develop digital tools and tailored actions to support buffalo and cattle farmers in the Mediterranean area in moving towards a more sustainable and net-zero dairy supply chain. Among these tools, the project developed a dedicated APP designed to support farmers in monitoring and improving farm sustainability performance. Since the transition to more sustainable dairy systems depends not only on innovations at the farm level, but also on society's expectations and acceptance, consumers' opinion is becoming ever more important (Yeter et al., 2025). The present study aims to investigate consumers' perspective regarding the sustainability of dairy products, with particular attention to which dimensions are considered most relevant in five countries involved in the project: Italy, France, Morocco, Türkiye, and Egypt. The dimensions analysed include environmental, social, economic, and governance-related sustainability (Oyinbo et al., 2024). The specific aspects associated with each dimension were identified through a literature review and a participatory process based on structured interviews, roundtables, and focus groups involving international experts, supply chain stakeholders and local actors. Results, collected on around 2,500 consumers, will be used to inform the development of the SUPREM-MILK APP, ensuring that the digital tool incorporates sustainability dimensions that are not only technically relevant for farmers, but also meaningful beyond the farm gate. Subsequently, multivariate analyses will allow the identification of the main driving factors and potential bottlenecks perceived by consumers across the investigated sustainability areas, highlighting possible differences among socio-cultural contexts. The expected results will contribute to more targeted communication strategies, consumer-oriented innovation pathways, and evidence-based policy actions aligned with Mediterranean consumers' sustainability expectations, thereby supporting the transition towards more sustainable, resilient, and socially accepted dairy supply chains.

Understanding Consumer Responses to Environmental and Organic Labels: A Cognitive and Behavioral Approach

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Sustainability has become a central priority in policy agendas worldwide, reflecting growing concerns over climate change, environmental degradation, and the long-term resilience of agri-food systems. The European Union has formalized its commitment to the green transition through the European Green Deal and its Farm to Fork Strategy, which identifies sustainability labelling as a key policy instrument to inform consumers and steer food choices toward more sustainable options. In this context, all-encompassing labels — such as the Eco-Score, which synthesizes the overall environmental profile of a product into a single, consumer-friendly signal — have emerged as prominent candidates for a harmonized EU framework. Yet the current labelling landscape remains fragmented, with such emerging indicators coexisting alongside established one-trait certifications, most notably the EU organic label (EU Leaf), one of the most recognized and trusted sustainability marks among European consumers. This proliferation raises important questions about label effectiveness and interaction effects. This study addresses two main research questions: (i) are all-encompassing labels more effective than one-trait sustainability labels in guiding consumers toward sustainable food choices? (ii) when both label types are simultaneously displayed, do they produce additive or competing effects on consumer preferences and willingness to pay (WTP)? To date, only limited evidence exists on these interactions, with one study suggesting that the simultaneous presence of all-encompassing and one-trait labels may generate conflicting effects, resulting in a weaker overall impact on consumer valuations. These findings raise concerns about the effectiveness of multi-label configurations as a policy strategy. To extend knowledge in this area, the study combines a large-scale online Discrete Choice Experiment (DCE) with a laboratory neuroeconomic protocol integrating Eye-Tracking and Electroencephalography (EEG), alongside peripheral physiological measures. The DCE elicits stated preferences and WTP from a sample of Italian consumers evaluating choice sets featuring packaged biscuits, a category in which sustainability and health cues are particularly salient. Alternatives vary in price, sustainability label (absent, Eco-Score, EU Leaf, or both), and health claim, enabling estimation of both main and interaction effects. The laboratory experiment involves a separate sample of participants who evaluate equivalent product images under simultaneous Eye-Tracking and EEG recording. Eye-Tracking identifies visual attention patterns across package areas of interest, while EEG captures cognitive load, emotional engagement, and motivational orientation in response to different labelling configurations. This combination is motivated by the complementarity between overt attentional behavior and the cognitive and affective processes that may influence choice without being fully accessible to introspection. Findings from the two studies are analyzed independently and then discussed jointly, with the aim of providing converging evidence on a shared research question. Based on existing literature, the EU Leaf is expected to generate higher WTP than the Eco-Score when presented individually, while simultaneous exposure to both labels is anticipated to increase cognitive load and reduce overall WTP. By integrating econometric and neuroscientific evidence, this study aims to advance understanding of the implicit mechanisms underlying consumer responses to sustainability labels, and to inform the design of clearer, more effective front-of-pack sustainability communication within the EU regulatory framework.

Directing agricultural innovation toward sustainable productivity growth: directionality, governance and measurement challenges

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Agriculture faces the dual challenge of increasing productivity while improving environmental sustainability. Achieving Sustainable Productivity Growth (SPG) requires innovation systems capable not only of generating new technologies and practices, but also of directing innovation towards outcomes that combine productivity gains with improved environmental performance. In this context, Agricultural Knowledge and Innovation Systems (AKIS) play a central role in shaping innovation trajectories through interactions among researchers, firms, farmers, policymakers, and other stakeholders. The OECD is making progress on developing strategies to strengthen AKIS and better align these systems with SPG objectives. Strong innovation systems in terms of research capacity and innovation outputs do not automatically deliver sustainable outcomes if innovation efforts are not intentionally directed towards societal and environmental goals. Innovation directionality therefore becomes a critical dimension of agricultural innovation policy. The paper develops a framework to analyse and monitor the capability of the AKIS to deliver SPG, including the design of policies, the measurement of efforts using novel methods and the governance of digitalisation. The paper analyses two complementary policy approaches for inducing innovation towards SPG. First, mission-oriented innovation policies (MOIPs) can provide clear strategic direction by articulating shared societal objectives while allowing flexibility in technological pathways and solutions. Second, transformative policy mixes can align incentives, governance arrangements, regulations, and support mechanisms to promote innovation trajectories consistent with SPG objectives. Both approaches require adaptive governance, strong co-ordination mechanisms, and continuous learning processes across AKIS actors. These governance challenges are increasingly shaped by digitalisation, as data infrastructures, digital platforms, and rules on data access and use influence knowledge flows, innovation incentives, and collaboration across the system. The paper also highlights the importance of monitoring and assessing not only the strength of innovation systems, but also their directionality. Traditional indicators such as R&D expenditures, patents, and scientific publications remain important but provide limited information on whether innovation efforts contribute to SPG objectives. To address this gap, the paper proposes a multidimensional framework combining indicators on inputs, outputs, institutional capacity, adoption and diffusion, and outcomes. Artificial intelligence (AI) and data-driven methods offer great potential to develop new indicators capable of capturing the orientation of innovation efforts. Illustrative applications using AI-based analysis of policy documents, agricultural patents, and firm-level activities to identify innovation patterns associated with SPG objectives, demonstrate the potential of combining AI tools with expert interpretation to improve the assessment and monitoring of innovation systems. These approaches also highlight the growing importance of data governance and digital capabilities as enabling conditions for measuring, steering, and scaling innovation for SPG. The paper contributes to ongoing debates on mission-oriented innovation policies in agriculture and proposes a framework for guiding, measuring and assessing innovation systems capable of supporting the transition towards more sustainable agri-food systems.

Financing Sustainable Food-System Transitions: A Comparative Analysis of Nordic and European AgriFoodTech Financing Ecosystems

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The transition toward sustainable agri-food systems increasingly relies on digital technologies, biotechnology, and platform-based innovation. However, emerging evidence suggests that different types of sustainable food-system innovations may face uneven access to financing depending on their technological characteristics, scalability profiles, and compatibility with dominant investment models. While existing AgriFoodTech research largely focuses on aggregate investment trends, less attention has been paid to how different financing ecosystems selectively privilege particular transition pathways. This paper examines how distinct financing and innovation ecosystems shape the development trajectories of sustainable AgriFoodTech firms in Europe and the Nordics. The study asks: (1) What types of sustainable food-system innovations are prioritized by different financing ecosystems? (2) How do financing patterns differ across upstream, midstream, and downstream AgriFoodTech segments? (3) To what extent do financing ecosystems favor scalable digital optimization models over infrastructure-intensive or industrial sustainability transitions? The paper draws on theories of mission-oriented innovation, sustainability transitions, and the political economy of finance. In particular, it conceptualizes financing systems not merely as sources of capital, but as selective mechanisms that shape which sustainability transitions become investable, visible, and scalable. Methodologically, the paper constructs a novel dataset of Nordic and European AgriFoodTech ventures identified through major financing and innovation ecosystems. Firms are coded according to value-chain position (upstream/midstream/downstream), business model, asset intensity, infrastructure intensity, sustainability mechanism, and financing ecology. Preliminary findings suggest substantial variation across financing ecosystems. Venture-oriented ecosystems appear to favor scalable downstream and platform-based optimization models, while public and deep-tech-oriented ecosystems more frequently support infrastructure-intensive, industrial, and biologically embedded sustainability innovations. The paper argues that these financing dynamics have important implications for the directionality, inclusiveness, and governance of sustainable food-system transitions.

Hospital-based farmers' markets as socio-economic food infrastructure: An Italian Initiative between Prevention, Embeddedness and Digital Coordination

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Hospitals can be understood not only as healthcare providers, but as socio-economic infrastructures capable of shaping demand, trust and collective orientations towards sustainable and healthy diets. This paper analyses a farmers' market initiative managed by Coldiretti, Fondazione Aletheia and Campagna Amica and hosted inside hospitals in Italy and supported by a digital platform for ordering, information exchange and logistical coordination. The objective is to examine how hospital-based farmers' markets can align prevention-oriented food environments, territorial value creation and digital innovation, thereby contributing to the debate on matching agri-food systems with ecosystems, health, sustainability and policy goals. The research question is: how do farmers, citizens, healthcare workers and institutional actors interpret the socio-economic value of this initiative and which conditions are needed for the digital platform to scale without weakening the relational proximity of farmers' markets? Farmers' markets are conceptualized as embedded markets, where economic action is shaped by social relations, trust and territorial meanings rather than by price [1,2]. The initiative is interpreted as a process of re-embedding food exchange within public-health institutions. It also extends the "public plate" perspective, which views public food procurement as a lever for sustainability, civic value and territorial development [3]. Short food supply chains are therefore treated as institutional innovations that may redistribute value, improve farmers' bargaining power and produce public goods such as transparency, healthy food access and local resilience [4,5]. This framing is reinforced by evidence on hospital farmers' markets as health-promoting food environments [6]. The study will combine semi-structured interviews with farmers, citizens, healthcare workers, hospital managers and platform organizers; participant observation during market days; and analysis of platform-related communication materials. Data will be analysed through framework analysis, using sensitizing dimensions such as trust, authenticity, convenience, perceived health value, logistics and digital usability. Particular attention will be paid to expectation–outcome misalignments between farmers and citizens. Expected results will identify the socio-economic mechanisms through which the initiative creates value, the factors that might contribute to this scalability, and the digital functions that can support coordination while preserving embeddedness.

Growing with Less: Hydroponic Transitions and Digital Innovation for Resilient Agri-Food Systems in Water-Scarce Regions: Economic, Policy, and Societal Dimensions

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Extended Abstract This paper examines the transition toward resource-efficient agri-food systems in water-scarce and energy-constrained territories, with attention to island and semi-arid regions such as those found in Greece. Conventional agriculture remains dependent on irrigation water, chemical inputs, and fossil-based energy, leading to environmental degradation, production risks, and greenhouse gas emissions. These pressures become acute during periods of tourism demand, when household and tourism uses compete with agriculture for limited water and energy resources. Against this background, the paper investigates whether closed-loop hydroponic systems, combined with renewable energy and digitally enabled monitoring, can constitute an alternative for resilient and sustainable food production. The study addresses not only technical efficiency but also economic, policy, and societal concerns, including food security, affordability, territorial cohesion, and rural resilience in resource-constrained regions. The paper has two objectives. First, it analyses how international and European policy frameworks address hydroponic transitions, digital innovation, climate adaptation, water efficiency, and renewable energy in the move toward sustainable agri-food systems. Second, it evaluates whether these frameworks create enabling conditions for the diffusion of closed-type hydroponic greenhouse-net house systems in territories facing water and energy scarcity. The analysis is guided by three research questions: (1) how do international and European policies frame hydroponic transitions and digital innovation as responses to climate stress, water scarcity, and energy constraints; (2) which policy instruments, regulatory arrangements, and economic incentives support water-saving, low-emission controlled-environment agriculture; and (3) to what extent do these frameworks integrate productivity, environmental sustainability, and social resilience in a coherent manner? The theoretical framework combines agricultural and resource economics, socio-technical transition theory, and policy coherence. Economic analysis focuses on input efficiency, cost structures, investment incentives, risk management, and market failures arising from environmental externalities and uneven access to infrastructure. Socio-technical transition theory helps explain how hydroponics, renewable energy integration, and digital monitoring tools may support a shift from resource-intensive farming toward circular and resilient production systems. Policy coherence is used to assess whether agricultural, climate, water, energy, and innovation policies generate compatible signals across governance levels. Methodologically, the paper adopts a comparative policy analysis of major international and European policy documents, including FAO frameworks on climate-resilient agrifood systems and digital agriculture, the Farm to Fork Strategy, the Common Agricultural Policy 2023–2027, and related sustainability and innovation initiatives. The empirical analysis codes documents for references to water efficiency, renewable energy, circularity, digital innovation, resilience, rural development, affordability, and equity. The paper aims to show that international and European policy agendas increasingly recognise the need for resilient, resource-efficient, and digitally enabled agri-food systems, yet support for integrated hydroponic and renewable-energy solutions remains fragmented. It further aims to demonstrate that hydroponic transitions can reduce water use, improve energy management, enhance productivity, and strengthen local food availability under conditions of scarcity. However, their wider adoption is likely to depend on investment support, technical skills, infrastructure, and stronger regulatory coordination. The paper argues that, in water-scarce regions, growing with less is not merely a technical imperative but an economic, policy, and societal challenge central to the resilience of agri-food systems.

Climate Resilience of Mediterranean Maquis Ecosystems: Evidence from Economic Valuation Studies

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Mediterranean maquis, garrigue and other scrubland formations cover extensive areas across the Mediterranean basin and deliver ecosystem services that rarely appear in any market price. Climate pressures are making this invisibility costly. Wildfires are becoming more frequent and severe, droughts are lasting longer, and rural depopulation is driving land abandonment across the region. Together, these pressures weaken the capacity of scrublands to protect soils, regulate water flows and store carbon. The economic valuation literature has not kept pace. Studies are scattered, methods differ widely, and pulling findings together into anything usable for policy has remained difficult. This paper draws on a systematic review of that literature to ask what we actually know, what we do not, and where the gaps matter most. The review follows PRISMA 2020 guidelines and covers Web of Science, Scopus and Semantic Scholar. Eight exclusion criteria governed the screening, with ecosystem type and geographic scope as the primary filters. Around 37 peer-reviewed articles passed full-text screening and were coded in Atlas.ti using an 84-code codebook organized into ten thematic categories covering valuation methods, ecosystem service types, contextual factors, policy instruments and research design. The analysis concentrates on climate-relevant services: carbon sequestration and storage, wildfire risk regulation, runoff control, aquifer recharge and soil protection. Contingent valuation and choice experiments dominate the monetary estimates. Benefit transfer and carbon market approaches are less common and show wider variance in reported values. Studies cluster around the Iberian Peninsula, with thinner coverage in North Africa and southern France and very little from the eastern Mediterranean. Willingness-to-pay estimates for wildfire risk reduction and carbon sequestration tend to be higher where ecosystem condition is better and management more active, but direct comparison across studies is difficult. Service definitions vary, spatial scales differ, and payment vehicles are inconsistent. Land abandonment keeps appearing as a background condition that raises fire risk and reduces landscape heterogeneity, yet studies that document this rarely attempt to put a number on its economic consequences. That gap between describing a threat and valuing it is probably the finding that will travel furthest from this review. The results are intended to support future valuation research and to provide an evidence base for payments for ecosystem services, agri-environment schemes and land management subsidies in Mediterranean member states. The study is part of the Erasmus+ project MEDSEVA (No. 2024-1-EL01-KA220-HED-000257652).

Developing policy strategies to decrease the consumption of high-water-footprint food

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People are depleting natural resources faster than they can be replenished, causing many negative outcomes. In Europe, especially the Mediterranean, water is the most essential and sensitive resource. Greece, in particular, has documented water shortages, especially on its islands. Applying sustainability principles is the first suggested solution and is central to the United Nations 2030 Agenda, with several of the 17 Sustainable Development Goals tied to freshwater resources. The Water Footprint (WF) serves as an environmental metric to inform the public about water issues and eco-friendly consumption. It measures direct and indirect water use and pollution created during the production of goods or services. Based on the above, this study explores young people's (n=750; Greece) profiles based on their perception of the WF of 21 foods (agriculture, fish, livestock, and foodstuffs); their actual sustainability practices; their materialistic values; as well as their food consumption direction and demographics. Data analysis revealed that the participants were considering themselves to be either individuals who follow a balanced Mediterranean diet (50.9%) or "meat-eaters" (42.7%), with only 6.4% being flexitarian, pescetarian, vegetarian, or vegan. Additionally, they neither agree nor disagree that they are materialistic or a "green" consumer, whereas in all cases, their MV ranged from 3.42 to 4.37. Participants perceive that the majority of the foods presented have neither high nor low WF (15 out of 21 foods) and that six foods tend to have somewhat high WF ($4.51 < MV$).

Consumer Perspectives on Cultured Meat and Seafood: Insights from Consumer Innovation Living Labs in Denmark

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The transition towards more sustainable agri-food systems is supported by the development and societal acceptance of innovative protein alternatives that can address environmental, ethical and food security challenges. Cultured meat and seafood are among these innovations and have attracted increasing attention due to their potential to reduce the environmental impact of conventional animal production. However, consumer acceptance remains crucial for successful market adoption and long-term integration into food systems. This study explores consumer perceptions of cultured meat and seafood and examines communication strategies that could facilitate societal acceptance. The research was conducted as part of the EU-funded FEASTS project (<https://feasts-innovation.eu/>) through Consumer Innovation Living Labs in Denmark. The study adopted a cumulative participatory design in which each phase informed the next and progressively explored consumer perceptions and communication preferences. The process comprised four sequential phases: Workshop 1 identified key barriers and drivers; Co-creation 1 translated these into product concepts; Co-creation 2 explored consumer-led communication narratives; and Workshop 2 examined how naturalness is understood and negotiated in relation to cultured foods. The findings show that Danish consumers evaluate cultured products using a pragmatic, evidence-based framework in which trust, transparency, perceived societal benefits and institutional legitimacy play central roles. Sustainability and animal welfare emerged as important drivers of acceptance, while perceived naturalness remained the most persistent barrier. However, perceptions of naturalness proved to be dynamic and context-dependent rather than fixed. Participants who engaged in discussion and information-sharing demonstrated more considered evaluations and a greater willingness to try cultured products. Consumers preferred balanced, transparent and benefit-oriented communication approaches, emphasising societal and environmental benefits while avoiding overly technical framing. The study contributes to the growing debate on sustainable food system transitions by demonstrating how participatory and co-creative methodologies can support engagement with novel food technologies and align food innovation with broader sustainability objectives.

Diversifying diets and scaling the potential of underutilized crops for sustainable and resilient food systems: insights from the DIVERSICROP action

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Agrifood systems are under pressure from multiple, interlinked challenges such as climate change, declining biodiversity and increasing expectations for secure, high-quality and sustainable food production. Together, these issues underscore the necessity of shifting toward more resilient and diversified food systems that support ecosystem preservation and meet long-term societal objectives. Underutilised crops represent a promising yet underexploited resource for improving dietary diversity, strengthening food security and enhancing agrobiodiversity across Europe. This paper combines insights from the DIVERSICROP action to explore the potential of peas, chickpeas and rye as nutrient-dense, environmentally resilient and culturally relevant crops whose role in modern diets remains limited. Evidence from recent research demonstrates that peas are rich in high-quality protein, dietary fibre, vitamins, minerals and bioactive compounds with antioxidant and anti-inflammatory properties. Chickpeas provide valuable protein and micronutrients, with processing techniques such as soaking, fermentation and cooking helping to reduce antinutritional factors and improve nutrient bioavailability. Rye contributes high levels of dietary fibre and functional compounds associated with digestive and cardiovascular health, while supporting resilient cereal production systems. Beyond nutritional and agronomic benefits, the successful integration of underutilised crops requires coordinated action across social, economic and institutional dimensions. Awareness-raising activities, capacity-building initiatives and interdisciplinary collaboration are essential for equipping stakeholders with the knowledge and skills needed to support diversification. Partnerships among farmers, producers, consumers, researchers and policymakers can create enabling environments for innovation, while targeted communication strategies help address misconceptions and highlight culinary versatility and health benefits. Mechanisms such as farmer incentives, educational programmes, public procurement, school feeding schemes, and improved market access are critical for scaling adoption. To translate scientific knowledge into practical dietary solutions, the DIVERSICROP network is developing a collaborative European cookbook that combines traditional and innovative recipes featuring these crops, linking nutritional science with culinary heritage and sustainability. At the same time, digital innovation, particularly artificial intelligence, offers new opportunities to accelerate this transition by supporting knowledge transfer, identifying context-specific sustainable practices, and enabling data-driven decision-making across value chains. Aligned with global biodiversity and climate commitments, this work moves beyond individual project outcomes to outline a strategic pathway for mainstreaming underutilised crops. Integrating biodiversity, policy frameworks, culinary innovation and digital tools can unlock their full potential, contributing to healthier diets, empowered rural communities, and more resilient and sustainable agri-food systems.

From Guideline Visibility to Dietary Pathways: Mapping Pea, Chickpea and Rye in European Sustainable Diet Transitions

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Objectives: The transition towards healthier and more sustainable European diets requires a closer understanding of how nutritionally valuable and environmentally resilient crops move from scientific and agricultural relevance to everyday dietary practice. This study focuses on pea, chickpea and rye as three underutilised crops with potential to support dietary diversification, plant-protein strategies, whole-grain intake and more resilient food systems. The objective of the study is to present an integrated policy–supply–consumption perspective on these crops by examining their representation in dietary guidance, availability in food balance data, appearance in food consumption datasets, and emerging role in food markets. **Research questions:** The study addresses four interrelated questions: How visible are pea, chickpea and rye in European Food-Based Dietary Guidelines? Are these crops named directly, embedded within broader food groups, or absent from consumer-facing dietary communication? How do production and domestic supply patterns compare with actual dietary exposure across European regions? Finally, what mismatches can be identified between policy visibility, agricultural availability, nutritional relevance and market development? **Theoretical framework:** The analysis is grounded in the concepts of sustainable healthy diets and nutrition-sensitive crop diversification. It also applies a Farm-to-Fork perspective, treating dietary guidance, agricultural supply, food composition, consumption pathways and market transformation as connected stages within the same food-system chain. Within this framework, “visibility” is understood not only as the presence of a crop in data or policy documents, but as its symbolic, nutritional and practical recognisability to consumers, policymakers and food-system actors. **Methodology:** The study combines two complementary case studies. First, a structured content analysis of European Food-Based Dietary Guidelines is conducted using official national documents retrieved from international repositories and national authorities. The analysis classifies the representation of the three crops as explicit, implicit or absent, and examines their positioning within food-group structures, visual models and health, sustainability or cultural narratives. Regional comparisons are made across Nordic/Baltic, Western/Central, Southern/Mediterranean and Central/Eastern/SEE regions. Second, a cross-country Farm-to-Fork data analysis links FAOSTAT Food Balance Sheets, EFSA food consumption data, international food composition databases - EuroFIR and FAO/INFOODS, and selected market trends analyses. This enables assessment of production, domestic supply, intake pathways, nutritional contribution and industry uptake, including cases where crops appear as ingredients in composite foods rather than as stand-alone foods. **Results:** The study shows that pea, chickpea and rye are present in European food systems, but not consistently visible across policy, dietary and market domains. Rye is strongly associated with Northern, Baltic and selected Central European dietary traditions, while chickpea visibility is pronounced in Mediterranean contexts. Peas appear widely, but often under generic legume or plant-protein categories. A visibility gap is identified - crops are cultivated, supplied or consumed indirectly, yet remain weakly communicated in national dietary guidance and while their varieties are difficult to trace in harmonised databases. The study highlights ways to improve crop-specific dietary communication, strengthen nutrition databases, and align crop diversification with public health, One Health and European food-policy goals. **Key words:** Underutilised crops; Food-Based Dietary Guidelines; Sustainable healthy diets; Dietary consumption patterns; Farm-to-Fork food systems

Posters

Enhancing consumer acceptance of underutilized crops through sensory science, hybrid food design and AI-driven innovation for sustainable diets

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Integrating underutilized crops into modern diets is essential for improving dietary diversity, nutritional quality and the sustainability of food systems in the context of biodiversity loss, climate change and reliance on a narrow range of staple crops. These global pressures threaten ecosystem stability and limit food system resilience. This study proposes an innovative multidisciplinary framework that positions taste preferences as a key but often underestimated driver of dietary change and sustainable food system transformation. The framework demonstrates how underutilized crops can be integrated into everyday diets through the development of appealing recipes and hybrid or blended food products that combine them with familiar ingredients (e.g., buckwheat-wheat pasta or lentil-chickpea burgers). These approaches provide a pragmatic strategy to enhance consumer acceptance while maintaining sensory quality. Crops such as lentils, buckwheat, sowthistle, Armenian cucumber, white eggplant and other locally adapted species are incorporated into dishes that combine traditional food culture with modern food innovation. Sensory evaluation and consumer testing are central to this approach, enabling assessment of taste, texture, aroma and nutritional perception. Evidence from sensory panels, focus groups and home-cooking trials across different European regions highlights the importance of cultural context, food heritage and familiarity in shaping acceptance. Repeated exposure and demographic-specific studies further improve understanding of consumer preferences and adoption pathways. Beyond conventional sensory analysis, the framework expands to include affective and cultural dimensions such as emotion, nostalgia and social associations, as well as ethnographic approaches that capture regional food identities. Emerging tools, including digital sensory platforms, at-home testing, virtual panels and artificial intelligence, together with advanced technologies such as electronic noses, electronic tongues and biometric feedback systems, offer new opportunities to enhance the precision, scalability and inclusiveness of sensory research. Participatory and co-creation approaches, including citizen science and consumer co-design, strengthen cultural relevance and innovation in product development, packaging and communication. At a systems level, integrating underutilized crops requires coordinated action across supply chains, certification schemes, marketing strategies and education initiatives promoting biodiversity and sustainable diets. Overall, the findings demonstrate that aligning sensory science with nutritional, cultural and environmental objectives enables underutilised crops to be positioned as both desirable and sustainable food options. Taste emerges as a central lever for dietary transition, while AI-enabled and interdisciplinary approaches accelerate the development of culturally meaningful, nutritionally valuable and widely accepted sustainable food solutions.

The Second Harvest: Farmer-Centric Circular Data Governance in Compliance-Driven Agricultural Value Chains

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The digital transformation of agriculture has created a new layer of economic value: farm-level data. Smallholder producers increasingly generate data through geolocation, satellite monitoring, certification systems, and compliance platforms, yet they remain structurally excluded from the economic returns such data creates. In this paper we develop the idea of circular data as a vehicle for economic empowerment of smallholder producers. Our arguments are based on circular economy, platform ecosystem research and transaction costs theory. We argue that agricultural data currently follows a linear extraction logic: it is collected from producers, processed by intermediaries, monetised in compliance and commercial markets, and rarely returned to its origin. By applying circular economy principles to data governance, we propose that farm-level data should circulate back to producers in forms that generate economic empowerment, including royalty income, improved decision-making, stronger market positioning, and access to financial services. We present an illustrative platform ecosystem that operationalises circular data through three mechanisms. First, coopetition governance enables cooperatives to share common data standards while competing through individual market relationships. Second, the servitisation of compliance data allows the platform to sell verified outcomes rather than transferring the underlying asset. Third, reinforcing feedback loops compound the value of data over time by increasing its reuse across regulatory, commercial, and financial applications. The European Union Deforestation Regulation, entering application on 30 December 2026, provides the regulatory forcing function that makes this circular model commercially viable without requiring philanthropic subsidy. The paper argues that when circular data governance is encoded as structural design rather than discretionary policy, compliance infrastructure can become a mechanism for producer economic inclusion. Implications are drawn for platform design, agricultural data governance, and the emerging regulatory landscape of EU supply chain due diligence.

Market Integration of Buckwheat-Based Foods: Consumer Insights from Five European Countries

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Agri-food systems across Europe remain highly dependent on a limited number of staple crops, contributing to biodiversity loss, reduced dietary diversity, and increased vulnerability to environmental and market shocks. Underutilized crops such as buckwheat (*Fagopyrum esculentum*) offer significant potential to support more resilient food systems while creating opportunities for farmers, processors, and rural communities. Despite its nutritional and environmental benefits, buckwheat remains underrepresented in European diets and food markets. Understanding consumer acceptance is therefore essential for its wider adoption and market integration. This study explores the role of consumer-oriented food innovation in promoting agrobiodiversity and integrating buckwheat-based products into European food systems, examining how sensory, cultural, and market factors shape their uptake and support sustainable value chains and biodiversity-enhancing crops. The research was conducted within the Horizon Europe BioValue project using a mixed-methods approach. Five buckwheat-based dishes were developed and evaluated: Buckwheat and Grass Pea Stew with Eggplant, Buckwheat Pockets Filled with Walnuts and Dried Fruits, Buckwheat Pretzels with Sonchus and Sundried Tomatoes, Buckwheat Pasta with Eggplant and Tomatoes, and a Vegan Burger with Eggplants, Lentils and Buckwheat. Consumer acceptance was assessed through sensory evaluations in Serbia, Greece, France, Hungary, and Türkiye, while qualitative insights were obtained through focus groups and home-cooking trials. Recipe dissemination through social media and online platforms additionally provided insights into consumer engagement and practical adoption. Results revealed substantial cross-country differences in consumer preferences. Buckwheat Pockets Filled with Walnuts and Dried Fruits achieved the highest overall acceptance, with average scores above 6 on a 7-point hedonic scale and particularly strong ratings in Serbia and Hungary. In contrast, Buckwheat and Grass Pea Stew with Eggplant received lower evaluations in France and Türkiye, while Serbian consumers assigned the highest ratings for taste, aroma, texture, and overall acceptability. Buckwheat Pasta with Eggplant and Tomatoes and the Vegan Burger with Eggplants, Lentils and Buckwheat were significantly better evaluated in Greece than in Serbia. Focus-group discussions showed that consumers associated buckwheat with nutritional quality, sustainability, biodiversity conservation, and gluten-free diets, and were more willing to adopt it when incorporated into familiar food formats. The findings suggest that introducing underutilized crops through culturally familiar products can increase consumer acceptance and support dietary diversification. Acceptance was highest in countries where buckwheat has a stronger culinary tradition, particularly Serbia and Hungary, while lower familiarity in France and Türkiye represented a greater barrier to adoption. The study highlights opportunities to strengthen local value chains, improve consumer education, expand retail availability, and increase demand for biodiversity-enhancing foods. The results demonstrate that agrobiodiversity can be a source of market value, rural economic opportunities, and sustainable growth supported by product innovation and coordinated value-chain development.

Smart Hops for a Sustainable Future: Mapping the Role of AI and Digital Tools in Climate Adaptation

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Climate change is increasingly reshaping agricultural production systems worldwide, creating substantial challenges for climate-sensitive crops such as hop (*Humulus lupulus*), whose productivity, quality, and economic value depend heavily on environmental conditions. Rising temperatures, altered precipitation patterns, prolonged droughts, and more frequent extreme weather events are already affecting hop-growing regions across the globe. Recent studies have reported notable declines in both hop yields and alpha-acid content in major European production areas, raising concerns about future productivity and product quality. These trends underscore the urgent need for innovative adaptation strategies that enhance climate resilience while promoting sustainable and ecosystem-based agricultural management. At the same time, advances in artificial intelligence (AI), precision agriculture, remote sensing, Internet of Things (IoT) sensors, and data-driven decision-support systems are creating new opportunities for improving the sustainability and resilience of hop production. These technologies can support real-time monitoring of crop growth, soil moisture, pest and disease outbreaks, and climatic conditions, enabling more precise management of irrigation, fertilization, and plant protection practices. Such innovations have the potential to reduce resource use, increase production efficiency, and strengthen the adaptive capacity of hop-growing systems under changing environmental conditions. Despite these promising developments, knowledge remains fragmented regarding how digital technologies are being applied in hop production, their contribution to climate adaptation and environmental sustainability, and their alignment with broader policy objectives related to sustainable agri-food systems and the Sustainable Development Goals (SDGs). This study presents a comprehensive scoping review of peer-reviewed literature published between 2010 and 2026 on hop (*Humulus lupulus*) production, with particular attention to the adoption of digital technologies and adaptation to climate change. Following PRISMA-ScR guidelines, scientific publications were systematically identified from Science Direct, Scopus, Web of Science and Google Scholar. Bibliometric and thematic analyses were conducted to map the evolution of research, identify dominant areas of inquiry, and highlight emerging trends and knowledge gaps. Particular emphasis was placed on understanding how technological innovations can support climate-resilient hop production, improve resource-use efficiency, maintain yield and alpha-acid quality, and contribute to broader sustainability and policy objectives within agri-food systems. Preliminary findings indicate a rapid increase in publications after 2020, reflecting growing concerns regarding climate-induced risks to hop production and increasing interest in digital transformation within agri-food systems. Studies consistently highlight the potential of AI-based forecasting models, remote sensing applications and digital image processing technologies to improve water management, disease detection, yield prediction, nutrient monitoring, and adaptive decision-making under changing climatic conditions. Recent development demonstrates how advanced sensor systems can provide real-time information on plant physiological status, soil conditions, and microclimatic factors, enabling a deeper understanding of crop responses to weather variability and environmental stress. By synthesizing sixteen years of research on hop production and digital agriculture, this study highlights emerging opportunities for integrating AI-driven solutions into climate adaptation strategies within the hop sector.

Cooperatives as Innovation Ecosystems in Dairy Farming: Evidence from Greece's Sustainable Livestock Transition

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The transition toward sustainable livestock systems requires more than the mere availability of new technologies and is increasingly understood as a broader socio-technical transition process involving knowledge diffusion, collaboration, and behavioral change among stakeholders (Vermunt et al., 2020). Agricultural cooperatives are increasingly recognized as important intermediaries that facilitate sustainability transition and innovation diffusion within agri-food systems through collective action, knowledge exchange, and farmer coordination (Bijman & Höhler, 2023; De Herde et al., 2020). This study investigates the role of cooperative dairy systems in shaping innovative behavior among livestock farmers in Greece. The research is based on primary quantitative data collected from members of major Greek dairy cooperatives. The analysis explores how cooperation, social influence, access to knowledge, technological orientation, and perceptions toward sustainability affect the adoption and diffusion of innovation within livestock production systems. The study examines multiple dimensions of innovation adoption, including animal nutrition, reproduction management, animal health, farm management technologies, digital practices, and environmentally oriented production methods. Particular emphasis is placed on the role of cooperatives in facilitating knowledge exchange, technical support, farmer interaction, and trust-building processes that may enhance innovation readiness among producers. Recent literature suggests that smart livestock technology adoption is strongly influenced by social interaction, support mechanisms, and farmer networks rather than technological availability alone (Dilleen et al., 2023). The findings suggest that innovation adoption in livestock farming is not driven exclusively by economic incentives or technological availability. Instead, social interaction, cooperative participation, peer influence, and access to training appear to play a critical role in shaping farmers' willingness to adopt innovative practices. Cooperative structures seem to strengthen innovation diffusion mechanisms by creating networks of communication and collaboration that reduce perceived risk and improve confidence in technological change. These findings align with emerging perspectives that conceptualize agricultural innovation as the outcome of interconnected innovation ecosystems involving producers, institutions, and knowledge-sharing networks (Misra & Wilson, 2023). The results further indicate that farmers with stronger technological orientation and greater engagement with cooperative support mechanisms demonstrate higher levels of innovation readiness and sustainability awareness. At the same time, barriers such as financial constraints, uncertainty regarding investment outcomes, limited access to specialized training, and resistance to change continue to impede the transition process. This study contributes to the growing discussion on sustainable livestock transition by proposing a broader understanding of cooperatives as innovation ecosystems within rural production systems. The findings highlight the importance of cooperative-based knowledge networks in supporting technological transformation, sustainability pathways, and long-term resilience in dairy farming, which are increasingly recognized as critical priorities for the future of sustainable agri-food systems (Klerkx & Leeuwis, (2009).

Pre-Conference Project Side Events

A Comparative Analysis between Kasseri PDO cheese and Mila Zagoras Piliou PDO apples

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Protected Designation of Origin (PDO) products play a significant role in promoting rural development, preserving cultural heritage, and enhancing the sustainability of agri-food systems. This study presents a comparative analysis of two Greek PDO products representing different agri-food sectors, Kasseri PDO cheese and Mila Zagoras Piliou PDO apples. The comparison aims to examine similarities and differences in their governance structures, value chain organization, sustainability performance, stakeholder perspectives, and future development opportunities. The analysis is based on the comparative framework developed within the GI-SMART project and integrates information from product specifications, governance structures, value chain characteristics, sustainability dimensions, stakeholder workshops, and SWOT analysis. The comparison considers environmental, economic, and social sustainability alongside institutional organization and governance mechanisms. The findings reveal two distinct models of geographical indication management. Kasseri PDO is characterized by a fragmented governance structure involving multiple dairy processors and livestock farmers, with strong dependence on traditional pastoral systems and export-oriented production. In contrast, Mila Zagoras Piliou PDO operates through a highly coordinated cooperative model led by the Zagorin Agricultural Cooperative, ensuring centralized decision-making, effective traceability, and strong producer coordination. Both products demonstrate substantial contributions to regional identity, cultural heritage preservation, and rural employment while maintaining high product quality standards. Despite their differences, both PDO systems face common challenges associated with climate change, increasing production costs, labour shortages, demographic decline, and the need to improve long-term economic resilience. The comparative assessment also highlights sustainability trade-offs, including higher production and storage costs associated with quality improvements and environmentally friendly production practices. Overall, the study demonstrates that geographical indications can effectively support sustainable territorial development when supported by appropriate governance mechanisms, stakeholder collaboration, and continuous adaptation to emerging environmental and economic pressures. Strengthening producer cooperation, investing in climate adaptation measures, enhancing digital traceability, improving sustainability reporting, and attracting younger generations into agriculture are identified as key priorities for ensuring the long-term competitiveness and resilience of both PDO systems.

Beyond Product Specifications: Stakeholder Perspectives on Sustainability in the Mila Zagoras Piliou PDO

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The integration of sustainability into Geographical Indications (GIs) has become an increasingly important objective of European agri-food policy, particularly following the adoption of Regulation (EU) 2024/1143. Product Specifications constitute the legal foundation of Protected Designations of Origin (PDOs), defining product characteristics, production methods and the geographical link. However, limited empirical evidence exists on how stakeholders perceive the relationship between Product Specifications, current production practices and sustainability. This study addresses three research questions: (i) to what extent does the current Product Specification of the Mila Zagoras Piliou PDO reflect sustainability-related production practices; (ii) how do stakeholders perceive the evolution of the production system since the original PDO registration; and (iii) what are stakeholders' views regarding the future evolution of Product Specifications in supporting sustainability while preserving product authenticity and territorial identity. The research was conducted within the Horizon Europe GI-SMART project using a qualitative case study approach. Data were collected through documentary analysis of the official Product Specification and related regulatory documents, complemented by an online stakeholder survey and a participatory workshop involving representatives of the producer cooperative, public administration and agricultural experts. The findings indicate that the current Product Specification establishes a comprehensive framework for safeguarding product identity, quality, traceability and production requirements, including cultivation and plant protection practices. At the same time, stakeholders observed that the production system has evolved since the original PDO registration through the wider application of Integrated Production Management and the strengthening of cooperative coordination in quality management and producer support. Participants considered that future revisions of Product Specifications could provide opportunities to better reflect the evolution of production practices while maintaining the product's authenticity, quality and geographical link. This study contributes to the ongoing discussion on the governance of Geographical Indications by highlighting the value of stakeholder perspectives in understanding the relationship between Product Specifications and the evolution of production systems. The findings provide useful insights for future discussions on the development of mature PDO systems within the evolving European policy framework.

Diversified Legume-Based Systems Enhance Productivity and Adaptation under Mediterranean Conditions

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Mediterranean agriculture is increasingly challenged by elevated temperatures, reduced rainfall, and greater climatic variability, which threaten crop productivity and system stability. Legumes play an important role in sustainable agriculture through crop diversification, biological nitrogen fixation, and biomass production. However, the adaptation of legume-based systems to Mediterranean environments depends strongly on species composition and cropping strategy. The objective of this study was to evaluate the productivity and adaptation of annual and perennial legume-based systems and to identify diversification strategies suitable for Mediterranean environments within the framework of the LEGENDARY project. Field experiments were conducted in 2025 at an experimental field in Orestiada, Greece. Perennial systems included red clover (NS Sana, Callisto) and white clover (Rivendel, Silvester) grown as pure stands and in mixtures with festulolium (Lofa) under different nitrogen inputs (0 and 20 kg N ha⁻¹), together with pure festulolium stands receiving 20 or 50 kg N ha⁻¹. Annual systems included field pea (Angelus, Mythic) grown as sole crops or intercropped with barley (Mariola), and faba bean (Lynx, Trumpet) grown as sole crops or intercropped with oat (Lion). Aboveground biomass, persistence, and total dry yield were evaluated under Mediterranean field conditions. The performance of legume-based systems varied considerably among species, cultivars, and cropping strategies. In annual systems, intercropping generally increased total dry yield, although the magnitude of the response depended strongly on genotype. Total dry yield increased from 1.63 to 2.82 t ha⁻¹ for Mythic and from 0.25 to 3.78 t ha⁻¹ for Angelus in mixtures with barley. Similarly, total dry yield increased from 2.30 to 3.20 t ha⁻¹ for Lynx in mixtures with oat, whereas Trumpet showed only a limited response (2.50 vs. 2.57 t ha⁻¹). These contrasting responses highlight the importance of genotype selection. Perennial systems also benefited from diversification. During the first cut, total aboveground biomass ranged from 128 to 317 g m⁻² in pure clover stands, whereas mixtures with festulolium produced up to 621 g m⁻². Festulolium biomass exceeded clover biomass at both cuts, indicating a strong contribution of the grass component to total productivity. Nitrogen fertilization further increased the dominance of festulolium within the mixtures, whereas the relative contribution of clover declined. Summer xerothermic conditions reduced regrowth after the first cut. Across all treatments, clover biomass declined by 27.9% between cuts, compared with a reduction of only 10.3% for festulolium, indicating greater tolerance of the grass component to heat and water stress. Furthermore, red clover exhibited greater persistence than white clover across cuts, suggesting superior adaptation to Mediterranean conditions. Diversified legume-based systems represent a promising strategy for Mediterranean agriculture. Legume–cereal mixtures enhanced total dry yield and reduced the risk of low productivity under adverse environmental conditions, while perennial mixtures improved persistence under heat and water stress. Species and genotype selection emerged as critical factors determining system performance and adaptation under Mediterranean conditions.

The Strategic Role of Legumes in the European Union Through the Lens of Competitiveness and Policy: The Greek Case

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The growing interest in legumes within the European Union reflects broader concerns related to food security, strategic autonomy, environmental sustainability, and the resilience of agri-food systems. Despite their recognized environmental and nutritional benefits, the European legume sector continues to face significant structural and economic challenges. The present study examines the position of legumes in the European Union by combining an assessment of sectoral competitiveness with an analysis of the evolving policy framework supporting protein crops and legumes. Its main objective is to explore how current policy priorities interact with existing market conditions and structural characteristics of the sector. Particular attention is given to the relationship between competitiveness performance, structural constraints within supply chains, and the policy instruments currently promoted at both European and national levels to support the development of the legume sector. The study is informed by theoretical perspectives on agri-food competitiveness, food system resilience, and strategic autonomy. Methodologically, it adopts a mixed analytical approach. First, the competitiveness of the European legume sector is assessed through a set of economic indicators covering the period 2018–2022. This analysis is complemented by an examination of the main structural characteristics and bottlenecks affecting legume value chains. Subsequently, the study investigates the policy framework shaping the future development of legumes in Europe, focusing on the Common Agricultural Policy 2023–2027, the European Green Deal, the Farm to Fork Strategy, and the EU Biodiversity Strategy. Finally, Greece is examined as a case study illustrating how broader European priorities are translated into national strategies, targeted support measures, and biodiversity-oriented interventions. The findings reveal that the European legume sector remains characterized by low levels of protein self-sufficiency, high import dependency, limited international competitiveness, and persistent weaknesses across supply chains. Structural constraints include fragmented production systems, insufficient processing capacity, weak market integration, and limited bargaining power. At the same time, recent European policy developments demonstrate an increasing recognition of legumes as a strategic component of sustainable food systems, biodiversity protection, climate adaptation, and protein autonomy. The Greek case further illustrates how national strategic plans can operationalize broader European objectives through coupled support schemes, rural development measures, biodiversity conservation initiatives, and targeted support for traditional and geographically indicated legume products. The results suggest that the future competitiveness of legumes in Europe will depend not only on increasing production capacity, but also on the ability to strengthen value-chain integration, reduce structural dependencies, and align agricultural, environmental, and food policies within a coherent strategic framework.

Towards disruptive changes in the food value chain in order to make it more sustainable

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The food value chain is the backbone of society but far from aligned with the Paris climate targets or the European Commission's Green Deal. About $\frac{1}{3}$ of greenhouse gas emissions (GHG) are emanating from it globally. About half are due to meat production which appropriates about 80% of agricultural land for feed production. The high land use is associated with biodiversity loss and natural habitat destruction. The unsustainable trajectory of meat production may be disrupted either by policy makers that bring agriculture in line with climate policies, or consumers that shy away from meat products for climate, health or animal welfare reasons, or innovators or incumbents that use new technologies to substitute meat products by offering the same sensual experience at lower cost and superior quality. Agricultural policy reacted to environmental harm exerted by agriculture by launching voluntary agri-environmental programmes. In addition, farm payments were made contingent upon compliance with environmental legislation that has become ever more stringent (e.g. Nitrates Directive, Water Framework Directive). However, data suggest that agriculture, the food industry and the respective policy fields are on a collision course with climate targets. In order to reach the emission reduction targets of the EU in 2030 and 2050 a new pathway of the European farm and food system is needed which overcomes the shortcomings of the current system and contributes to tackling the "triple challenge" of providing food security and nutrition for a growing population; providing livelihoods people involved in farming and along the food chain, and contributing to environmental sustainability. So far, progress towards GHG reduction from the food value chain has been very small globally and in Europe too. Today, the agricultural sector contributes to 10% of greenhouse gas emissions in the EU. The largest share is due to methane emissions from cattle and the management of farm manure. This invited talks session explores the potentially disruptive impact of regulators, incumbents, startups or consumers and elaborates diffusion curves for meat alternatives based on in-depth analyses of these potential disruptors. The focus of the talks are twofold: a) options to make the transition towards a more sustainable food system feasible and an exploration of their economic impacts on the value chain and b) novel approaches to measure GHG emission on farms more effectively. A frequently overlooked topic are opportunities for an industrial policy with respect to alternative proteins. Natural Language Processing Approaches in combination with LLMs demonstrate that this is one of the few areas where European firms are close to the frontier. Advanced and focused industrial policy is needed to keep this position against rapidly catching-up Asian countries.

Assessing the Agrobiodiversity of Greek Crop Wild Relatives in Sustainable Leafy Vegetable Production

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Greece represents a critical Mediterranean hotspot for plant agrobiodiversity, harbouring an extensive array of crop wild relatives (CWRs) directly linked to staple and speciality leafy vegetables, including brassicas, chicory, and amaranth. These wild populations are reservoirs of valuable genetic variation, offering untapped traits for climate resilience, including drought tolerance and disease resistance, which are increasingly essential for modern crop improvement. This study explores the urgent need for comprehensive in situ and ex situ conservation strategies to protect these vulnerable genetic resources from habitat loss and anthropogenic erosion. Furthermore, we discuss interdisciplinary approaches that integrate Traditional Ecological Knowledge (TEK), ethnobotanical documentation, genomic characterisation, and phenotypic evaluation to support the conservation and sustainable use of CWRs and facilitate the introgression of beneficial wild alleles into domesticated cultivars. Traditional ecological knowledge held by local communities and foragers provides valuable insights into species distribution, ecology, seasonal availability, and utilisation practices, complementing scientific research and conservation planning. By bridging TEK, traditional foraging knowledge, and modern plant breeding, the utilization of Greek CWRs can significantly broaden the genetic base of commercial leafy vegetables. Ultimately, this research highlights the importance of valorising these neglected wild relatives to support sustainable agricultural transitions, strengthen biocultural heritage, and enhance global food security.

Improving literacy in (agro)ecology using legumes as a common thread: a necessary first step towards promoting their consumption and production

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Legumes are a treasure: not only because of the multitude of ecosystem services they provide, but also because they are the perfect subject of study for connecting the public with ecology – both in its simplest forms and in its most complex interactions – in a way that is accessible and appealing. Legumes have been part of human life since ever, as demonstrated by the numerous traditional recipes, songs and proverbs that refer to both domesticated and wild species. However, as with other elements of nature, they are becoming largely unknown to the public nowadays, as a result of a growing disconnect between humans and their natural environment. Lack of knowledge leaves the population vulnerable. Knowledge makes us powerful. The LegumES project operates within this framework, highlighting the ecosystem services provided by legumes. This is an academic, abstract and often debated concept, which is difficult to convey to the general public. Legumes provide a starting point, beginning with socio-cultural ecosystem services — such as recipes handed over from previous generations — and, from there, serving as a common thread leading to more complex concepts, as well as highlighting the value of a region's cultural and intergenerational diversity. This is precisely one of the aims of the 'Farmland Biodiversity for Rural Wellbeing' living lab, coordinated by Aprisco, whose participation in LegumES seeks to identify the value that legumes bring to the population of northern Extremadura (Spain) and highlight this value for each stage of the entire value chain. The ultimate aim is to increase ecological literacy amongst the rural population, using, in this case, legumes as a common thread. Rural areas provide the ideal setting for launching local initiatives — small in scale but profound in their transformative potential — that draw on the knowledge still alive regarding these plants, both in the kitchen and on farm, and link it to the scientific knowledge generated within those same territories. Furthermore, the rural context offers several characteristics that provide added value: it enables the needs of the entire value chain to be met within a single territory; it builds on end-users who already have a fairly close connection with the natural environment around them; and it facilitates unique channels of knowledge transfer, such as reaching producers through their children's schools. If we want to promote sustainable food systems, we must promote rural development based on the science of agroecology that improves the quality of life of rural citizens. As a first step, it is essential to disseminate the knowledge generated in research in the territory to the inhabitants of this territory, thereby fostering a closer link between research and the public and to ultimately increase the perceived value of science. To this end, legumes can serve as an educational tool that can reach all the inhabitants of a region. In short, legumes can act as a bridge between science and the public, increasing (agro)ecological literacy, constituting this a necessary first step towards promoting both their consumption and their production.

Bridging Crop Wild Relatives Research and Policy: Evidence, Gaps and Pathways for Conservation and Sustainable Use

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Crop wild relatives (CWRs) are increasingly recognised for their contribution to biodiversity conservation, crop improvement, climate adaptation and food-system resilience. However, their growing scientific recognition has not been accompanied by an equally developed understanding of how CWR-related evidence can be integrated into policy frameworks. To address this issue, this paper synthesises 101 peer-reviewed studies, combining bibliometric mapping with structured thematic synthesis to examine how CWR research informs policy-relevant debates. By connecting dispersed strands of evidence across environmental, economic and societal dimensions, the paper clarifies how existing research can better support the conservation and sustainable use of CWRs. The synthesis shows that the policy relevance of CWR research is not absent but remains fragmented and unevenly connected to the conditions required for policy integration. The review therefore reframes the CWR policy challenge as one of translation: turning dispersed scientific knowledge into the governance capacity, institutional coordination and implementation pathways needed to support the conservation and sustainable use of CWRs.

Unravelling the impacts from a European food data ecosystem – A comparative case study

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The data ecosystem is a concept based on information systems and data and it has become a novel concept in the recent, contemporary literature. The key perspective is that this ecosystem focuses on data which become a strategic resource allowing supply chain members / actors to work together to increase the value emanating from this resource. This is different to a traditional model of data exchange which is driven by the supply-demand of data; this data ecosystem aims to co-create and support the co-evolution of all actors related to data generation and exchange. These data ecosystems can be seen in contemporary public and private settings but their wider implementation in businesses is to be seen providing a major research gap to be examined. This work will fill this research gap in the current literature and it will try to answer the following research question: “How can the ECOREADY project's data ecosystem support food supply chain members and what capabilities and approaches are required”. A multiple and cross-case study approach is an appropriate method to explore this research question. This approach is based on the application of a digital platform (Observatory), which is developed by the ECO-READY project involving European food supply chain members but with a focus on the food production node. The Observatory is our primary data ecosystem and it includes 10 European Living Labs examining important issues impacting food supply chains including, inter alia, food security, climate change, and biodiversity. This multiple and cross-case study will be based on primary and empirical data provided by these 10 Living Labs. Findings and originality The paper will shed light on this research gap and it will showcase the major capabilities of the ECOREADY data ecosystem including food supply chain management issues focusing on strategic and operational dimensions. The paper will also unravel the capabilities and processes required to be implemented via this data ecosystem in order to support food supply chain members especially at the farm production gate as well as to illustrate the relationships with the downstream food supply chain members. This paper aims to enhance the current and ongoing scientific discussions related to the development and implementation of a original data ecosystem in food supply chains. Although the focus is on farm production we are confident that our work will generate significant implications for the wider, post-farm gate supply chain. Practical impact This work will support managers and practitioners working in the food supply chain who aim to develop and implement a data ecosystem platform which will, in turn, enhance operation and supply chain performance.

Engineering AI-Ready Knowledge Ecosystems for Agricultural Innovation: A Digital Framework for Research-to-Practice Transfer

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Sustainable agricultural innovations often fail to achieve widespread adoption because scientific knowledge is fragmented, difficult to access, and insufficiently adapted to farmers' practical needs. This paper presents the digital knowledge infrastructure developed within the Horizon Europe Crop-MATCHING project as a scalable framework for transforming evidence-based agricultural practices into accessible, multilingual, and reusable digital learning resources. The proposed architecture integrates validated knowledge curation, structured metadata, microlearning modules, collaborative digital communities, and learning analytics to support knowledge transfer across diverse agricultural contexts. Beyond delivering educational content, the platform establishes an AI-ready knowledge base capable of supporting future recommendation systems and digital advisory services aligned with the European Agricultural Knowledge and Innovation System (AKIS). The paper discusses the design principles, digital components, and expected contribution of this approach to accelerating the adoption of sustainable farming practices while providing a transferable model for future digital agricultural extension initiatives.

Conservation and use of crop wild relatives for sustainable agriculture in the BiodivRural Living Lab in Spain

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Crop wild relatives (CWRs), counterparts to domesticated crops, are a valuable source of genetic variation in agriculture. However, their utilisation presents challenges. The EU-funded COUSIN project aims to demonstrate the use of CWRs for breeding and farming through COUSIN readiness levels (CRLs). Focused on wheat, barley, pea, lettuce, and brassicas, it demonstrates how CWRs can address agricultural challenges. Based on the activities conducted over the first two and a half years in the BiodivRural Living Lab, an Agroecology Partnership living lab in Extremadura (Spain), we provide a brief overview about the ex-situ and in-situ conservation of crop wild relatives and their use in plant breeding and direct farming, facilitated through extensive phenotyping activities of CWRs and subsequent breeding material in the lab, high-throughput facilities and experimental outdoor gardens. Furthermore, we show how the research activities of COUSIN in the Living Lab are used to raise awareness about the value of biodiversity for food security among different target groups, including children, tourists and conservation agencies. These communication and dissemination activities focus on aspects such as genetic diversity, domestication, breeding, or the conservation of plant genetic resources.