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ORIGINAL ARTICLE **OPEN ACCESS**

Agricultural Economics and the Transformation Toward Sustainable Agri-Food Systems

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ABSTRACT

Agri-food systems around the world are facing a sustainability crisis. Addressing the many interconnected issues requires fundamental transformations, moving beyond incremental improvements of various details toward broader and more profound systemic change. In this article, which is also the introduction to the ICAE 2024 Special Issue, we explore the role of our agricultural economics profession in shaping these transformation processes, examining how our discipline contributes to understanding agri-food system dynamics and identifying opportunities to enhance sustainability and resilience. We argue that agricultural economists can and should play a more central role in international agri-food systems research and policy initiatives by integrating multiple sustainability goals and metrics with rigorous economic analysis. Interdisciplinary cooperation with colleagues in agronomy, nutrition, environmental sciences, social and political sciences, and other relevant fields is necessary, as is the further development and use of data-driven approaches. However, equally important is maintaining strong theoretical foundations to develop hypotheses and understand behavioral mechanisms. Close exchange with nonacademic stakeholders at all system levels is key for policy relevance. We also provide an overview of the plenary papers presented at ICAE 2024 on various facets of agri-food system transformation and sustainable development.

1 | Introduction

Current agri-food systems are not sustainable, neither in terms of reaching important nutrition and human health goals, nor in terms of operating within the planetary boundaries. More than 700 million people are currently affected by chronic undernutrition (FAO 2024). Over 3 billion people suffer from micronutrient deficiencies because healthy and nutrient-adequate diets are unaffordable (Passarelli et al. 2024; FAO 2024). Energy and nutrient deficiencies increase people's susceptibility to infectious diseases, physical and cognitive development impairments, and

premature death (Development Initiatives 2022). While the proportion of undernourished people globally declined substantially between 1950 and 2015, the absolute numbers of people suffering from nutritional deficiencies have remained stubbornly high, making it unlikely that the zero-hunger sustainable development goal (SDG 2) will be achieved by 2030. At the same time, more than 2 billion people worldwide are overweight or obese, leading to serious chronic health issues and noncommunicable disease risk. Overall, unhealthy diets and malnutrition in its various forms account for more than one-third of the total global burden of disease (Gödecke et al. 2018; von Braun et al.

This article is the Introduction to the ICAE 2024 Special Issue, in which the plenary papers presented at ICAE 2024 are included. ICAE 2024 was the 32nd International Conference of Agricultural Economists, held from August 2–7, 2024 in New Delhi, India.

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2023). Beyond nutrition and health, other social issues in agri-food systems include precarious labor conditions, discrimination against women, and other inequities along agricultural and food value chains (Quisumbing and Doss 2021; Fabry et al. 2024).

In terms of environmental dimensions, agri-food systems are responsible for one-third of all greenhouse gas (GHG) emissions, with land use, land-use change, and livestock husbandry being the main sources (Crippa et al. 2021; Parlasca and Qaim 2022). Even if the combustion of fossil fuels were stopped immediately at global scale, the GHG emissions from food and agriculture alone would suffice to thwart the Paris climate targets until 2050 and beyond (Clark et al. 2020; Ivanovich et al. 2023). Agriculture is also responsible for the largest part of global biodiversity loss and many other environmental problems, including soil and land degradation, air pollution, water quality degradation, and related loss of important ecosystem functions (Springmann et al. 2018; Pendrill et al. 2022; Pereira et al. 2024; Qaim et al. 2024). Climate change and other environmental issues are already contributing to yield failures and food production declines in many regions (Ortiz-Bobea et al. 2021; Rezaei et al. 2023). These problems will likely get worse in the coming years and decades. The worst impacts of climate change on agriculture and food security are expected to occur in tropical and subtropical regions, where malnutrition is widespread anyway and where many of the poor depend on agriculture for their livelihoods.

There is broad international consensus that agri-food systems need major transformations to become more sustainable (Schneider et al. 2025). The urgent need for action was the main motivation for the first United Nations' Food Systems Summit that was held in New York in 2021 (von Braun et al. 2023). Agriculture and food systems also featured prominently at recent UN Climate Change and Biodiversity Conferences. However, while the need for transformation is widely recognized, there are many open questions. What concrete steps could be useful, and through which policies and mechanisms could these steps be most effectively instigated? Because of the complexities of food systems, changes at one level (e.g., farm production) may have undesirable effects at other levels (e.g., consumption) or may lead to leakage effects and spillovers in other parts of the world. Possible tradeoffs between the multiple sustainability dimensions (e.g., human nutrition vs. nature conservation goals) also need to be considered. And, since food production, processing, trade, and consumption decisions are made by billions of individuals around the globe, the most suitable leverage points for policymaking toward improved agri-food systems' sustainability need to be determined.

Recent modeling studies show how sustainable agri-food systems could look like (Springmann et al. 2018; Willett et al. 2019; Gaupp et al. 2021; White and Hall 2024). These modeling studies suggest that sustainable food and nutrition security for all within the planetary boundaries is possible in principle, but that major changes in production, distribution, and consumption are needed. However, most of these modeling studies include little economics research (Ruggeri Laderchi et al. 2024). This means that key questions, such as how to get to those sustainability scenarios, how to incentivize the needed behavioral change, and what this would mean for broader economic development, are not yet sufficiently addressed. Without more economic research, the

needed policy steps cannot be taken, at least not in targeted and efficient ways.

In this article, we explore the critical role that the agricultural economics profession can and should play in shaping important agri-food systems transformation processes. We reflect on how our discipline contributes to understanding and influencing agri-food systems and discuss ways in which it can further strengthen its role in global sustainability discourses and policy initiatives. We highlight opportunities for agricultural economics to foster more sustainable and resilient agri-food systems. Furthermore, we provide an overview of the plenary papers presented at the 32nd International Conference of Agricultural Economists (ICAE) that was held in August 2024 in New Delhi, India (ICAE 2024). These papers, which were peer-reviewed and revised after the Conference, are included in this ICAE 2024 Special Issue and offer new insights into the pathways and challenges for successful agri-food systems transformation.

2 | Major Roles and Challenges for Agricultural Economics

2.1 | Need for Economics in Agri-Food Systems Analysis

The recognition that agri-food systems are a major contributor to some of the most pressing global challenges, such as climate change, biodiversity loss, hunger, poverty, and obesity, but also a crucial part of the solution is still relatively recent (Just 2023). Economists, and in particular agricultural economists, can play an important role in finding pathways to more sustainable agri-food systems. With our educational background at the interface of economics, behavioral sciences, environmental sciences, and natural sciences, we are well equipped and experienced to help understand critical system transformation needs and constraints, such as the conceptualization and measurement of externalities, synergies and tradeoffs between various sustainability dimensions, as well as incentive structures and responses of different food system actors, including farmers, traders, processors, and consumers, among others (Fan 2021; Béné et al. 2020).

However, broader international research and policy initiatives around sustainable agri-food systems seem to be dominated by other disciplines, including nutritionists and climate and environmental scientists, with agricultural economists being underrepresented. There is definitely scope for a stronger role of agricultural economists in high-level interdisciplinary analyses. For example, numerous reports on sustainable agri-food systems highlight the need for healthier diets, more sustainable farming practices, and reduced food waste, but the proposed scenarios and strategies oftentimes lack rigorous economics and behavioral analysis. This is a missed opportunity, since agri-food systems analyses without considering economic realities, opportunities, and constraints are incomplete and may result in unrealistic and/or inefficient and inequitable outcomes.

If agricultural economists do not get more involved in addressing policy-relevant questions related to the economics of agri-food systems transformation, other disciplines—less suited to take on this task—will likely do so, which would gradually render our

own profession meaningless. This must not happen because we have a lot to contribute.

2.2 | Interdisciplinary Cooperation and Disciplinary Rigor

As agricultural economists, we are used to interdisciplinary perspectives, using economics tools to analyze questions of agricultural production, markets, as well as environmental and nutrition outcomes. We are able to look across various scales and thus integrate micro-, meso-, and macro-level perspectives. These skills are extremely useful for connecting to other relevant disciplines—such as agronomy, nutrition, environmental sciences, and social sciences—and thus shaping the research of interdisciplinary agri-food systems consortia. By fostering interdisciplinary collaboration, agricultural economists can make a strong contribution to transformation processes (Fresco et al. 2021).

However, realizing this potential requires deliberate action. Agricultural economists should not try to mimic mainstream economists, who often shy away from interdisciplinary cooperation. In the journals and career tracks of mainstream economics, interdisciplinary approaches are hardly rewarded. To build on our comparative advantages, agricultural economics programs should embrace interdisciplinary skills development, such as systems thinking, data science, and effective communication and cooperation across disciplines and beyond narrowly-defined academic circles. In addition, academic institutions should shape incentive structures such that interdisciplinary research and real-world relevance are valued appropriately in hiring, tenure, and promotion processes. This includes broadening the horizon of journals considered relevant beyond the field of economics, rewarding policy-oriented, cross-disciplinary work, and recognizing the larger time and financial resources needed for meaningful interdisciplinary cooperation in comparison to purely disciplinary work.

Nevertheless, while expanding the scope beyond narrowly-defined disciplinary boundaries is key for remaining relevant, it is also crucial to preserve and further develop some core principles and methods of agricultural economics. Any scientific discipline risks losing its identity and strength if it tries to include too many aspects without maintaining a solid foundation. We remain economists and need to build our interdisciplinary analysis on economic theory and rigor. Without this, our contribution would remain shallow.

One important example where a strong economic foundation is needed to accelerate transformation is the analysis and design of incentive structures. Progress toward more sustainable agri-food systems has been frustratingly slow, even though the major issues and the need for change have been widely recognized for years. Agricultural economics must use its core economics principles and methods to enhance our understanding of why transformation processes are not advancing as rapidly as they should, and how relevant steps at various system levels can be accelerated. In this context, a closer integration with political economy and industrial economics to better understand structural and institutional barriers is also important (Béné 2022; Resnick and Swinnen 2023).

2.3 | Leveraging Data without Losing Context and Focus

One of the most significant opportunities for agri-food systems research lies in the growing availability and quality of data, including biophysical, climate, economic, and social data. These data offer large potential to track transformation processes, explore interconnections, and refine disciplinary and interdisciplinary models (Schneider et al. 2025). The integration of high-resolution satellite imagery, sensor-based monitoring, eye-tracking, social media, and machine learning techniques enhances our ability to evaluate agricultural productivity, environmental sustainability, consumer behavior, and market dynamics almost in real time and at unprecedented granularity (Wuepper et al. 2025; Katare et al. 2025). Since agricultural economics has long been a discipline with a strong empirical and applied focus, we have a comparative advantage in terms of using, integrating, and interpreting diverse data types (Runge 2008) and should hence assume a leading role in developing and analyzing data systems for agri-food systems transformation (Carletto 2021).

However, data-driven approaches should not come at the expense of direct engagement with stakeholders. Maintaining close connections with farmers, traders, consumers, policymakers, and other actors in agri-food systems is crucial to aligning theoretical models with empirical realities (Reardon 2025; Schwarz et al. 2021; Michelson 2025). There is also a growing concern that over-reliance on empirical analyses and big data may soften theoretical foundations and meaningful interpretation. While sophisticated econometric models and machine learning techniques can provide valuable insights, they must be guided by well-developed and codesigned theoretical frameworks to create sound hypotheses and ensure coherence, relevance, and explanatory power (Zilberman 2019).

Big data undeniably enhances our ability to track progress and quantify change. However, it is still unclear to what extent these data can drive the much-needed change in agri-food systems. Many persistent challenges in agri-food systems—such as inequality, environmental degradation, and structural barriers to market access—have long been recognized, yet meaningful change has been slow. Rather than assuming that more data will automatically lead to better outcomes, we should also focus on which type of data will have the strongest impact to spur transformation processes.

2.4 | From Identifying Tradeoffs to Shaping Solutions

A central challenge in achieving sustainable agri-food systems is managing tradeoffs between different dimensions of sustainability. While agricultural economics has made significant strides in identifying tradeoffs, our discipline must go further and also identify solutions for how to reduce such tradeoffs efficiently.

A few examples may be instructive. More environmentally-friendly agricultural practices can enhance biodiversity, but—at the same time—may also increase labor demand and possibly lower farmers' incomes (Daum et al. 2023). Specific innovations

to reduce labor needs and well-targeted compensation measures may possibly help overcome the tradeoff and incentivize innovation adoption.

Supermarkets and other modern retailers may increase market efficiency and make foods more accessible and affordable for consumers, but may also contribute to higher consumption of ultra-processed foods, thus contributing to rising obesity and chronic health risks (Khonje et al. 2020). Smart regulation of the food industry and of market food environments could be designed to avoid such undesirable diet, nutrition, and health effects.

Creating new employment opportunities in rural areas that are also accessible for women can contribute to women's empowerment and higher financial autonomy, but may also exacerbate women's time constraints with possible negative effects for childcare and nutrition (Melaku et al. 2024). A fairer distribution of childcare and other housework tasks within the family and/or more accessible external childcare options could be useful to better align household income, women's empowerment, and child nutrition goals.

Identifying tradeoffs is important, but stopping there can also lead to a “do nothing” approach because it is unclear what exactly should be done to promote sustainable development. Inaction, however, is not helpful in a situation where agri-food systems transformation is urgently needed. Agricultural economists can play an important role in analyzing and fine-tuning solutions to reduce existing tradeoffs, which involves not only understanding the technical aspects of various sustainability dimensions, but also addressing the political, social, and economic contexts in which decisions are made (Schneider et al. 2025).

2.5 | The Role of Agricultural Economics Associations

Topics around agri-food systems, land-use change, the bioeconomy, and sustainable development have attracted broad research and policy attention in recent years, which is great for our agricultural economics profession. As argued above, we need to broaden our horizon and get more involved in policy-relevant interdisciplinary cooperation. However, interdisciplinary work also comes with challenges. There is an increasing number of interdisciplinary conferences and journals, sponsored by various types of organizations. While such dynamics are welcome in general, they can also lead to a situation where especially young colleagues may lack attachment to a disciplinary community that is important for benchmarking, quality control, and professional development. We need to communicate that interdisciplinary work is great, but comes with the risk of staying superficial if not grounded in rigorous theories and methods.

Agricultural economics associations, their journals, and regular conferences play an important role in providing platforms for exchange and disciplinary homes for agricultural economists. It is important to further develop our agricultural economics associations, conferences, and journals by advancing new topics, experimenting with new formats, and increasing our attractiveness and visibility also beyond our traditional target groups.

Also here, we should not try to mimic mainstream economics associations and journals but have a stronger emphasis on interdisciplinary approaches and policy relevance. Our profession will continue to thrive when we proactively address economic issues of sustainable agri-food systems and contribute to shape and accelerate much needed transformation processes at global, regional, and local levels.

3 | ICAE 2024

The ICAE is the major triennial event of the International Association of Agricultural Economists (IAAE), bringing together scholars from all continents working on economic and social aspects of agri-food systems. The ICAE events have a tradition of almost 100 years. The 31st ICAE in 2021 had to be held online due to the COVID-19 pandemic. Hence, the 32nd ICAE in 2024 was the first in-person IAAE conference after 6 years. ICAE 2024 was held from August 2–7, 2024 in New Delhi, India, and was a very successful event. ICAE 2024 under the theme “Transformation Towards Sustainable Agri-Food Systems” was inaugurated by the Indian Prime Minister, Narendra Modi, and attracted around 1100 participants from 70 countries. Many of the participants were early-career researchers. This ICAE 2024 Special Issue of IAAE's journal “Agricultural Economics” features the plenary papers presented at the Conference. These papers are summarized below.

3.1 | Elmhirst Lecture

Leonard Knight Elmhirst (1893–1974) served as the first President of the IAAE from 1929–1958 and was designated, founder president, until his death in 1974. In his honor, the Leonard K. Elmhirst Memorial Lecture was instituted in 1976 and presented by T.W. Schultz. Since then, an Elmhirst Memorial Lecture has been an integral part of every triennial ICAE and is always presented by an eminent scholar in the first plenary session. After the lecture, the Elmhirst lecturer is awarded the Leonard K. Elmhirst Medal, a very high IAAE recognition. At ICAE 2024, the Elmhirst Memorial Lecture was presented by Thomas W. Hertel.

In his Elmhirst Lecture paper in this Special Issue, Hertel (2025) argues that sustainable transformations of agri-food systems need to be guided by appropriate frameworks and policy instruments. In particular, he examines economic policies that respect planetary boundaries. The paper highlights the need for integrated global-local approaches and considers market-mediated spillovers and synergies. It identifies potential unintended consequences of rigid policies, such as spillovers of environmental pressures to other regions or sectors, and calls for holistic economic modeling to anticipate and mitigate such outcomes. Hertel (2025) also emphasizes the importance of market mechanisms, such as international trade and pricing strategies, and the integration of community responses and localized adaptations into global policy designs. The article argues that trade, technological innovation, and community-specific adaptations are essential for strategies that help us stay within the planetary boundaries. Economists, agricultural economists in particular, are in a prime position to make these much-needed contributions to related sustainability discourses.

3.2 | Healthy and Sustainable Diets and Nutrition

The second plenary session at ICAE 2024 focused on the economic aspects of healthy and sustainable diets, that is, diets that are nutritious, healthy, and affordable for consumers while having as little impact on the environment as possible. Most diets observed around the world today are not healthy and sustainable, which is true in low- and middle-income countries as well as in high-income countries. In other words, substantial dietary shifts are needed to make agri-food systems more healthy and sustainable.

In their paper in this Special Issue, Zhang et al. (2025) examine dietary transitions in China over the past two decades and propose a multifaceted policy approach to integrate both supply-side and demand-side interventions to make diets more healthy and sustainable. China has experienced a rapid change of diets in the last two decades with strong implications for dietary quality and environmental burdens (He et al. 2018). In their analysis, Zhang et al. (2025) address key factors such as affordability and environmental impacts of diets, while acknowledging the importance of regional contextualization (Ye et al. 2024). The authors also translate their findings from China into lessons for other countries undergoing similar dietary shifts.

The costs and affordability of diets are further analyzed by Masters et al. (2025) in their article in this Special Issue. The authors provide a detailed global analysis of food access using the “cost of a healthy diet” metric, highlighting its utility in measuring the affordability of nutritious diets. Affordability as a main barrier to food security and healthy diets has gained wide recognition in recent years (Bai et al. 2021). By incorporating updated food price data and affordability thresholds, Masters et al. (2025) reveal that nearly three billion people worldwide are unable to afford a healthy diet. The study further demonstrates how variations in diet costs across food groups and income levels provide critical insights into the structural barriers to food security. The paper adds to calls for continuous global monitoring and the development of methodologies that link food prices to agricultural policies and social protection measures (Headey et al. 2024). The approach by Masters et al. (2025) provides actionable information for governments and organizations aiming to enhance food security and access to nutritious diets worldwide.

3.3 | Agri-Food Value Chains and Sustainability

The third plenary session at ICAE 2024 focused on the economics of agri-food value chains and sustainable development. Most of the negative environmental and social externalities in agri-food systems occur in farming and along the value chains, including processing and trade, meaning that interventions aimed at sustainability have to focus on value chains and how to organize them better (Meemken et al. 2021; Ruben et al. 2021).

In their article in this Special Issue, Wollni et al. (2025) evaluate the role of voluntary sustainability standards, such as Fairtrade, Organic, or Rainforest Alliance, offering a conceptual framework to assess their impacts across environmental, economic, and equity dimensions. Using case studies from Ghana, Rwanda, and

Peru, the authors reveal both synergies and tradeoffs between the different sustainability dimensions, such as improved incomes at the cost of equity or environmental goals. Wollni et al. (2025) advocate for a comprehensive evaluation approach that integrates context-specific factors and policy alignment to optimize sustainability outcomes.

Much of the value in agri-food supply chains is generated by midstream actors, especially the food processing and trading industries. Against this background, Barrett and Gómez (2025) argue in their paper in this Special Issue that these midstream actors deserve particular attention. Midstream value chain actors are often not in the focus of agricultural economics research, likely also because of data limitations (Grabs et al. 2024). Barrett and Gómez (2025) highlight how targeted policies and natural market processes can incentivize midstream actors to adopt practices that align profitability with broader societal objectives, such as equity, resilience, and environmental sustainability. The number of actors in the midstream is much smaller than the number of actors at both ends of agri-food value chains (namely, farmers and consumers), meaning that the implementation and monitoring of sustainability interventions at this midstream level may be easier in general. This midstream potential for agri-food systems transformations is not yet fully realized.

Another area of study that deserves relatively little attention in agricultural economics research, likely also due to data issues, is labor in farming and along agri-food value chains. In their paper in this Special Issue, Meemken et al. (2025) address the pressing problem of precarious employment conditions in agri-food systems. The paper provides a comprehensive review of policy tools to promote decent work in agri-food. Agricultural labor markets often have unique characteristics that complicate policy interventions. The authors underline the lack of robust evaluations of existing labor policies and advocate for rigorous research designs, including transdisciplinary collaboration. The paper calls for integrating labor, migration, trade, and social policies into coherent strategies that address both regional and global employment challenges.

3.4 | Gender in Agri-Food Systems

The fourth plenary session at ICAE 2024 dealt with gender in agri-food systems. Gender gaps are rampant in almost all economic and policy spheres around the world. A particular focus on gender in agri-food systems is important for at least two reasons. First, women are critical actors in agriculture and agri-food systems sustainability, playing essential roles in production, processing, and distribution, as well as in food consumption decisions and meal preparation within the household. Their contributions are fundamental to ensuring food security and resilient supply chains (Quisumbing and Doss 2021; Visser and Wangu 2021). Second, if gender dynamics are overlooked, agri-food systems transformation steps—such as increased commercialization of the small farm sector or the concentration of value creation in high-value nodes of food supply chains—could further marginalize women. This could reinforce existing inequalities rather than making agri-food systems more inclusive and equitable (Mehraban et al. 2022).

In her paper in this Special Issue, Quisumbing (2025) reviews and discusses frameworks and metrics of intrahousehold gender dynamics. The paper describes and analyzes the evolution of the research field from early bargaining power models to contemporary empowerment indices like the women's empowerment in agriculture index (WEAI). By highlighting the significance of joint decision-making and ownership in household dynamics, the paper emphasizes the need for nuanced policy responses that go beyond traditional two-person bargaining frameworks.

The division of labor in agri-food systems between men and women is further analyzed by Doss and Gottlieb (2025). In their article in this Special Issue, Doss and Gottlieb (2025) critique simplistic narratives around the feminization of agriculture. They advocate for a deeper examination of gendered labor patterns and how structural transformations, including shifts in rural employment and migration dynamics, shape opportunities for men and women differently. Gender is a crucial analytical category to further understand the reallocation of labor within the agricultural sector and to nonagricultural activities. The paper also contributes to the literature on intersectional barriers that influence who can access emerging economic opportunities, primarily relating to gender, socioeconomic status, and institutional constraints.

The nexus of gender and climate resilience in agriculture is at the center of the paper by Akter (2025) in this Special Issue. The article introduces the climate resilient development for agriculture (CRDA) framework, which incorporates mitigation, adaptation, and equity considerations into a roadmap for agricultural transformation in the face of climate change. Akter (2025) emphasizes the need for integrating a development perspective into climate resilience frameworks and for explicitly addressing climate-induced losses and damages incurred by different actors in agri-food systems. Actionable pathways for ensuring sustainable and inclusive transitions in agri-food systems could be leveraged through innovative financing mechanisms, such as green bonds and insurance. However, more research is needed to understand how to reach and support the poorest households.

3.5 | Agri-Food Systems, Climate, and the Environment

The fifth plenary session at ICAE 2024 focused more specifically on climate and environmental issues in agri-food systems and how to address them through appropriate research and policy. Agri-food systems contribute significantly to climate change and many other environmental problems. Conversely, global environmental change is also negatively impacting agriculture and food security in many ways.

In their article in this Special Issue, Benami et al. (2025) analyze the implementation and evaluation of major agri-environmental programs in the United States. The authors advocate for leveraging geospatial data and experimental methods to enhance program efficacy and ensure equitable outcomes, particularly for historically underserved producers. The article makes a compelling case for more tailored, data-driven programs and robust monitoring frameworks at the agriculture-environment nexus.

Groundwater and energy are also key agricultural inputs, with severe implications for natural resource-use efficiency and the environment. In her article in this Special Issue, Balasubramanya (2025) explores the role of irrigation technologies with a particular focus on South Asia. In many parts of South Asia, agricultural production heavily relies on irrigation, and groundwater depletion rates are staggering (Lutz et al. 2022). Balasubramanya (2025) emphasizes the challenges posed by political and administrative barriers to pricing water and energy. Efficient irrigation technologies could play a major role in mitigating environmental pressures. However, there seem to be significant awareness and knowledge gaps in the heterogeneous small farm systems, with widely varying levels of technology adoption and impacts. Balasubramanya (2025) advocates for more microdata-driven studies to evaluate the scalability and efficacy of irrigation technologies while also considering behavioral and institutional factors. Closer collaboration between researchers, practitioners, and policymakers is needed for the design of appropriate and evidence-based interventions that support sustainable groundwater use without compromising farmer livelihoods.

Addressing another critical dimension of agriculture's role in sustainable development, Chand (2025) in his paper in this Special Issue examines the broader economic and social contributions of the sector. He argues that agriculture's contributions to poverty reduction, nutrition, and climate change mitigation requires a renewed policy emphasis. The paper highlights a disconnect between structural and occupational transformations, emphasizing the need for agriculture-centric strategies that address disparities in income and employment. By framing agriculture as a critical driver of sustainable development, Chand (2025) calls for integrated approaches that bridge traditional sectoral boundaries.

3.6 | Novel Approaches in Agri-Food Systems Research

The sixth plenary session at ICAE 2024 was dedicated to novel data types and innovative methodological approaches in agri-food systems research. Developing and integrating novel approaches in agricultural economics research is important for making competitive and policy-relevant contributions. Exciting new opportunities in data availability and computing power have emerged recently.

In their article in this Special Issue, Wuepper et al. (2025) highlight the large potential of using satellite data for advancing policy-relevant agricultural and environmental economics research. The increasing availability of high-resolution satellite imageries, combined with novel machine learning algorithms, offer researchers innovative means to observe and analyze land use and agricultural practices at scale. The article provides a detailed discussion of workflows and best practices for related research studies while also addressing limitations and complexities of satellite-derived measurements. By showcasing examples of variable construction and making reproducible codes available, Wuepper et al. (2025) aim to inspire further applications of satellite data in agricultural economics research. These novel tools offer opportunities to complement traditional datasets, enhance ground-truthing efforts, and uncover new insights into land-use changes, innovation adoption, and productivity trends.

Expanding the exploration of novel data sources, Katare et al. (2025) shift the focus to consumer behavior in online retail environments. In their article in this Special Issue, the authors demonstrate how digital footprints of consumers, such as online page visits and product interactions, can inform strategies to promote healthier and more sustainable consumption. By leveraging insights into consumer decision-making pathways and responses to product labeling, Katare et al. (2025) propose interventions that encourage informed consumer choices aligned with multiple sustainability goals.

Complementing these discussions on measurement innovation, in her article in this Special Issue, Michelson (2025) examines the role of advanced data and metrics for understanding smallholder farming realities in low- and middle-income countries. She analyzes GPS-based plot measurements, high-frequency surveys, satellite imageries, and machine learning algorithms, among other novel approaches in micro-level development research. The article also identifies critical gaps, such as the lack of robust metrics for informal agricultural activities and the spatial characterization of agricultural risks. Michelson (2025) argues for a balanced approach that combines technological innovation with sustained investments in traditional methods like farm and household surveys, ensuring the robustness and inclusivity of data collection efforts. This multipronged approach of data collection is crucial for capturing the diverse and evolving conditions of small farms worldwide.

The theme of research methodologies is also taken up by Reardon (2025) in his article in this Special Issue. He conceptualizes his own successful approach of identifying and addressing gaps in existing research and policy paradigms, starting with identifying conventional wisdom and then—in many cases—throwing overboard this conventional wisdom by using field observations and survey data showing that the real world does not always align with well-established assumptions. Reardon (2025) uses several examples from his research over the last several decades—including nonfarm employment, the “hidden middle”, and the “supermarket revolution”—to describe this approach of shifting research fields into new directions.

4 | Conclusion

Current agri-food systems are not sustainable. Substantial systems transformations are needed to ensure food and nutrition security for all within the planetary boundaries. While several modeling studies exist that show how healthy and sustainable diets and agri-food systems could look like, the big open question is how to get there. What types of innovations and policies are needed at what levels to bring about systemic change? How can behavioral constraints and political economy motives that hinder transformative change be overcome? How can effective economic incentives look like, and what needs to be done to ensure efficient and equitable outcomes? These and other questions need to be addressed by economists, which is not yet happening sufficiently.

Agricultural economists can and should play a stronger role in addressing relevant knowledge gaps and in developing strategies that can guide the much-needed transformation processes. Agricultural economists are trained to understand not only the

economics principles, but also many of the agronomic, environmental, nutrition, health, and natural science relationships, at least broadly, as is needed for successful interdisciplinary cooperation. Our profession knows how to conceptualize and evaluate externalities, how to identify synergies and tradeoffs between various sustainability dimensions, and how to analyze people's preferences and behavioral constraints. In order to remain policy-relevant, agricultural economists should be more involved in interdisciplinary and transdisciplinary agri-food systems consortia. In fact, we should drive the transformation research agenda, as we are better able to bridge across disciplines and scales and between research and policy-making than many other scientific communities.

Global research cooperation and benchmarking is facilitated by international associations and their regular conferences. The plenary papers presented at ICAE 2024, and included in this Special Issue, underscore the dynamics of our agricultural economics profession and the growing attention to policy-relevant work around sustainable agri-food systems. More of this is needed. ICAE 2024 was a landmark event, showing that agricultural economists have much to contribute to making our world a better place.

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