Between code and conscience: early-career researcher reflections on agroeconomic modelling and international research collaboration

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See Online for appendix

Work on the second EAT-*Lancet* Commission report on healthy, sustainable, and just food systems began in 2022 and is now nearing completion after 3 years and contributions from more than 100 researchers. The economic modelling undertaken for the Commission was led by the Global Economics Team of the Agricultural Model Intercomparison and Improvement Project (AgMIP)—a collaboration that brings together ten global economic models and modelling teams across different institutions. This Viewpoint, authored by ten early-career researchers (ECRs) from AgMIP who worked on the global economic modelling for the 2025 EAT-*Lancet* Commission, offers the first direct perspectives of ECRs in a large, international collaboration focused on the future of food systems and global economic modelling. The Viewpoint offers a forward-looking perspective on global agroeconomic modelling based on experiences during the project, starting with actionable strategies to enhance the inclusivity and sustainability of international research collaborations. The Viewpoint then identifies key limitations of the models used in the project and offers suggestions for improvement through better integration of demand, policy interventions, biophysical processes, and spatial aspects to increase accuracy and relevance. We build on the reflections on modelling to explain the central role of AgMIP-style research collaboration in the personal and professional development of ECRs. The Viewpoint concludes by reflecting on the broader futures assumed in the models and the implications of a changing political landscape on research from the perspective of ECRs.

Introduction

Socioecological transformation, including that of the global food system, is a defining challenge of our time. Early-career researchers (ECRs) working in this interdisciplinary field have a dual responsibility to not only conduct research that addresses this urgent challenge but also help to shape the future of research communities we are a part of. This Viewpoint emerged from the collective experiences of ECRs involved in the economic modelling effort of the 2025 EAT-*Lancet* Commission led by institutions within the Agricultural Model Intercomparison and Improvement Project (AgMIP), with the intent of documenting and making visible the experiences of ECRs within such large-scale international projects. All ten coauthors are ECRs, representing the majority of ECRs involved in the project and contributing to the vast majority of ECR time invested. We acknowledge that we do not speak for all the ECRs on the project nor can we reflect every individual experience.

As ECRs at the start of our academic careers, we have far less experience than mid-career and senior researchers, some of whom were involved in the early development of models that are used. However, we offer fresh perspectives shaped not only by recent doctoral and postdoctoral training but also by a different generational lived experience, influenced by the unfolding polycrisis of the 21st century. This experience has shaped us professionally; for instance, some ECRs chose to study economics in the aftermath of the global financial crisis, and we are researching sustainability motivated by escalating climate change.

In-keeping with trends within and outside of academia, we, as junior professionals, represent a more gender-diverse cohort than many of our more senior colleagues. Our roles in the project differ too, with ECRs responsible for running models and processing, analysing, and visualising results (appendix p 1), whereas our senior colleagues focus more on research design and project management. Importantly, as ECRs, we have most of our professional journeys still ahead of us, which brings a future-oriented perspective to our engagement with the research community. These differences allow us to offer unique and valuable reflections on agroeconomic modelling, grounded in the lived experience of participating in a large international research project.

Existing ECR perspective articles in the literature have addressed topics such as interdisciplinarity in sustainability science[1] and futures research[2] and transdisciplinarity in science.[3] More closely related to our domain, ECR perspectives have discussed the development of an early-career agricultural economist network in Europe[4] and the future of food system research.[5] These articles are either derived from ECR workshops and conference events,[5–8] discipline-specific surveys,[9] or both.[10] However, none of the articles provide direct perspectives of ECRs working in a large, international, high-profile research initiative such as the 2025 EAT-*Lancet* Commission. Furthermore, we believe this Viewpoint is the first to present an ECR perspective on pertinent issues shaping the future of food systems and global agroeconomic modelling research.

This Viewpoint is structured in two parts. In the first part, we share our insights as ECRs in the setup and organisation of international research collaborations. We discuss the challenges to make initiatives such as AgMIP for the 2025 EAT-*Lancet* Commission more diverse and inclusive

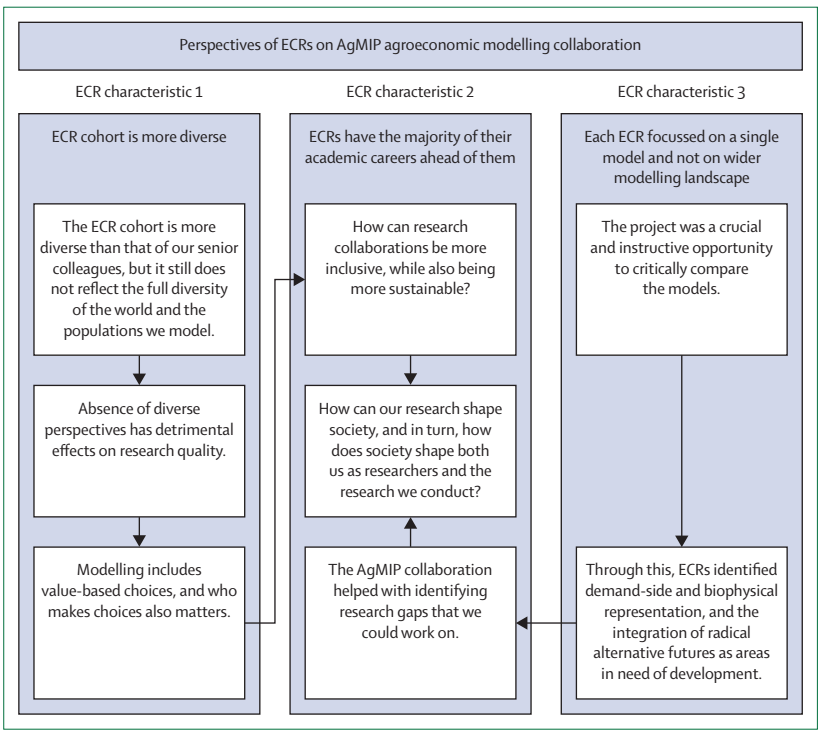

Figure 1: **Perspectives of early-career researchers (ECRs) on the Agricultural Model Intercomparison and Improvement Project (AgMIP) agroeconomic modelling collaboration for the 2025 EAT-*Lancet* Commission in the context of three distinguishing characteristics of the ECR cohort compared with those of all AgMIP collaborators**

and more sustainable. We explain where we see synergies and where trade-offs might arise between two goals. In the second part, we reflect on the models and their underlying paradigms. We discuss how the comparison of scenario results in the project has helped us to identify shared model shortcomings and led us to be critical of the futures assumed in the models. We conclude by emphasising that research collaborations such as AgMIP are essential for the personal and professional development of ECRs and that participation in this project within AgMIP has allowed us to identify and refine our future research agendas that will likely unfold in an era of deepening political and societal instability, with challenges and consequences for how, what, and why science is conducted, applied, and justified. Figure 1 presents an overview of the core components of this Viewpoint.

Part 1: lived experience as researchers

The ECR coauthors were identified from their participation in monthly AgMIP whole-group project calls and via a desk-based review of contributions to ancillary papers associated with the project. Fourteen individuals, identified as ECRs, were invited via email to participate in this Viewpoint. Ten individuals confirmed their interest in participating and formed the coauthor team. A survey was designed and administered via Qualtrics in March, 2025, to all ten coauthors, achieving a 100% response rate. The survey included demographic and background questions to better characterise the ECR cohort and open-ended questions on coauthor experiences within the project.

The panel presents a summary of the reflections of the survey, grouped thematically as personal experience, reflections on the AgMIP project and the modelling exercise, and broader reflections on the 2025 EAT-*Lancet* Commission. The reflections were organised into areas deemed to be strengths and challenges.

While many ECRs described their experience as empowering and a time of extraordinary personal growth, some ECRs also reported stress and insecurities that contribute to the ever so prevalent mental health burden in academia.[11,12] Furthermore, concerns about inclusion and sustainability were raised, which are discussed in more detail in the following sections.

Who models and who is being modelled?

Although the Global South is home to the majority of the world's population[13] and communities most vulnerable to climate change[14] and food system disruptions,[15] only three of the ten ECRs participating in this Viewpoint are nationals of countries from the Global South (India, the Philippines, and Brazil; figure 2A). The institutions where we are currently working at are all located in the Global North (the USA, Germany, Spain, and the Netherlands; figure 2A).[15] This mismatch among researchers, both ECRs and senior researchers, doing the modelling and those being modelled raises important questions about whose knowledge, values, and priorities shape the present and future food system research. For instance, researchers unfamiliar with indigenous knowledge may overlook local knowledge that plays a key role in some food systems. Similarly, the political connotations of simulated policies may vary greatly across countries and socioeconomic groups; researchers external to those may miss these nuances. Inequalities in global research funding and infrastructure often force researchers to relocate. Although high-income countries benefit from the diverse perspectives of researchers, the researchers are bound by the research priorities of their host institutions and job insecurity through limited-term contracts. This dynamic reinforces high-income country-centric concepts of food systems transformation and economic development, while marginalising alternative knowledge systems potentially valuable for addressing global challenges. Regional and ethnic under-representation extends beyond our project and is well documented throughout academia[17,18] and food systems literature.[19,20]

Additionally, gender imbalance in academia remains challenging,[21,22] despite evidence showing that gender-diverse research teams are more likely to produce innovative research.[23,24] Among the 46 researchers involved in the AgMIP modelling for the 2025 EAT-*Lancet* Commission, gender parity exists among men and women for the ECR cohort. However, among mid-career to senior-career researchers, 79% (27 of 34) were men (figure 2B).

Panel: **Summary of the surveyed personal reflections of early-career researchers (ECRs) working on the economic modelling for the 2025 EAT-*Lancet* Commission**

Personal experience

Strengths

- I would characterise my first experience of a large, international multi-institution research effort as a time of extraordinary personal development and growth. (ECR 7)
- Scenario implementation was a learning-by-doing experience. It deepened my understanding of the model's intricacies and allowed me to propose ways to enhance transparency in model development within my research group. (ECR 1)
- It was an empowering experience. I was entrusted with the responsibility for this project while still being a doctoral researcher, proving to myself that I can produce results fast under tight deadlines and that I enjoy working collaboratively. (ECR 3)

Challenges

- Limited gender and nationality diversity, particularly the representation of women and non-European participants, led to a predominantly European perspective in both the group and the models used. (ECR 5)
- I found the project a bit overwhelming. Participating in calls with many senior scientists whose publications I find impressive and exciting and frequently cite was at times intimidating. (ECR 2)
- During whole-group meetings, I felt as though the senior researchers talked and the ECRs were hesitant to speak up. (ECR 3)
- The acute mental health crisis among ECRs is well known[11] and stems from systemic issues in the current academic structure.[12] The mental health burden within this project stemmed from having to correctly implement scenarios under tight deadlines, often under precarious employment status and competing workload demands. This burden was compounded by working in a field where the realities of an unfolding social–ecological catastrophe were constantly in one's mind. (synthesis from several ECRs)

AgMIP

Strengths

- Communication between modelling teams was clear and often well structured. (ECR 10)
- Issues were discussed collectively and decisions made collaboratively. (ECR 5)

Challenges

- Modelled demand-side changes were treated more as arbitrary exogenous shocks. (ECR 9)
- Better data infrastructure at the outset would have reduced the need for ad-hoc solutions. It was frustrating to design these pipelines while the project was live. (ECR 6)

2025 EAT-*Lancet* Commission

Strengths

- A great example of public investment in science (via state-of-the-art models) being leveraged to try and tackle global challenges. (ECR 9)
- Participating in such a large project is crucial for an ECR. (ECR 5)

Challenges

- It would have been more efficient to have a clear research design at the outset to minimise changes and the need to rerun and process data multiple times. (ECR 6)
- At times, there were instances of the modelling ask being expanded partly due to unclear or poorly documented scenario agreements and research design within the Commission. (ECRs 5 and 7)
- I often felt like the timelines did not align with what the other groups expected from the modelling group. (ECR 3)
- Interdisciplinary interaction between different Commission working groups could have been better. Few members had a background in quantitative whole-systems thinking, which limited meaningful engagement with the modelling work. (ECR 3)
- EAT-*Lancet*'s self-styled Great Food Transformation fell short, in my view, of truly engaging with radical visions and paradigms of transformation. (ECR 7)

Reflections are grouped under three themes—namely, personal experience, Agricultural Model Intercomparison and Improvement Project (AgMIP), and 2025 EAT-*Lancet* Commission—and categorised into strengths and challenges. These reflections are extracted as close to verbatim as possible but have been edited for clarity and succinctness where necessary.

Additionally, people of all gender identities who do not conform to traditional masculine norms face systemic barriers rooted in masculine defaults and culture in academia.[25] Women in early career stages often face a dilemma between career advancement and caregiving responsibilities, with childcare and maternity responsibilities potentially interrupting careers. For example, breastfeeding, an important, sustainable, and health-promoting practice,[26–29] poses an additional barrier to full participation in academia, even though it should be actively

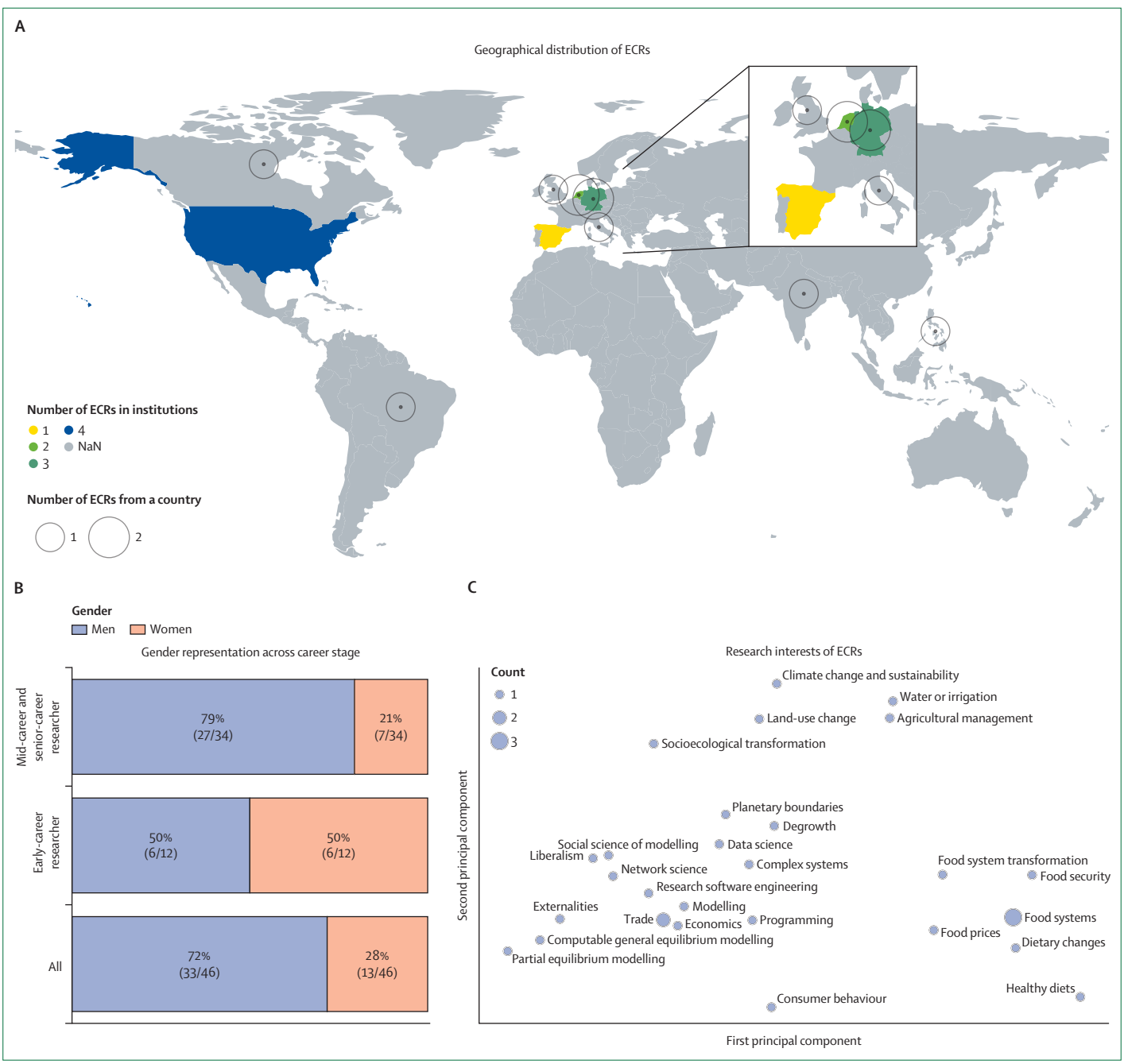

Figure 2: **Geographical and gender distributions and research interests of early-career researchers (ECRs)**
(A) Geographical distribution of ECRs who were surveyed (n=10). Colours on the map indicate the number of ECRs at institutions in each country. Circle size represents the number of ECRs who identified that country as their nationality, with the circle centred on the country's centroid (marked by a black dot). Inset: institutions and ECR nationalities in Europe. (B) Gender distribution across career stages based on the analysis of author lists from background papers. The bar graph shows gender proportions within each career stage and for all authors combined. (C) Research interests of ECRs. Research interests were encoded into high-dimensional vectors using the Scientific Paper Embeddings using Citation-informed Transformers (SPECTER) model, which captures semantic relationships between academic concepts based on citation patterns in the scientific literature.[16] The resulting high-dimensional embeddings were then reduced to two dimensions using principal component analysis for visualisation. Point size indicates the frequency of each research interest in the dataset. Proximity between points represents semantic similarity within academic literature. NaN=not a number.

supported as a key element of just and transformed food systems. Furthermore, academic institutions often lack adequate parental leave, flexible work, and childcare support, thereby restricting participation in conferences, collaborations, and fieldwork. These compounding systemic disadvantages hinder women and under-represented gender identities from advancing to higher-level positions. Gender imbalance in those positions leads to increased service and

mentoring burdens, reducing time for research, and jeopardising further advancement, especially for women belonging to under-represented groups in terms of race, nationality, and socioeconomic background.[30,31] These challenges are not unique to the 2025 EAT-*Lancet* Commission modelling or the AgMIP modelling community, but they reflect wider structural inequalities within academia and society, which ultimately shape our career trajectories and constrain who can thrive in international sustainability research.

As an ECR cohort working on a multi-model ensemble project, we recognise the importance of diverse expertise in improving model representation, challenging assumptions embedded in models, and developing contextually appropriate solutions. Although we aim to outline our vision for future global agroeconomic modelling (Part 2: perspectives on modelling), we also acknowledge that our perspectives are limited and influenced by our own experiences, background, education, personal research interests, and institutional focus (figure 2C). Limited long-term funding impedes the establishment of modelling teams and computational resources in under-represented regions. These funding disparities, alongside expenses for publications, conferences, and travel, present substantial obstacles to disseminating research and accessing global forums. Such challenges exacerbate inequalities between researchers in high-income and low-income countries, raising difficult moral dilemmas, especially around sustainability–inclusion trade-offs with academic travel. Furthermore, current knowledge production systems should be re-evaluated to identify structures perpetuating inequities in research opportunities, recognition, and influence. Dismantling these structures would help integrate diverse perspectives into food systems modelling and enable researchers from under-represented backgrounds to address global challenges.

However, progress is evident. The modelling research for the 2025 EAT-*Lancet* Commission has brought together ten global economic modelling teams from the AgMIP community. For many of us ECRs, this has been our first time working within a global intercomparison project, which has allowed us to gain experiences that go beyond our own models and exchange knowledge with other modellers, an experience many of us found rewarding (panel). Most of our collaboration took place virtually, which helped to make participation more accessible. The growing adoption of open-source models and accessible training courses, such as those provided by MAgPIE[32,33] and CAPRI,[34,35] democratises access to research tools beyond well resourced institutions. These developments, although incremental, mark important steps towards more equitable food systems research.

Living up to our science

Moral struggles of ECRs

As ECRs working on food systems transformation, we are aware of the crucial role dietary shifts play in addressing climate change[36–39] and other environmental challenges and sustainability goals.[38–41] We contribute to advancing this knowledge[41] and engage in outreach to communicate our findings. However, we also experience the tension between scientific knowledge and action, both in society and academia. Although we can align our individual food choices with sustainability principles at home, we perceive sustainable options in workplace canteens and conferences to be limited, creating systemic barriers to living up to the science we promote.

International travel, which is common in academia,[42] challenges our personal alignment with sustainability principles and comes with trade-offs in terms of diversity, equity, and inclusion in research. For example, even though the majority of project meetings were held online, several ECRs participated in in-person Commission meetings in Switzerland, Mexico, and France, which necessitated both short and long-haul flights. Meanwhile, ECRs who did not travel for project meetings were still expected to present their associated research, which, given the environmental cost of conference travel,[42,43] provoked a moral dilemma. Furthermore, the monetary costs of travelling represent structural advantages for researchers financially able to travel, exacerbating disadvantages for researchers with limited resources. Visa restrictions add another layer of exclusion when researchers from some countries face more time-consuming and costly processes to obtain visas or are not granted visas at all. Paradoxically, if researchers from high-income countries reduce their travel emissions by focusing on regional conferences and collaborations, they might unintentionally decrease collaboration opportunities with and for researchers from less privileged regions who either have to travel further or are excluded.

These challenges leave us ECRs in a moral dilemma. We strive to act sustainably, align with scientific evidence, and contribute to a fair and diverse research community, but we recognise how systemic constraints and academic norms limit the scope of individual decision making.

Addressing the dilemma towards systemic solutions

We identify the following three key focus areas towards sustainability and inclusion for international research consortia such as AgMIP and the 2025 EAT-*Lancet* Commission based on our experience in the project and our concerns regarding diversity and sustainability: rethinking conference travel, improving online collaboration, and aligning catering and canteen offerings with the planetary health diet (PHD). We support the suggestions outlined in the Cercedilla Manifesto[44] that conference organisers should question whether a physical meeting is necessary and that attendees should consider how their in-person attendance contributes to the meeting. The format and location of meetings should be selected based on sustainability (eg, travel distance) and accessibility (eg, hybrid formats). Across the wider 2025 EAT-*Lancet* Commission (where AgMIP researchers participated in the Economic Modelling Working Group), there were five week-long

in-person whole Commission meetings over the 3-year project that alternated between North America and Europe. Most of the events offered hybrid participation. Among our ECR group, two ECRs attended one meeting and two ECRs attended two in-person meetings. For the AgMIP-specific component of the project, collaboration was primarily virtual, combining monthly whole-group calls with bilateral engagement facilitated through Slack, email, and shared data repositories. This collaboration was successfully coordinated by the team at Cornell University. However, the success of this remote collaboration likely benefited from well established networks built by senior researchers through prior in-person meetings within AgMIP or the 2025 EAT-*Lancet* Commission.

In addition, the plenary format of the calls hindered some ECRs from engaging beyond their own modelling teams. As one ECR noted, "I found the project slightly overwhelming. Participating in calls with many senior scientists whose publications I find impressive and exciting and frequently cite was at times intimidating" (ECR 2). Another ECR reflected, "During whole-group meetings, I often felt as though the senior researchers talked and the ECRs were hesitant to speak up" (ECR 3; panel). Although there was frequent bilateral communication among ECRs, it was only later in the project that a more formal ECR-wide group was established. Moreover, this collaboration remained largely limited to teams from high-income countries that were already well established and connected. Actively engaging with teams, institutions, and potentially individual modellers from under-represented regions is crucial to broaden global collaboration.

We recognise that hybrid formats can be more inclusive, especially for participants with funding and visa restrictions, health issues, and caregiving responsibilities, thus structurally benefiting researchers from the Global South and women, in addition to not involving any travel emissions.[45,46] However, such formats risk reinforcing existing inequalities if in-person attendees gain disproportionate access to networking and collaboration opportunities. To mitigate these inequalities, a mix of exclusively virtual and a few in-person meetings might be more inclusive. Pairing conference trips with longer research stays for ECRs can further justify environmental and financial costs while deepening collaboration between teams.

Moreover, the results of the 2025 EAT-*Lancet* Commission[39] highlight the importance of diets for both health and the environment. Aligning catering at academic events with the PHD offers a concrete step towards sustainability. Providing healthy, largely plant-based meals[44] and decreasing food waste (eg, by reducing options and portion sizes) should be prioritised. This approach should extend beyond conferences to include universities and research institutes.

Making conferences more sustainable and inclusive, making travel more purposeful, and aligning food offerings with scientific recommendations are practical steps that also signal a broader commitment to integrating sustainability in academia. By implementing these changes, the academic community can become more inclusive, diverse, and environmentally responsible, with potential spillover effects, for example, with wider university procurement practices.

Part 2: perspectives on modelling

Personal reflections on modelling

Food systems are complex,[47] and models partially depict this complexity by capturing the direct and indirect effects of food system processes and dynamics. Our survey revealed that for many ECRs, modelling is central to their academic identity (figure 2C). A number of the models that we use often entail a steep learning curve to achieve a baseline level of proficiency. Therefore, many ECRs in the project have invested considerable time in understanding their respective models well enough to run and analyse scenarios and contribute to model development. Accordingly, most of us have focused exclusively on one model and have not yet gained expertise with other models. In this regard, collaboration between modelling teams as in AgMIP for the 2025 EAT-*Lancet* Commission was very educational (panel). For instance, ECR 7 described their experience as "I would characterise my first experience of a large, international multi-institution research effort as a time of extraordinary personal development and growth." ECR 1 reflected "[…]. It deepened my understanding of the model's intricacies […]", while ECR 3 shared, "It was an empowering experience. […]." These collaborations enabled us to compare our respective models with those of other teams. This perspective strengthened our abilities to make better informed decisions—eg, regarding the comparative suitability of our model for a specific research question.

Additionally, ECRs often work in smaller teams, closely aligned with their supervisors and their research group, and typically publish with a limited number of coauthors. Participating in this project broadened our understanding of collaboration and writing large, multi-author manuscripts together. As ECR 5 noted, "Participating in such a large project is crucial for an ECR" (panel). Overall, our involvement in the AgMIP modelling for the 2025 EAT-*Lancet* Commission has provided an essential step in ECR development.

Areas of future model development

Comparing scenario results across the different models and investigating the source of outliers required many of us to analyse aspects of our model that were previously overlooked but also fostered a more critical perspective of our own models' capacities and some assumptions shared across models.

The project included ten global economic partial equilibrium, computable general equilibrium, and integrated assessment models, which are rooted in neoclassical economic theory. These models generally follow a market clearing approach, where a broad equilibrium is reached between supply and demand mediated by prices. In our

project, the models are used to assess the society-wide adoption of the PHD, climate change mitigation action, and their impact on environmental and socioeconomic indicators, such as greenhouse gas emissions and food prices. The models also offered insights into the competition for land and other resources and cross-regional spillover effects of policy or diet changes.[48]

Drawing on insights from the scenarios designed and simulated, we identify three crucial aspects for improving these models to better investigate transformation towards sustainable, healthy and just food systems. The first aspect is demand-side representation. The transition to the PHD is central to the scenarios developed for the 2025 EAT-*Lancet* Commission, making meaningful and accurate depiction of consumer behaviour in the market setting essential. The second aspect is the representation of biophysical aspects. Apart from the implications for human health, the environmental impacts of agrifood systems motivate the need for diet transformation. However, environmental and climatic conditions also affect agricultural production. Therefore, the accuracy and relevance of scenario results also depend on how well these bidirectional relationships are captured in the models. The third aspect is deep engagement with underlying socio-political-economic futures. Keeping humanity's impact within planetary boundaries is a substantial challenge, requiring far-reaching actions. Measures such as the adoption of the PHD or mitigation of climate change are not modelled in isolation but in the context of economic paradigms selected by the modellers.

Demand side

The intercomparison highlighted differences in how models implement scenarios. All models treat the PHD as an exogenous shock (panel). As noted by ECR 9, "Modelled demand-side changes were treated more as arbitrary exogenous shocks". However, the mechanisms vary. CAPRI adjusts the demand function such that at baseline prices, consumers adopt the PHD.[49] Yet, resulting price changes lead to second-round consumption adjustments, preventing exact adherence to the PHD. MAgPIE, in contrast, fixes intake levels to exactly match the PHD, assuming no consumer price response.[41] IMPACT adjusts demand to the PHD while maintaining market equilibrium, allowing for price fluctuations but without explicitly modelling consumer reactions.[50] MAGNET fixes the intake of major the PHD food groups in physical quantities and allows prices to determine the composition of food items within the food groups, thereby incorporating consumer responses and maintaining market equilibrium.[48]

Although our simulations evaluate the implications of dietary shifts, many of these policy interventions required to achieve these changes are beyond the scope of our models. As such, our simulations only capture a part of the potential future scenarios involving dietary transformations. In particular, demand-side policies are not modelled in sufficient detail to assess the feasibility of a global food system transformation, and consumer reactions are not endogenously modelled. One explanation for this imbalance compared with the often detailed depiction of supply-side policies is that applied models are designed around prevailing narratives, policy makers' demands, and funding opportunities.[51] Consequently, supply-side measures, particularly financial and regulatory policies, dominate.[52] In contrast, demand-side interventions receive less attention due to their long-term nature, indirect mechanisms, and challenges in quantification.[52,53]

Furthermore, several models have not focused on value chain segments between production and consumption, which has been termed as the missing middle,[54,55] and household heterogeneity.[56] More detailed modelling of the food value chain and demand can improve modelling capabilities. Moving beyond raw agricultural commodities and broad categories of processed foods to using food intake data, explicitly representing food processing, and differentiating consumer behaviour across household groups will enable a more accurate assessment of demand-side policies and provide deeper insights into health, environmental, and socioeconomic outcomes.[57] Modelling the entire food supply chain, including food waste at various stages, is essential for informed policy making.[58]

Biophysical aspects

Besides demand-side improvements, we identify the representation of biophysical processes, particularly climate extremes and spatial scales, as an area of improvement. Climate variability and extreme weather events are often not adequately represented in our economic simulation models. Even though all models incorporate biophysical input data, including projections of future climatic conditions and their effects on yields[50,59] and some models (eg, MAgPIE[33]) consider changes in precipitation and mean surface temperature from global hydrology and vegetation models,[60,61] these inputs are typically provided as long-term averages.[62–64] As a result, the models omit increasingly frequent extreme events that profoundly impact land use, food security, and climate change mitigation potential in the land system.[65–67] Additionally, the input data provided by global crop and vegetation models often include the effect of CO_2 fertilisation.[68] Although this inclusion is an important process that should be considered in crop models,[68] high-concentration scenarios can lead to the overestimation of yield outcomes unless negative climate impacts on crop growth are also better represented in global crop and land use models. Future modelling efforts should explore incorporating climate variability through probabilistic approaches within economic models[69,70] or through closer integration with crop models that simulate extreme events.

Planetary boundaries and other environmental indicators often depend on finer spatial resolution than that used in global economic models, which typically operate at regional or national scales. Although our models incorporate biophysical data provided at a fine spatial scale (eg, grid cells of 0.5° resolution), these data have to be aggregated for use

in economic optimisation processes.[33] Moreover, even integrated assessment models seldom incorporate feedback mechanisms into hydrology and vegetation models, thereby limiting the ability to reflect how economic decisions could alter local environmental conditions.[71,72] Improvements could include the full coupling of economic and biophysical models or the application of post-processing steps that disaggregate model outcomes using biophysical and hydrological information.[73,74]

Socio-political-economic futures

Modelling complex systems and futures requires decisions about which variables, processes, and scenarios to include. These decisions reflect modellers' judgements about relevance, shaped not only by technical constraints (eg, data availability, computational capacity) but also by political and ethical considerations such as policies and technologies to model. Furthermore, these assessments may be shaped by the modellers' personal characteristics, including gender, age, socioeconomic background, or ethnic groups. Therefore, it is essential not to systematically exclude groups and perspectives from academic discourse and modelling activities.

Modelling choices have the potential to introduce biases or lead to policy-prescriptive models.[75,76] Despite differences in model implementations and foci, the models used in the project share core structures, theoretical foundations, and epistemologies. These overlaps limit the range of futures modelled and narrow the solution space for policy decisions. As a result, attractive alternatives are potentially excluded from the futures negotiated and pursued.[77,78]

This section highlights value choices embedded in our modelling tools. We reflect on how future modelling efforts can improve transparency, accountability, and inclusivity by acknowledging how model-based results promote some narratives and policies, exclude others, and how this challenges should be addressed.

Non-monetary values, such as biodiversity; indigenous values towards land, gender, and power dynamics; and life satisfaction, are either captured as proxies or not at all. Despite progress in biodiversity research to include indigenous values,[79] integrating heterogeneous epistemologies into quantitative economic modelling remains difficult.

The modelled scenarios are based on the shared socioeconomic pathways (SSPs),[80] which outline a broad range of foundational aspects of societal futures. However, all SSPs assume constant economic growth, an assumption that is increasingly debated, given the uncertain possibilities around decouple economic growth from environmental damage.[81] Moreover, economic growth is often used as a proxy for human wellbeing, despite evidence that this link may only hold up to a certain level.[82] Alternative approaches, such as degrowth and post-growth, are increasingly discussed[83–86] but remain difficult to model.

Our results show that the adoption of the PHD combined with climate mitigation measures alone is insufficient to reach a safe and just operating space.[41] Achieving sustainability goals will require additional measures beyond those simulated. As our simulations are based on the middle-of-the-road scenario SSP2, they cannot reveal which further transformations are needed to stay within planetary boundaries. Currently, only biophysically based optimisation models[87] or static lifecycle assessments[88] assess more ambitious pathways, including degrowth, circularity, and fully vegan diets, which is considered a shortcoming of the underlying design as one ECR stated in the survey: "EAT-*Lancet*'s self-styled Great Food Transformation fell short, in my view, of truly engaging with radical visions and paradigms of transformation" (ECR 7; panel).

Addressing modelling limitations with respect to the demand-side modelling, biophysical aspects, and underlying growth paradigm is crucial for enhancing the credibility of economic simulation models in informing policy decisions that account for both socioeconomic and environmental complexities.

Conclusion

This Viewpoint presents a collective reflection from ten ECRs who contributed to the global economic modelling for the 2025 EAT-*Lancet* Commission report—an experience that, for several ECRs, marked our first engagement with a high-profile, international, multi-institutional project. Our roles and levels of involvement varied, resulting in diverse perspectives rather than a singular ECR experience. From this experience, we identified two overarching themes that deserve deeper consideration—the lived experience of researchers and our perspectives on modelling.

We highlight the over-representation of researchers from institutions in the Global North in the economic modelling of global food systems, resulting in a lack of inclusion of perspectives from the Global South. We additionally discuss structural barriers faced by women and people from underrepresented geographical, ethnic, and socioeconomic backgrounds. Considering diversity and sustainability, we assess existing formats of academic collaboration, both broadly and as exemplified in this project.

Participation in this project shaped our development as researchers. The project enhanced our understanding of the capabilities and limitations of our models and improved our ability to critically interpret modelling results. Acknowledging these limitations has been instrumental in defining our individual research agendas. Our collective reflection as ECRs also made us aware of the theoretical foundations and assumptions underlying all ten models, motivating us to explore novel and heterodox modelling approaches.

Some challenges have clear solutions, while others involve dilemmas and trade-offs. Aligning conference catering with the PHD and limiting travel to essential in-person meetings are pragmatic steps. Nevertheless, as ECRs who are still building professional networks, we recognise the advantages of physical meetings despite their

monetary and environmental costs and the ongoing challenge to ensure fair participation for all. Fully virtual collaboration often relies on networks previously built by senior researchers; hence, we acknowledge that building the foundation for our own future virtual collaborations also requires in-person network building. To foster meaningful collaboration among the next generation of researchers, we propose further ECR-led projects such as this Viewpoint and increased representation on the AgMIP Executive Committee and in the leadership of similar projects.

The polycrisis we model—including climate change, malnutrition, and socioeconomic inequality—requires urgent policy action. Our research indicates that moderate pathways (SSP2) are insufficient to maintain the ability of the Earth system even when combined with climate change mitigation action and food system transformation. Yet, real-world trends increasingly resemble fragmented pathways (SSP3), raising doubts about the feasibility of even moderate scenarios. As ECRs at the start of our academic journeys, we face a profound challenge. Our research points to the need for transformative changes across and beyond agri-food systems, but in several of our countries, policy makers openly question scientific evidence and powerful vested interests block, delay, or co-opt meaningful action.

Still, we draw motivation from the international collaboration through the AgMIP modelling for the 2025 EAT-*Lancet* Commission and the shared learnings and experiences. Steering the craft of global agroeconomic modelling is challenging through generations of researchers. Will ECRs still name the same issues in 10 or 20 years? We hope not. Working on how to address some of the largest global crises is a privilege. We, and other ECRs in this field, should strive to shape the future of research to not only be rigorous but also be inclusive, critical, and reflexive to better enable us to confront the complex and urgent problems of our time.

Contributors

FT, FB, and MG are equal co-first authors. MG conceptualised the study and designed the survey. MG, FT, FB, MS, DC, and AM wrote the original draft of the manuscript. MG, FT, and FB led project administration. MS was involved in data visualisation. FT and FB extensively reviewed and edited the manuscript. MG, FT, FB, MS, DC, AM, HL, TdL, GT, and TDO completed the survey. All authors were involved in writing and reviewing the manuscript. All authors had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Declaration of interests

We declare no competing interests.

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