

What do we know about THE FUTURE OF MEASURING FOOD SYSTEMS?

Jessica Fanzo (Columbia University), Bianca Carducci (Columbia University),
and Michael Puma (Columbia University and NASA)



Key messages

- Many food systems-related databases, tools, and dashboards are available, but to ensure these tools are useful for decision-makers, they must be harmonized and their sophistication increased to capture trade-offs and synergies.
- The Food Systems Countdown Initiative holds great potential to address this need, but its success will depend on several factors, such as filling national and subnational data gaps, ensuring countries formalize their commitments, translating global ambitions into national contexts, and integrating sectoral policies and programs.
- A new generation of food systems indicators must capture multifaceted interactions, trade-offs, and synergies by integrating observations, models, and complex system analyses with clear metadata for appropriate use.

RECENT TRENDS AND CHALLENGES

To better characterize food systems, a descriptive analysis of a comprehensive set of indicators is an essential step, including diet, nutrition, livelihood, and environmental outcomes, as well as potential food system determinants. It is challenging to comprehend food systems fully because of their myriad components, actors, processes, interactions, inherent uncertainties, and the limits of what is knowable and predictable within such complex systems. However, over the last 20 years, the ecosystem of food systems data and data tools has evolved into an intricate and multifaceted landscape characterized by a wide range of resources and platforms. Some platforms include searchable databases, dashboards, and country and regional platforms.

To provide a few examples, the [Food Systems Dashboard](#) aggregates data from over 40 sources and presents approximately 300 indicators spanning various components of food systems. This comprehensive tool enables users to describe, diagnose, and decide on actions related to food systems at both national and subnational levels (Fanzo et al. 2020). The World Bank's [Global Food and Nutrition Security](#) dashboard focuses more on food crisis severity. Complementing these tools are specialized diet-related resources, such as the [Global Diet Quality Project](#) for standardized food group consumption data collection and the [Food Compass](#), which rates the healthfulness of foods around the world. The [Food Prices for Nutrition](#) project has developed metrics for analyzing food price and diet cost data. The Food and Agriculture Organization of the United Nations (FAO) has a number of data platforms, the best-known of which is its flagship database, [FAOSTAT](#). This database provides free access to a significant range of food and agriculture statistics for over 245 countries and territories, covering all FAO regional groupings from 1961 to the present. IFPRI also has several databases and related analytical tools, including the [IMPACT \(International Model for Policy Analysis of Agricultural Commodities and Trade\) model](#), which combines climate, crop, and economic models to analyze future scenarios for agricultural production and food security, and the [Food Security Portal](#), which provides country-level information on food security indicators.

This diverse ecosystem of data sources and analytical tools collectively has the potential to empower researchers, policymakers, and practitioners to gain deep insights into the multifaceted nature of food systems, facilitating

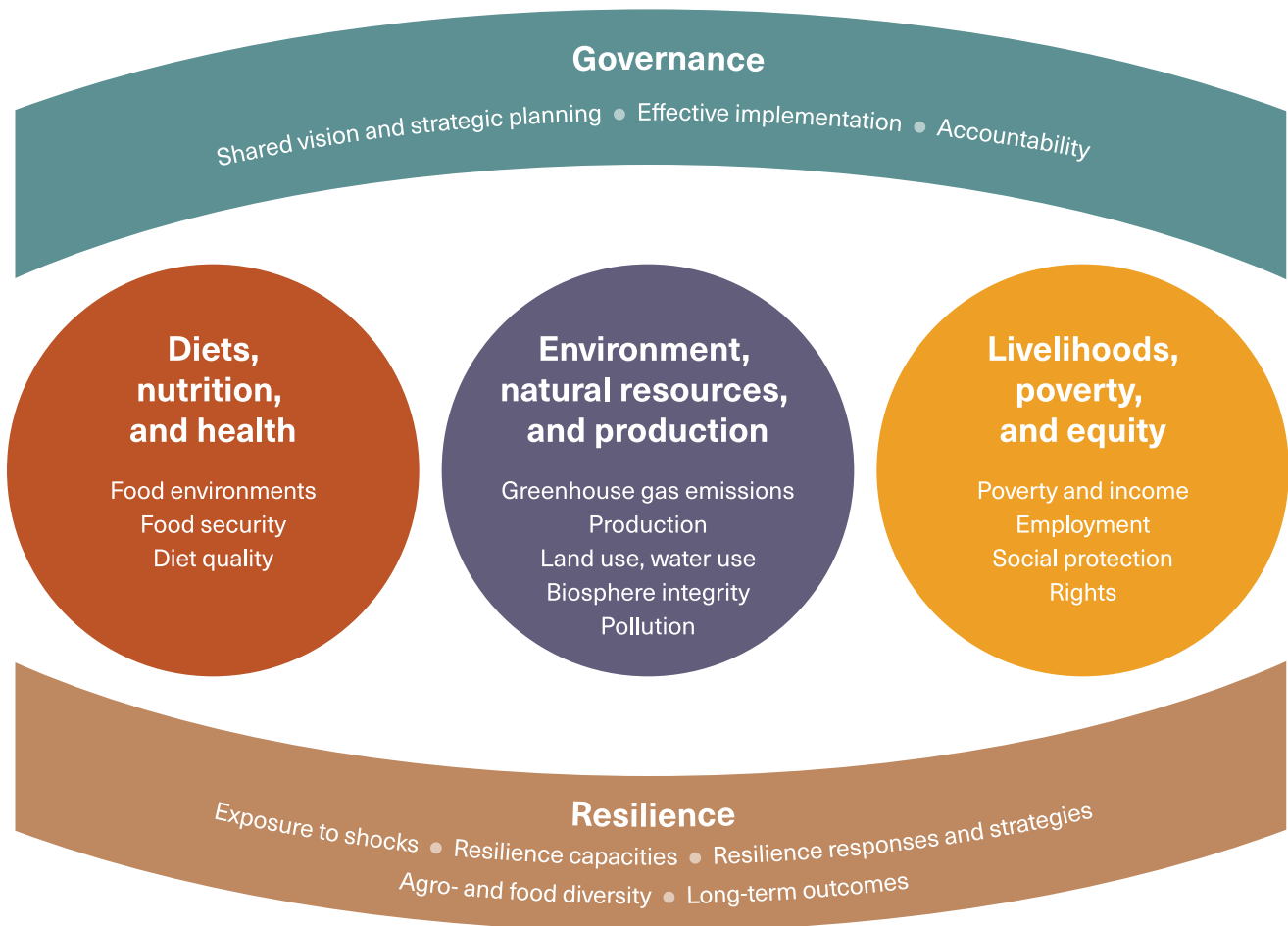
evidence-based decision-making and policy formulation. However, data standardization and harmonization across these diverse tools (Zhou et al. 2022) and increased participatory approaches for users of data tools are critical for food system transformation (Béné et al. 2024).

LATEST FORESIGHT RESEARCH

Foresight can take many forms, including learning from the past and present to inform our understanding of the future. Careful selection, compilation, and analysis of key indicators is essential not just for understanding food systems today, but also as a precondition for rigorous analysis of possible future pathways and projections for food systems transformation. For example, IFPRI's IMPACT model can generate projections to inform decisions about future food systems.

The [Food Systems Countdown Initiative](#) (FSCI) is an interdisciplinary collaboration of researchers that emerged from the 2021 United Nations Food Systems Summit. Over a two-year process, the collaboration developed a comprehensive, independent, science-based framework to monitor food systems that includes five themes: (1) diets, nutrition, and health; (2) environment, natural resources, and production; (3) livelihoods, poverty, and equity; (4) governance; and (5) resilience (Fanzo et al. 2021) (Figure 1). The FSCI then used a rigorous, multi-stakeholder process to select 50 indicators to monitor change across these five themes. The 50 indicators provide a comprehensive yet concise picture of food systems (Schneider et al. 2022). While the FSCI does not include foresight data, there is potential to consider projections of a portion of these 50 indicators in the future.

Using this framework, the current baseline analysis of the FSCI indicators reveals the complex challenges in global food systems: no country, region, or income group exhibits desirable status across all indicators. These baseline data also highlight significant gaps (as discussed above) that need to be filled in order to guide action in service of food system transformation to meet the Sustainable Development Goals, and ensure that food systems contribute positively to the many global goals linked to them (Schneider et al. 2023). The FSCI will undertake this research and action agenda in the coming years as well provide regularly updated assessments that track

FIGURE 1 The five thematic areas of the FSCI

Source: Fanzo et al. (2021).

progress from this baseline forward, including the addition of new indicators or the refinement of the current set of indicators as food systems science progresses.

In addition, monitoring the performance of food systems across countries requires setting clear numerical targets for each indicator. Target setting will allow decision-makers to use the framework as a starting point to: consider what changes in indicators are required at different scales; compare with neighboring countries; and forge coalitions to drive change. The choice of the specific numerical target values is typically: taken from the 2030 Sustainable Development Goal Agenda and other international agreements; drawn from the scientific literature; or calculated based on top-performing countries (van Vuuren et al. 2022). However, little consensus exists on which science-based methods for performing such assessments are best across a large set of indicators, hence bringing the risk

of cherry picking and arbitrary target setting among the 50 indicators and potentially compromising the robustness, usefulness, and credibility of such assessments (Gebara et al. 2024). To mitigate such challenges, the FSCI aims to develop a standardized method that recognizes the interplay between global and regional targets, incorporating both achievable and aspirational targets across scales.

KEY GAPS AND OPPORTUNITIES FOR FORESIGHT RESEARCH

Significant progress has been made in ensuring that food system-related data are available, but gaps remain, including data on links across supply chains (storage, transport,

processing), food environments, livelihoods, and consumer behaviors. Data availability varies across geographic areas and income groups and data are often available only in highly aggregated forms. It is particularly challenging to disaggregate data by geographic location at the sub-national level. In addition to gaps in data availability, poor quality data (for example, sometimes only modeled estimates) and other data-related challenges can make monitoring food systems and assessing and implementing effective policy and intervention strategies more challenging. The frequency of data collection is also limited, with very little real-time data available across food systems components. Lastly, the temporal and spatial interconnectivity of food system data makes exploring the relationships among food systems inputs, processes, outputs, and outcomes a challenging endeavor (Marshall et al. 2021). These data limitations and complexities underscore the need for improved research approaches.

Given these data challenges and system complexities, we must explore opportunities that allow researchers to capture the dynamic nature of food systems, including their feedback loops, trade-offs, and synergies (Nayak and Waterson 2019). Current metrics often fail to reflect the complex interactions within these systems, potentially leading to oversimplified assessments and interventions (Allen et al. 2019). To tackle this challenge, we call for a new generation of indicators built by combining observations, models, and complex system analyses. For instance, a systemic risk indicator could integrate real-time supply chain data, climate stress patterns, and economic volatility to provide early warning signals, while a predictive health indicator might combine dietary data with local food environments and machine learning to identify intervention points before health crises emerge.

Developing these next-generation indicators requires leveraging advanced models – including artificial intelligence, agent-based models, econometrics, simulation models, and complex systems science – to innovate how we understand and measure food systems. While these models incorporate novel computational approaches, they must be grounded in a historical understanding of how food systems have evolved. As Brooks and Place (2019) note, while future transformations may differ from past ones, historical patterns remain relevant for constructing plausible scenarios and testing assumptions about future changes. Such modeling approaches depend on integrating diverse datasets, such as satellite imagery, climate data, economic indicators, health

surveys, and logistics networks. Platforms like Dojo ([Dojo Modeling Platform 2024](#)) support this integration by serving as versatile platforms that allow researchers to unify diverse data sources and sophisticated models. By analyzing how these factors interact within such platforms, we can gain deeper insights into system resilience, efficiency, and vulnerability while remaining cognizant of how past policy decisions around productivity, trade, and environment have shaped food systems. Critically, these indicators should include metadata to explicitly highlight guardrails for their appropriate use. For instance, Dojo enables users to add detailed metadata to models and datasets, which promotes reproducibility and ensures results are applied appropriately ([Dojo Modeling Platform 2024](#)). This comprehensive approach not only enhances our understanding of food systems' complexities but also provides clear guidance on the indicators' applications and limitations.

These advancements are directly applicable to the FSCI. By incorporating advanced indicators and methodologies, the FSCI can more accurately monitor progress and identify areas needing attention. This integration presents an opportunity to address critical questions, such as how to effectively measure system resilience or assess the impact of policy interventions across different sectors.

However, significant gaps remain in the availability and accessibility of high-quality, granular data necessary for these advanced models. Questions about standardizing data formats, ensuring interoperability, and protecting data privacy require urgent attention. Opportunities for further foresight research include developing interoperable platforms for data sharing, creating standardized protocols for metadata annotation, and exploring the use of emerging technologies like machine learning and blockchain to enhance data security and traceability.

The set of 50 FSCI indicators is meant to be examined holistically to better understand synergies and trade-offs across different domains of food systems. In an upcoming paper, the FSCI authors assess interactions across the indicators and find that certain governance and resilience indicators have the greatest number of connections to other indicators across all food system themes, thus highlighting key leverage points for action (this may have been due to their generality) (Schneider et al. 2025). Whether those relationships between indicators were synergistic or antagonistic, what is certain is that the interactions between indicators are context-dependent and

strongly influenced by policy measures taken at local or national scales.

While these advances in data integration and modeling show promise, the political context presents additional measurement challenges that are difficult to capture. Foresight analyses must become more sophisticated to analyze potential patterns of policy change and how politics and policies, especially in a competitive international environment, trigger deviations from the norm that lead to unpredictable trends. This shifting political landscape may mean that the indicators we have on hand are insufficient, and we need new metrics (along with participatory stakeholder consultation and engagement to review foresight outcomes) to measure future food systems change. This approach to measurement may also mean that we need to incorporate historical insights into scenarios of the future. These scenarios should include assumptions of what “was” and what “is” to support what “if” type scenarios for unexpected policy shocks.

By tackling these issues and fostering interdisciplinary collaboration, we can create a more robust framework that supports more effective interventions for food system transformation.

This chapter was supported by the CGIAR Research Initiative on Foresight and the CGIAR Science Program on Policy Innovations. We would like to thank all funders who supported this research through their contributions to the [CGIAR Trust Fund](#).

The authors of this chapter are **Jessica Fanzo**, Professor of Climate and Food and Director of the Food for Humanity Initiative in the Columbia Climate School at Columbia University; **Bianca Carducci**, a Postdoctoral Scientist in the Columbia Climate School at Columbia University; and **Michael Puma**, Professor of Climate in the Columbia Climate School and Unit Director of the Center for Climate Systems Research at Columbia University and the NASA Goddard Institute for Space Studies.

Related chapters on the future of food system drivers and impacts, regional and national perspectives, food commodities, and foresight tools are available in our [Table of Contents](#).

Citation: Fanzo, J., B. Carducci, and M. Puma. 2025. “What Do We Know About the Future of Measuring Food Systems?” In *What Do We Know About the Future of Food Systems?*, eds. K. Wiebe and E. Gotor, Chapter 35. Washington, DC: IFPRI. <https://hdl.handle.net/10568/175019>

Photo credit: Ryan Brown/UN Women

References

- Allen, T., P. Prosperi, B. Cogill, M. Padilla, and I. Peri. 2019. "A Delphi Approach to Develop Sustainable Food System Metrics." *Social Indicators Research* 141: 1307-1339. <https://doi.org/10.1007/s11205-018-1865-8>
- Béné, C., C.K. Chege, B. Even et al. 2024. "Why Building Participatory Dashboards Is Key for Sustainable Food System Transformation." *Frontiers in Sustainable Food Systems* 8 : 1405670. <https://doi.org/10.3389/fsufs.2024.1405670>
- Brooks, K., and F. Place. 2019. "Global Food Systems: Can Foresight Learn from Hindsight?" *Global Food Security* 20: 66-71. <https://doi.org/10.1016/j.gfs.2018.12.004>
- Dojo Modeling Platform. Accessed Oct. 17, 2024. <https://www.dojo-modeling.com/>
- Fanzo, J., L.Haddad, R. McLaren, et al. 2020. "The Food Systems Dashboard Is a New Tool to Inform Better Food Policy." *Nature Food* 1: 243-246. <https://doi.org/10.1038/s43016-020-0077-y>
- Fanzo, J., L. Haddad, K.R. Schneider et al. 2021. "Viewpoint: Rigorous Monitoring Is Necessary to Guide Food System Transformation in the Countdown to the 2030 Global Goals." *Food Policy* 104: 102163. <https://doi.org/10.1016/j.foodpol.2021.102163>
- Gebara, C.H., C. Thammaraaksa, M. Hauschild, and A. Laurent. 2024. "Selecting Indicators for Measuring Progress Towards Sustainable Development Goals at the Global, National and Corporate Levels." *Sustainable Production and Consumption* 44: 151-165. <https://doi.org/10.1016/j.spc.2023.12.004>
- Marshall, Q., A.L. Bellows, R. McLaren, A.D. Jones, and J. Fanzo. 2021. "You Say You Want a Data Revolution? Taking on Food Systems Accountability." *Agriculture* 11 (5): 422. <https://doi.org/10.3390/agriculture11050422>
- Nayak, R., and P. Waterson. 2019 "Global Food Safety as a Complex Adaptive System: Key Concepts and Future Prospects." *Trends in Food Science and Technology* 91: 409-425. <https://doi.org/10.1016/j.tifs.2019.07.040>
- Schneider, K.R., J. Fanzo, L. Haddad et al. 2023. "The State of Food Systems Worldwide in the Countdown to 2030." *Nature Food* 4: 1090-1110. <https://doi.org/10.1038/s43016-023-00885-9>
- Schneider, K.R., R. Remans, T.H. Bekele et al. 2025. "Governance and Resilience as Entry Points for Transforming Food Systems in the Countdown to 2030." *Nature Food*. <https://doi.org/10.1038/s43016-024-01109-4>
- van Vuuren, D.P., C. Zimm, S. Busch et al. 2022. "Defining a Sustainable Development Target Space for 2030 and 2050." *One Earth* 5: 142-156. <https://doi.org/10.1016/j.oneear.2022.01.003>
- Zhou, B., S. Liang, K.M. Monahan et al. 2022. "Food and Nutrition Systems Dashboards: A Systematic Review." *Advances in Nutrition* 13: 748-757. <https://doi.org/10.1093/advances/nmac022>

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

A world free of hunger and malnutrition

IFPRI is a CGIAR Research Center

1201 Eye St, NW, Washington, DC 20005 USA | T. +1-202-862-5600 | F. +1-202-862-5606 | Email: ifpri@cgiar.org | www.ifpri.org | www.ifpri.info

Handle: <https://hdl.handle.net/10568/175019>

© 2025 International Food Policy Research Institute (IFPRI). This publication is licensed for use under a [Creative Commons Attribution 4.0 International License \(CC BY 4.0\)](https://creativecommons.org/licenses/by/4.0/).