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Introduction

Foresight and trade-off analyses: Tools for science strategy development in agriculture and food systems research

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Abstract

Foresight and trade-off analyses offer organizations such as CGIAR an opportunity to better prepare for alternative futures through adaptive research strategy and management. This essay introduces a set of papers that explore foresight and trade-off analyses within the context of the major reforms now occurring in the CGIAR. We tease out lessons not only for One CGIAR, but also for international development research organizations more broadly.

Keywords: agricultural R&D, CGIAR, international development

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1 Introduction

From the Desert Locust threat in Africa and Asia to the global pandemic COVID-19 and resulting sharp economic contraction worldwide, 2020 has brought unprecedented shocks to our agricultural and food systems (AFS). These shocks serve as an urgent call to action for all organizations involved in agricultural and food research to collaborate across disciplines, nations, and sectors to better prepare for the future. To facilitate better planning and preparedness, we can anticipate megatrends and shocks that may disrupt AFS and negatively impact livelihoods, thus impeding progress toward the Sustainable Development Goals (SDGs), especially of SDG(1) 'end poverty in all its forms everywhere' and

SDG(2) 'end hunger, achieve food security and improved nutrition and promote sustainable agriculture' (United Nations 2015). Foresight and trade-off analyses offer organizations such as CGIAR an opportunity to better prepare for alternative futures through adaptive research strategy and management. Foresight analysis explores different plausible future scenarios and their possible impacts. Trade-off analysis studies how much, if any, of gains in one desired outcome one must sacrifice to achieve gains in one or more other desired outcomes. Although this essay and the papers that follow explore foresight and trade-off analyses within the context of the major reforms now occurring in the CGIAR, these lessons apply to international development research organizations more broadly. The CGIAR can learn much from this collection of papers, but so can other organizations.

AFS will evolve in ways that cannot be entirely anticipated, mainly because of the complex relationships between human and natural systems and the vastly decentralized and largely uncoordinated nature of decision making throughout interconnected systems. Foresight approaches are ideally suited to explore, both qualitatively and quantitatively, these complex relationships and possible pathways toward achieving the SDGs and other desired outcomes. Combined with trade-off analysis, which make the likely impacts of alternative management decisions across multiple objectives more transparent, these complementary tools can help organizations to understand and adapt to the implications of system change and shocks like those of 2020. For example, foresight analyses might anticipate patterns of growth in production and consumption of alternative protein sources (i.e. plant-based proteins or cultured meats) by combining projected trends in income and population growth with the cost structure and reliability of emergent technologies. Trade-off analyses enable the assessment of likely impacts of more or less animal-sourced protein production and consumption on human nutrition and health, farm livelihoods, land use patterns, and greenhouse gas emissions. Together, foresight and trade-off analyses facilitate the assessment of alternative plausible futures and their varied prospective impacts on multiple outcomes the organization and its stakeholders identify as objectives.

Although the underlying models and analytical tools often attract considerable attention, the primary value of foresight and trade-off analyses for AFS research and for international development organizations goes beyond impact estimates from modeling. Often, the most essential and influential element of this approach is the engagement of internal and external stakeholders in meaningful discussions about system understanding, possible future disruptions, the need for the research, its desired impacts, and suitable indicators for monitoring and evaluating progress toward those shared goals. Effective foresight and trade-off analyses are iterative processes that effectively engage stakeholders at international, national, and regional levels across the AFS value chains, from input suppliers and natural resource managers to food processors and retailers, to food consumer groups.

Precisely because of the complex, decentralized nature of AFS, system optimization is impossible. When foresight and trade-off analysis tools are used to facilitate dialogues, however, they can channel the power of human agency—to cooperate, to innovate, to adapt, or to resist or obstruct—toward productive, inclusive outcomes and away from destructive or exclusive ones. These tools can inform the development, execution, and evaluation of research strategies and reduce coordination and information failures that too often impede impact. We therefore strongly recommend the integration of these tools into ongoing decision making, priority setting, and monitoring and evaluation (M&E) processes. Once foresight and trade-off analyses are routinely used in strategy development and assessment, they will become indispensable tools in participatory decision making. Despite the many benefits of conducting foresight and trade-off analyses, many organizations do not use these tools adequately or at all.

2 The One CGIAR context

Founded in 1971, CGIAR is an AFS research organization with an approximate yearly budget of US$900 million and 11,000 staff across more than seventy countries (CGIAR 2020a). CGIAR is co-funded by national governments, development agencies, and private foundations. In late 2019, CGIAR embarked on an extensive reform toward 'One CGIAR', boldly reforming its governance, partner engagement, funding, and research priorities anchored in the unifying mission of 'Ending hunger by 2030—through science to transform food, land, and water systems in a climate crisis' (CGIAR 2020b). Its 2030 Research Strategy, currently under development, will focus on five impact areas: (1) nutrition and food security; (2) poverty reduction, livelihoods, and jobs; (3) gender equality, youth, and social inclusion; (4) climate adaptation and greenhouse gas reduction; and (5) environmental health and biodiversity. These impact areas intersect with inevitable trade-offs among and within them.

In an effort to inform the One CGIAR research strategy and associated new management practices, the Independent Science for Development Council (ISDC)—a body comprised of eight AFS experts from outside the CGIAR tasked with providing rigorous strategic advice to the CGIAR System Council, and the broader system as a whole—undertook a synthesis review of AFS-oriented foresight and trade-off analyses. Syntheses are most commonly used for scholarly purposes, to define the central tendencies of a collection of related studies, but they can also prove useful tools for informing management and practice. In particular, syntheses can inform diverse decision-makers, often with divergent objectives across AFS disciplines and organizations. Further, the perceptions and understandings of policymakers may vary greatly from those of researchers. Syntheses can provide multiple perspectives on an issue, helping to build cooperation and trust in addition to scientific insights. While reaching full consensus is usually impossible, the process facilitates reaching agreement on steps and directions that must be taken to advance contentious issues, such as the allocation of research resources.

Building on prior work (e.g. Serraj and Pingali 2019), in early 2020, ISDC commissioned two foresight reviews on the five One CGIAR impact areas. The first review focused on the societal impact areas 2 and 3 (Lentz 2020), while the second review centered on the climate and environment impact areas 1, 4, and 5 (Zurek *et al.* 2020). Summaries of those two reports have been revised into the two papers that follow this introductory essay (Lentz, this issue; Zurek *et al.* this issue). The reviews were the first phase in a stepwise approach to extracting actionable knowledge from existing AFS foresight studies.

Referenced studies, a subset of the thousands published (Wiebe *et al.* 2018), used a range of foresight methods, including trend and megatrend analysis, scenario planning, and visioning and backcasting (Table 1), as explained in Lentz (2020). The foresight reviews were the focus of a multiday ISDC meeting where Council members built a consensus of reflections specific to the role of foresight studies and trade-off analyses in the One CGIAR transition. The trade-off analysis report built on the earlier foresight reviews and the ISDC consensus (Antle and Valdivia 2020); it is summarized in another article in this issue (Antle and Valdivia, this issue). The overall aim of ISDC's foresight and trade-off analysis project was to investigate the possible impacts of different CGIAR future investment portfolios across the five impact areas, along with plausible alternative development pathways. The project concluded with eight foresight reflections, nine trade-off implications, and three trade-off recommendations all through the lens of One CGIAR (ISDC 2020a, 2020b).

3 Implications beyond One CGIAR

Although commissioned for CGIAR, these studies resulted in strong messages that are also applicable for other AFS research and international development organizations:

Table 1. Common foresight methods of literature reviewed

Foresight method	Description	Question asked
Trend and megatrend analysis	Trend analysis examines how potential drivers of change have developed over time and how the trend may develop in the future. A megatrend is similar but larger in scale and described as an observable phenomenon. Emerging megatrends can often be categorized as social, technological, economic, environmental, political, or demographic shifts. This method focuses on understanding drivers and their likely direct consequences.	What is driving us toward a specific future?
Scenario planning	Scenario planning describes plausible future states given realistic scenarios for key underlying trends. Scenarios show how changes to select trends create different futures. Scenarios are neither predictions nor attempts to show the most likely future trends nor prescriptive guidance on how best to reach a desired outcome. Scenarios explore differing patterns of interactions between the key drivers of change. In contrast to megatrends analysis, scenario planning typically emphasizes the indirect effects of trends arising from feedback within systems.	What are likely future worlds under alternative realistic scenarios?
Visioning and backcasting	Visioning starts with the present and uses current trends to develop pathways to attain the preferred future. Visioning and backcasting studies define a desired future state and then work backward to define feasible paths from the present to that desired state. Unlike scenario planning, which expressly maps out multiple future states (desirable as well as undesirable), the backcasting approach starts with a single desired future state.	How can we reach a desired future outcome?

1. The foresight literature emphasized several megatrends such as climate change, increasing competition for and degradation of natural resources, and increased demand for food, in the face of population and income growth, and resulting shifts in dietary patterns. This highlighted the need for innovations in AFS toward sustainable increases in food production that also meet consumers' nutritional requirements. These concerns have already drawn considerable, high-level attention (e.g. WEF 2018; FOLU 2019; Willet *et al.* 2019; WRI 2019). The need to simultaneously adapt to and mitigate against climate change has raised formidable challenges for the design of robust AFS (Mbow *et al.* 2019). Globally and locally, AFS will need to adapt to greater water stress, more frequent extreme events, existential threats to coastal agro-ecosystems, transformative change to agro-ecosystems due to abiotic and endogenous ecological shifts, and the impact of climate change on crop and livestock pests and diseases. At the same time, AFS also need to make a sizable contribution toward a reduction in greenhouse gas emissions and biodiversity conservation.
2. The reviews also found that the foresight literature examined focused heavily on megatrends and devoted relatively little attention to systemic shocks—such as pandemics, major trade wars or conflict, or a protracted economic depression. This stands

in contrast to the rapid rise of resilience-oriented donor and operational agency programming and associated research, with the objective of shock-proofing sustainable development (Barrett *et al.* 2020a). All agricultural research and international development organizations, not just One CGIAR, must prepare for scenarios involving major disruptions to operations and background conditions. The dialogues sparked by foresight and trade-off analyses can help foster improved coordination among different stakeholders if—or more likely, when—further disruptions arise. The scope of the foresight reviews did not include identifying why these gaps existed in the literature, nor does ISDC infer that the presence of such gaps in foresight work implies a misdirection in the five impact areas that CGIAR has identified as important. On the contrary, this indicates an opportunity for One CGIAR and its partners to exercise thought leadership in helping to fill these gaps.

3. Despite clear recognition of the likely negative societal consequences of climate change and environmental degradation, the foresight literature gave at best superficial treatment to the One CGIAR impact areas of (1) nutrition and food security; (2) poverty reduction, livelihoods, and jobs; and (3) gender equality, youth, and social inclusion, as well as how these areas intersected with climate change adaptation, greenhouse gas reduction, environmental health, and biodiversity. Few foresight studies focused on more than intermediate outcomes, such as food prices or crop and livestock output, or on proxy indicators such as per capita income or average daily dietary energy consumption. Studies generally showed that trends in population growth, urbanization, migration, climate change, and natural resource degradation and depletion will have adverse consequences for gender equality, poverty reduction, and nutrition, especially in low- and lower-middle-income countries, but rarely unpacked mechanisms and proxy indicators sufficiently to inform research strategy effectively. International development organizations, in particular, must be alert to these omissions and might benefit from conducting their own, strategically focused foresight studies as part of their normal business planning activities.
4. Technology and innovation played significant roles in future scenarios across all One CGIAR impact areas in the literature. Increasing total factor productivity (TFP) of farm-level food production and supply chains' processing, distribution, storage, and transport, manifest in part in decreasing food waste and loss, will be crucial to achieving synergies across impact areas. Otherwise, the trade-offs between climate and environmental objectives and gender, nutrition, and poverty could be stark. This highlights the central importance of AFS research for international development, from exposures to outcomes. Historically, AFS TFP growth has been the most powerful engine of agricultural and structural transformation in reducing poverty and improving nutrition while conserving fragile natural environments (World Bank 2008). Future foresight work on technological change should, however, more explicitly consider complementary adoption and adaptation pathways, in particular how to obviate social and economic obstacles to diffusion of innovations, especially among women and youth. The current foresight literature gave insufficient attention to these issues. Extensive experience within CGIAR and elsewhere cautions that the challenges to scaling up technically sound discoveries can be formidable (Stevenson *et al.* 2019). Moreover, the dramatic changes occurring within developing country agri-food value chains increasingly tie technological change to private firm behaviors and to the institutions and policies that govern investment and trade (Barrett *et al.* 2020b).
5. A separate but related issue is that the foresight literature largely underestimates the governance challenges of extremely decentralized AFS. Indeed, foresight research exhibited considerable naiveté around the potential for scientific knowledge to influence national and global governance, policies, or institutional arrangements. This is especially important in order to resolve barriers to the adoption of innovations by

marginalized producers and, more broadly, to ensuring inclusion of underrepresented groups—the poor, women, youth, and future generations—in the gains from reforms. The deeply fraught issue of the science–policy interface demands much greater attention by both sides, given that this often constitutes the biggest blockage for true innovation to occur.

6. Increasingly, trade-off analysis also is used to explore cross-scale linkages and changes in consumer behavior. This capability enables adaptation of these research management tools to priority setting and program monitoring not only at global level, but equally at smaller spatial scales. This capability is especially important given the high diversity among AFS and the context-specific nature of decision making in highly complex systems.
7. Finally, any innovation-oriented organization must be alert to, and continually assess the inevitable, unintended consequences of new technologies, policies, and institutions. Both foresight and trade-off analysis tools can help obviate the natural tendency to focus only on intended impacts. This not only facilitates early and appropriate responses to unanticipated outcomes, but can also help identify and reinforce the synergistic effects of innovations across multiple impact areas.

4 Conclusion

The articles that follow summarize three important reports that provided the background ISDC required to develop informed recommendations for CGIAR leadership during a critical time of organizational change. As reflected in their commentary on the papers collected here, the leaders of the CGIAR foresight community have already internalized and advanced these insights and continue to advance the science and practice of foresight and trade-off analyses (Wiebe and Prager, this issue).

Although this project was conceptualized to meet the needs of CGIAR, many findings and recommendations may serve as valuable guidance for other AFS research and international development organizations at a time of accelerating global AFS transformation. There is much to learn, not only from the megatrends and various scenarios, which foresight studies have extensively explored, but equally from their omissions of the One CGIAR impact areas. When coupled with evolving methods of trade-off analysis, especially linked across macro-to-meso scales appropriate to different decision-makers, these offer a powerful toolkit for the development, execution, and ongoing M&E of a research strategy. Agricultural research and international development organizations can use these methods for continuous improvements of AFS performance against multiple indicators.

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