



# Transforming Food Systems: The Missing Pieces Needed to Make Them Work

Eileen Kennedy,<sup>1</sup> Patrick Webb,<sup>1</sup> Steven Block,<sup>2</sup> Timothy Griffin,<sup>1</sup> Dariush Mozaffarian,<sup>1</sup> and Rachel Kyte<sup>2</sup>

<sup>1</sup>Friedman School of Nutrition Science and Policy, Tufts University, Boston, MA, USA and <sup>2</sup>Fletcher School of Law and Diplomacy, Tufts University, Medford, MA, USA

## ABSTRACT

Food systems lie squarely at the intersection of several overarching goals of the UN and member states, as embodied in the Sustainable Development Goals, including eliminating poverty, hunger, and malnutrition in all its forms, achieving good health and well-being, while promoting environmental sustainability. The need for radical transformation of current food systems is inescapable if the world is to achieve one, let alone all, of these goals. Meeting this challenge will inevitably be disruptive to current food systems, carry costs, and be politically onerous. But the projected benefits far outweigh these difficulties. This commentary spells out the complexity of issues that need to be tackled to design and implement food systems that improve diets, nutrition, and health in an equitable fashion, while simultaneously respecting planetary boundaries. Six critical domains are identified that must be addressed for the successful transformation of food systems: 1) reinvent agriculture, 2) transform food environments for healthy diets, 3) mitigate climate change, 4) productively engage the private sector, 5) influence public policy priorities, and 6) establish true cost accounting of food. Because science is crucial for each of these domains, a research-driven strategy, emphasizing a collaborative process, is outlined. Bold, new, but technically and politically feasible actions are needed to effectively transform current food systems. *Curr Dev Nutr* 2021;5:nzaa177.

**Keywords:** food systems, sustainable development goals, environment, malnutrition, agriculture

© The Author(s) 2020. Published by Oxford University Press on behalf of the American Society for Nutrition. This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited. For commercial re-use, please contact [journals.permissions@oup.com](mailto:journals.permissions@oup.com)

Manuscript received October 31, 2020. Initial review completed November 24, 2020. Revision accepted December 4, 2020. Published online December 10, 2020.

The authors reported no funding received for this study.

Author disclosures: The authors report no conflicts of interest.

Address correspondence to EK (e-mail: [Eileen.kennedy@tufts.edu](mailto:Eileen.kennedy@tufts.edu)).

Abbreviations used: FBDG, food-based dietary guideline; GHG, greenhouse gas; NCD, noncommunicable disease; SDG, Sustainable Development Goal.

## Introduction

The UN will host a Food Systems Summit in September 2021. The Summit will convene heads of state, senior country delegates, and business leaders as well as civil society and other stakeholders. One overarching issue for the summit is to develop game-changing strategies for a dramatic transformation of food systems to achieve healthy, sustainable diets that are produced with equitable access and will preserve or regenerate the natural environment. The Secretary General and other UN leaders are clear that bold new actions are required to transform the way food is produced and consumed to achieve dramatic progress in addressing the 17 Sustainable Development Goals (SDGs). The Summit will concentrate on developing specific, actionable, multistakeholder inputs into priorities, challenges, and opportunities to redesign food systems at the local, national, and international levels.

### Current food and nutrition challenges

The statistics on food insecurity and malnutrition in all its forms are unequivocal in underscoring the scale of the challenges ahead. Poor diets are a main contributor to the global burden of disease, causing

an estimated 8 million deaths, affecting about 1 in 7 people in 2019 (1, 2). Today, almost 1 billion people do not have access to enough calories, 2 billion are thought to be deficient in dietary sources of vitamins and minerals, and ~3 billion continue to consume suboptimal diets that significantly increase the risk of food insecurity, undernutrition, overweight and obesity, and associated diet-related noncommunicable diseases (NCDs) (1, 3, 4).

### Food Systems at a Crossroads

Today's food systems were designed to address problems of the mid-20th century: to provide ample, cheap, shelf-stable, starchy calories for a growing world population, fortified with key micronutrients where feasible to prevent clinical nutrient deficiencies (5). Human and planetary concerns of the 21st century—the intersections of chronic diseases, improved but continuing food insecurity, undernutrition, and sustainability—require a fundamental transformation of food systems to meet evolving and future needs of consumers, producers, and the resource base on which all life depends.

The link between nutrition and sustainability is often understood in terms of the health and environmental impacts of diets. This construct is important but also unnecessarily narrow. In line with the SDGs, economic and societal outcomes are also components of the food system; income inequality, social discrimination, and constrained economic opportunities are concomitant with barriers to obtaining healthy diets, or in some cases, enough calories. In practical terms, this means seeking a much deeper understanding of the drivers of food choice in all contexts around the world. This goal goes far beyond seeking to “resolve hunger” through increased grain supply or by reducing greenhouse gas (GHG) emissions. As the global population increases in coming decades, coupled with rapid urbanization and increased incomes, patterns of dietary demand will change dramatically, and the ways in which food systems underpin such changes will be critical.

The complexity of food systems has been compounded by recent events. The coronavirus pandemic and associated policy responses have highlighted how vulnerable today’s global, national, and local food systems are to disruptions, be they limiting agricultural labor and other inputs at the farm level, restricting transportation and processing, or affecting trade and consumers’ purchasing power. At the same time, the pandemic has also underscored the significant negative environmental resource and climate impacts of the food we produce and how we choose to eat. Choices made by consumers (dietary patterns), market agents (involved in moving, storing, processing, and selling food), and producers (technologies and agricultural practices) affect and are affected by the climate and the evolution of the global burden of disease. This can have profound implications for planetary and human health, not just for vulnerable populations and communities, but for the entire planet. Thus, tackling the escalating costs associated with healthcare and productivity losses while better managing global emissions and natural resource degradation that threaten planetary boundaries, requires a laser-like focus on the urgent need to transform our food systems over the coming decade—one that is good for us and our planet.

## Food Systems for Tomorrow

A major redesign in food systems is essential to combat food insecurity and malnutrition in all its forms within planetary boundaries (6). The UN decade of action on nutrition (2016–2025) led by FAO and WHO, has emphasized a redesign of food systems as 1 of 6 essential actions to achieve the SDGs, in particular: SDG 1, no poverty; and SDG 2, zero hunger (7). Seven other SDGs that can only be met by redesigned food systems include: SDG 3, good health and well-being; SDG 10, reduced inequalities; SDG 11, sustainable cities and communities; SDG 12, responsible consumption and production; SDG 13, climate action; SDG 14, life below water; and SDG 15, life on land.

To this end, several high-level reports have recently emerged emphasizing the urgency of reforming our food systems to achieve the SDGs (1, 6, 8). The Global Panel on Agriculture and Food Systems for Nutrition report (6) highlights that climate, globalization of diets, urbanization, income growth, and changing consumer trends have led to changing diets and consumer behavior and patterns for food; this report points out that our current food systems are imperfect and rely heavily on providing quantity without emphasizing the quality of food.

To achieve progress will require a “food systems approach” that encourages government and private sector stakeholders to coalesce to prioritize nutrition through high-quality diets while protecting the environment. Despite the similarity in findings from the recent food systems reviews, major questions still remain unanswered in considering food systems transformation. A critical gap is the lack of strong empirical evidence to guide policy decisions around nutrition, sustainable agriculture, and the environment.

To fill information gaps, each of these recent high-level reports calls for a multidisciplinary way of thinking using a “One Health” approach to establish sustainable practices in agriculture to improve the well-being of humans, animals, and the planet (see, e.g., [www.tuftsctsi.org/research-series/one-health](https://www.tuftsctsi.org/research-series/one-health)). To achieve this integrative thinking requires a perspective that explicitly rejects the traditional siloed approaches that viewed agricultural development as largely distinct from health and nutrition concerns, and the interaction of both with the environmental impacts. The upcoming UN Food Systems Summit in 2021 demonstrates the global community’s growing awareness of the need for such integrative approaches to these complexly interconnected challenges.

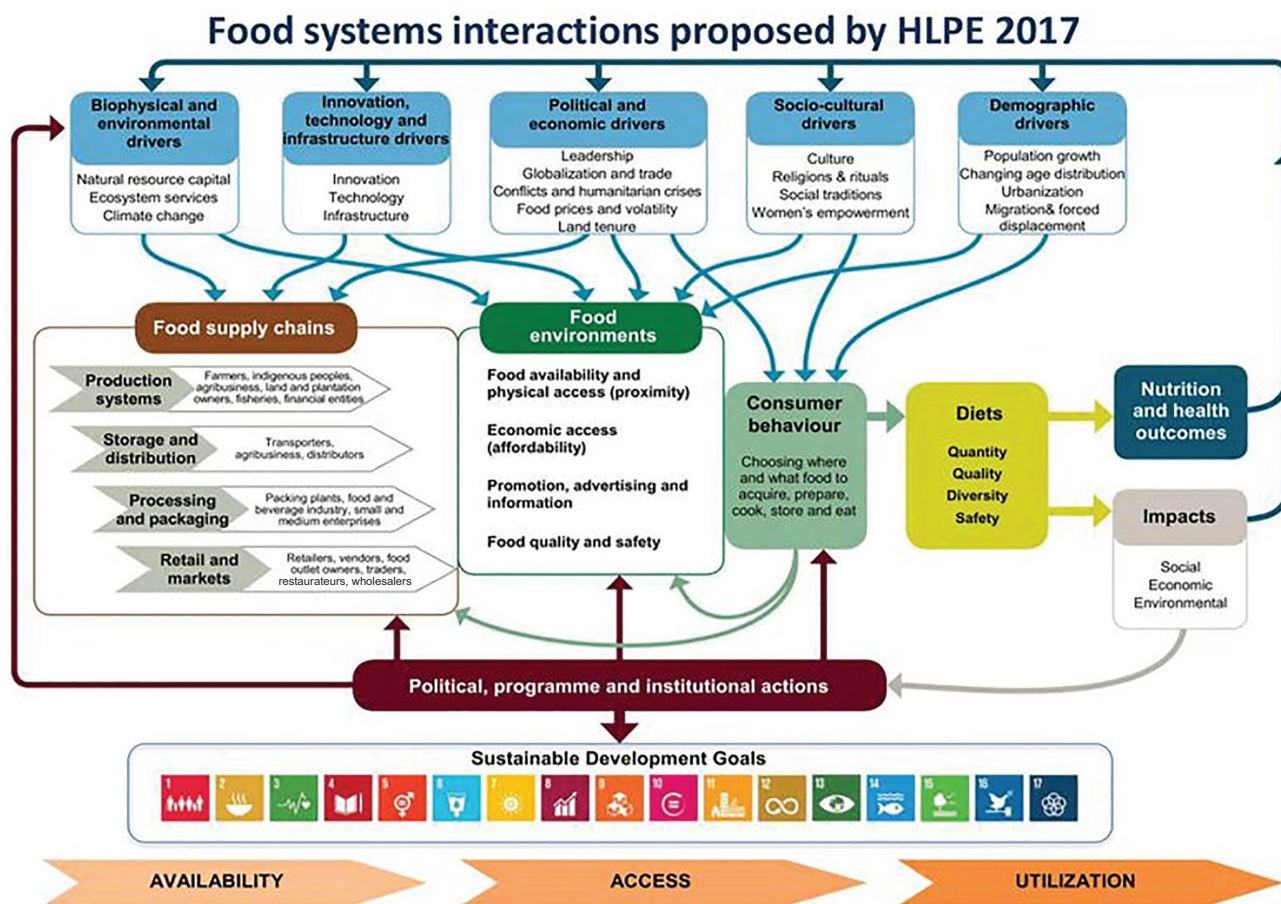
The complexity of food systems is illustrated in **Figure 1** (8). The framework includes: biophysical and environmental drivers; innovation, technology, and infrastructure drivers; political and economic drivers; sociocultural drivers; and demographic drivers, as 5 distinct areas that influence changes in the food system. These drivers, in turn, affect the food environment, food supply chain, and consumer behavior, which ultimately determine the health, nutrition, social, and economic outcomes of the food systems.

Much media and political attention (largely driven by empty supermarket shelves) has been concentrated on enhancing the resilience of the global supply chains. Although that is important in the short term, the fundamental challenge is how to create transformational change that can tackle global problems via making healthy diets available and affordable (and desirable) to all through reconfigured sustainable food systems (9).

## Food Systems: From Evidence to Action

It remains hard to convince many policymakers of the need to facilitate urgent, often radical, changes in food systems. The essence of this is captured from the following quote: “Evidence-based policy making is an important aspirational goal, but only a small proportion of research has the policy impact it might have. Most researchers are not trained to create policy impact from their work” (10). The inherent complexity of food systems with multiple stakeholders (including governments and the private sector) with conflicting interests and differing degrees of power and authority creates a situation in which there is no effective governance of food systems. Defining the priorities and the “how” remains hard. A new kind of policy thinking is needed, underpinned by new evidence of what can work, and how to manage a transition in which science, technology, business, and government are all united towards a common planetary goal.

A recent commentary (11) identified some of the priority actions that are critical for the transition of food systems towards sustainable, healthy diets (**Figure 2**). These policy questions are divided into 4



**FIGURE 1** Food systems conceptual framework. HLPE, High Level Panel of Experts on Food Security and Nutrition. Adapted from reference 8 with permission. Nutrition and Food Systems. FAO. 2017.

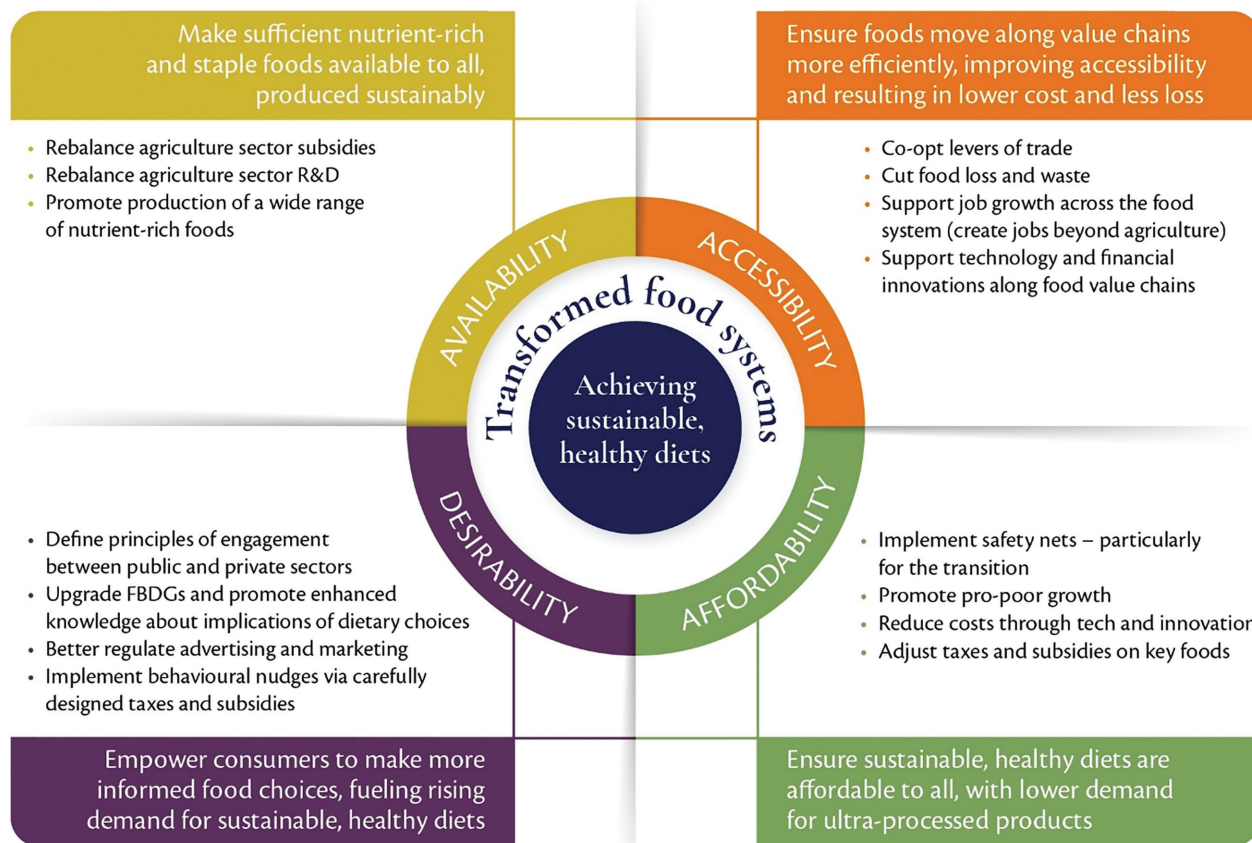
domains: availability, accessibility, affordability, and desirability. Within each of these domains a series of specific policies are identified. However, each of these domains contains unanswered issues that preclude advancing specific policy advice.

Although useful, the schematic does not address trade-offs *between* competing SDGs, nor the relative importance, practicality, and feasibility across the range of policy options available at the national and subnational levels. Two examples illustrate this conundrum. First, many countries, in their multisector nutrition plans, advocate for increased production of nutrient-rich foods (12). Thus, the recommendation in Figure 2 to “Promote production of a wide range of nutrient-rich foods” is consistent with many national-level plans. How to achieve this policy objective, however, is complicated. There is often an inconsistency between country-level agricultural goals and household-level priorities. For example, encouragement of an increased production of a variety of crops, although admirable, flies in the face of smallholder realities. Research on household decision making shows that smallholders put a premium on producing basic staples to ensure food security, over and above the cultivation of nutrient-dense fruits and vegetables (13). The case of Myanmar illustrates this further. The government has historically pursued what is termed a “Rice Bowl Policy,” stressing an inordinate emphasis on rice production (13); here again, this has been a major

challenge in encouraging a more diversified agricultural production in Myanmar.

Figure 2 also identifies “Define principles of engagement between public and private sectors.” Here again, this goal is admirable, but thus far has been elusive to achieve in many countries. A summary of the challenges to advancing public-private sector collaborations within 24 low- and middle-income countries include: lack of trust, absence of demonstrated models for reaching SDG2, vested interests, and corruption, to name a few (13). This is not to suggest that public-private sector initiatives are unimportant but rather methods to achieve this collaboration have not been effectively developed and/or tested.

Upcoming debates on the design of future food systems will be fierce. There is an urgent need for an body like the Intergovernmental Panel on Climate Change dedicated to collation and translation of science relating to food systems. A significant deepening is needed of the scientific agenda relating to the politics and the economics of food systems: how production, trade, pricing, and procurement policies require us all to consider “who pays?” via health costs, climate externalities, income losses from shifting agricultural subsidies, and so much more. Economic models (food trade, prices, transportation logistics, demand) need to be fully articulated across the world, and fully integrated with



**FIGURE 2** Policy priorities for a food system transformation. FBDG, food-based dietary guideline. Adapted from reference 11 with permission.

other complex dynamic modeling relating to climate change, on the one hand, and to natural resource depletion and degradation, on the other. Each of the above must be effectively integrated into an understanding of the many societal, economic, and political trade-offs associated with necessary action.

This is no small agenda. An improved coordination of the science and its messaging to policymakers and the business communities is needed to promote a clearer understanding and coherent public and private sector responses. The future for transformed food systems depends on collective action at the interface of science and policy. Many stakeholders will have roles in convening, facilitating, and catalyzing partnerships dedicated to the mobilization of a new science for serious but pragmatic change.

### The Missing Pieces of the Food Systems Puzzle

There are many key questions posed for food systems that can only be addressed through transdisciplinary/multi-partner efforts. These questions can be allocated into 6 broad categories: 1) reinvent agriculture; 2) transform food environments for healthy diets; 3) mitigate climate change; 4) engage the private sector; 5) influence policy priorities; and 6) establish true cost accounting. There are a range of questions in each of the 6 domains. The illustrative questions discussed

below are only a small sample of the myriad issues that need to be addressed.

### Reinvent agriculture

A key element of all food systems falls under the rubric of agriculture: food and nonfood product production, distribution, marketing of commodities, and livestock. The litmus test for successful agriculture is changing dramatically; agricultural policies will be judged against a much more complicated set of factors (13). The agriculture sector will be expected to increase output (quantity and quality) on the same amount of land and to do so in an environmentally sensitive manner.

Some policy options for agriculture are detailed in Figure 2. For example, the call for production of a wider range of crops is regularly discussed as a key policy option for agriculture. There are, however, huge gaps in our understanding of how to ensure an evidence-based approach to agricultural policies without a much better understanding of what works and in what local contexts. There are important questions, the answers to which require serious attention to research and development. Many countries are emphasizing farmers' uptake for production of nonstaple crops that have both nutrition and economic value. The "how" to achieve this goal is ambiguous given our current state of knowledge. Some other examples further illustrate this point. We need a much better understanding of how access in various types of markets (agricultural input, agricultural output) mediate differently

between agricultural production and diet and nutrition outcomes. The inability to provide evidence on some potentially impactful innovations in agriculture limits widespread adoption of revised policies. The success in reinventing agriculture to contribute to more effective food systems hinges on high quality data that respond to pertinent policy options.

### Transforming food environments for healthy diets

It is the food environment that links agriculture to consumer food choices. There are a lot of theories, untested, about how the food environments can be improved to contribute to healthy diets. Typically, policy officials stress the promotion of food-based dietary guidelines (FBDGs) and/or consumer education as 2 tools to improve consumer choice. Do these tools work? Are there multiplier effects of combining the promotion of FBDGs and consumer education? How can commercial food companies be best incentivized to support healthy sustainable diet choices in line with national public health goals? It is important to identify effective methods for linking national public goals with commercial interests as a way to improve the food environment. These are just a few of many questions for which we need more data to bring about effective behavior change for food choices and consumer behaviors.

### Mitigate climate change

Climate is changing at an alarming rate. Climate change is a threat to agriculture and livelihoods, with wide-ranging current and future impacts including reduced agricultural productivity, increased frequency of natural disasters, and higher variability of water availability (13). Lack of research related to some critical questions precludes making significant progress in mitigating the effects of climate change. How do we reduce the climate impact due to the diets we consume while realizing the need for animal-sourced foods for improving the nutritional status of certain populations? How can we mitigate the risk associated with livestock ownership due to the relative risk of zoonotic diseases and implications for human health and nutrition?

### Engage the private sector

Models of successful public-private sector partnerships historically, and even at the present time, are limited. Yet it is impossible to envision a successful transformation of food systems without an active involvement of the private sector across the whole food system. Here again, some critical questions need to be addressed. What kind of incentives/taxes and/or subsidies should be provided to improve access and availability of nutritious foods? Similarly, how can governments get buy-in from the private sector to reformulate products and standardize food labeling and packaging because these are elements that can influence consumer preferences? How can we leverage the supply chain networks of the private sector to improve access and availability of nutritious foods?

### Influence policy priorities

There is universal agreement that evidence-based policies are critical. Policy formulation can be influenced if there is strong, consistent information on cost-effectiveness of different policy options. In many cases these data are not available. There are, however, unanswered questions. How might trade liberalization and globalization, particularly in low- and middle-income countries, affect sustainable production and con-

sumption of energy-dense, highly processed foods? How do various instruments of trade policy affect the supply, price, and availability of nutrient-rich foods across rural markets?

### Establish true cost accounting of food

An accurate accounting of costs and savings is necessary to evaluate the utility of various policy options in agriculture, food, and nutrition. Regrettably, these kinds of data are rarely available to guide policy choices. For example, what do we know about the costs and benefits of regenerative agricultural practices to sequester GHGs and reduce use of water, topsoil, and pesticides if widely implemented? What are the incentives in business innovations to create healthier processed and packaged foods that reduce NCDs when implemented?

### Conclusions

Addressing the questions in the above 6 domains is an urgent priority. Practical solutions will necessarily be forced to grapple with difficult trade-offs among competing objectives, while exploiting synergies where possible. The challenge of balancing potential trade-offs among competing objectives is heightened by the competing economic and political interests of multiple stakeholders and the lack of mechanisms for global governance to coordinate the needed responses. Action cannot wait until the end of 2021; it must start today!

### Acknowledgments

The authors' responsibilities were as follows—EK, PW, SB, TG, DM, and RK: were involved in the conceptualization, review, and comments on revisions of the manuscript; EK, PW, and SB: drafted the various versions of the manuscript; and all authors: read and approved the final manuscript.

### References

1. Global Nutrition Report. 2020 Global nutrition report [Internet]. [cited 2020 Oct 27]. Available from: <https://globalnutritionreport.org/reports/2020-global-nutrition-report/>.
2. The Lancet. Global burden of disease [Internet]. 2020 [cited 2020 Oct 27]. Available from: <https://www.thelancet.com/gbd>.
3. FAO, IFAD, UNICEF, WFP, WHO. The state of food security and nutrition in the world [Internet]. 2020 [cited 2020 Oct 27]. Available from: <https://www.fao.org/documents/card/en/c/ca9692en>.
4. GDB 2017 Diet Collaborators. Health effects of dietary risk in 195 countries, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet* 2019;393:1958–72.
5. Mozaffarian D, Rosenberg I, Uauy R. History of modern nutrition and science: implications for current research, dietary guidelines and food policy. *BMJ* 2018;361:k2392.
6. Global Panel on Agriculture and Food Systems for Nutrition. Foresight 2.0 [Internet]. 2020 [cited 2020 Oct 27]. Available from: <https://www.glopan.org/foresight2/>.
7. WHO. Decade of action on nutrition [Internet]. [cited 2020 Oct 27]. Available from: <https://www.who.int/nutrition/decade-of-action>.
8. High Level Panel of Experts on Food Security and Nutrition. Nutrition and Food Systems [Internet]. Rome: Committee on World Food Security; 2017 [cited 2020 Oct 27]. Available from: <https://www.fao.org/3/a-i7846e.pdf>.

9. Global Panel on Agriculture and Food Systems for Nutrition. Covid-19 [Internet]. 2020 [cited 2020 Oct 27]. Available from: <https://glopan.org/resources-documents/Covid-19>.
10. Brownell K. Strategic science with policy impact. *Lancet* 2015;385: 2445–6.
11. Webb P, Benton TG, Beddington J, Flynn D, Kelly NM, Thomas SM. The urgency of food systems transformation is now irrefutable. *Nat Food* 2020;1:584–5.
12. Kennedy E, Kershaw M, Coates J. Food systems: pathways for improved diets and nutrition. *Curr Dev Nutr* [Internet] 2018;2(9):nzy027[cited 2020 Oct 27]. Available from: <https://academic.oup.com/cdn/article/2/9/nzy027/5061742>.
13. Kennedy E, Jafari A, Stamoulis K, Callens K. The FIRST programme: food and nutrition security, impact, resilience, sustainability and transformation: review and future directions. *Glob Food Sec* [Internet] 2020;26:100422[cited 2020 Oct 27]. Available from: <https://www.sciencedirect.com/science/article/pii/S2211912420300766>.