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# Food Systems – Definition, Concept and Application for the UN Food Systems Summit

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**A paper from the Scientific Group of the UN Food Systems Summit**

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# Contents

## Abstract

The UN Food Systems Summit is about changing food systems to achieve healthier, more sustainable and equitable food systems. This paper aims to inform about concepts and definitions of food systems and determinants of their change. To foster a clear understanding of food systems, especially with regard to the upcoming Food Systems Summit, we first present a general food systems concept. We then introduce a concept which is specifically designed for the Food Systems Summit, based on the five goal-oriented Action Tracks (serving SDG2) and their interlinkages. We suggest a food system definition that encompasses the broad set of actors and drivers and embeds the concept of sustainability within it. Annexes to the paper draw attention to selected food systems studies and important policy papers that draw on food systems concepts.

# 1. Introduction

The UN Food Systems Summit is about actions that promise *change* to achieve healthier, more sustainable and equitable food systems. As we are headed toward the Summit, the very concept of food systems needs to be clearly understood for fruitful deliberations and ultimately also actions. Therefore, a main purpose of this paper is to inform about *concepts and definitions of food systems*. In that context, drivers and mechanisms of change of food systems need clarification. Conceptualizing *systems' change* is relevant for policy opportunities and for setting ambitions for the Food Systems Summit.

Change in food systems comes about through external and internal forces as well as feedback mechanisms among these forces. These feedback mechanisms may be short-term, but often they may actually come with long delays, such as the impact of greenhouse gas emissions manifesting in climate change. Population growth and migration are fundamental drivers and shape change in food systems, combined with urbanization. Changing consumer habits, for instance when incomes raise, is another driver of great importance. Science, innovation and technology have huge impacts on food systems' changes. Markets, trade, and infrastructures – increasingly combined with digitization – are cutting across internal and external drivers of food systems' change. Purposeful policy interventions attempt to influence all these forces of change, or their consequences, such as the loss of biodiversity. Policies, however, are also partly driven and re-defined by these factors. Moreover, there are long-term natural and evolutionary biological change processes that also impact the multiple interactions within the food systems.

Food systems have been continuously subject to change and adaption since they evolved in the Neolithic about 15 thousand years ago, though change has been especially dramatic in the past 200 years. Food systems are bound to further change in the future given that we are developing towards an ever more urban society and that the population will possibly be stabilizing at about 9 to 10 billion people by the end of this century. Drivers of the change processes are developments within science and related innovations as well their interlinkage with policies, both of which are linked to the interests, needs and accomplishments of farming communities, the food industry, and the demand of consumers. We discuss both, *change that happens anyway* (i.e. drawing on a so called "positive theory" of systems) and *change that is actively pursued and goal-oriented*, especially within the context of the Sustainable Development Goals (SDGs) by, for instance, setting new norms (i.e. drawing on normative theories of systems).

With this paper we aim to inform the interested Food Systems Summit public. Our goal is not to develop new concepts and theories, rather to assist in the understanding of food systems, their dynamics, their indirect effects of exogenous influences and impacts of policies through system linkages, and to relate these concepts in helpful ways to the concept of UN Food Systems Summit.

The way in which changes in food systems impact sustainability in its diverse social, economic, and environmental dimensions must be of key interest to us. The role of science and innovation is an important theme here, as some of the conflicting issues about food systems changes can be remedied by innovations.

In the following, we first define and elaborate on a concept of food systems (Chapter 2) before applying this concept to the context of the Food Systems Summit (Chapter 3). The Annexes provide information on various food systems frameworks (Annex 1) and key documents on food systems' objectives (Annex 2). Finally, Annex 3 offers a selected bibliography on the subject.

## 2. A General Food Systems Concept

The food system includes the related resources, the inputs, production, transport, processing and manufacturing industries, retailing, and consumption of food as well as its impacts on environment, health, and society. There is an accelerating momentum worldwide to adopt the food systems approach to bring consumption and production patterns together.[1]

A practical definition of food systems should meet two essential criteria:

(1) it should be suitable for the purpose at hand, which is to support the global and national collective efforts to bring about positive change in food systems, accelerating progress on meeting the 2030 Agenda and the SDGs; and

(2) it should be sufficiently precise to define the domains for policy and programmatic priorities. It should also serve concepts for data gathering, modelling, and analysis to assist in effective policy action. Simultaneously, it should be sufficiently general not to exclude any aspects of the economic, social, and environmental dimensions of sustainability.

The significance of criterion (1) is that the definition should guide not only scientific inquiry, but also actions of all types, toward a common purpose: food systems changes and in the long run even transformation. The idea of transformation as commonly used can refer to any large-scale change, whether intended or not, whether beneficial to a specific goal and to a specific context or geography or not.[2] The point of criterion (2) is to avoid the intellectual hubris that accompanies many efforts of characterising and graphically depicting food systems' complexities in great detail. Efforts to map food systems visually help scientists as well as decision makers to identify key interactions and the mechanisms, both natural and social, which regulate those interactions. Yet, food systems maps that try to be fully comprehensive tend to collapse under the density and complexity of the interactions to be described and analysed. At the other extreme, food systems maps and models that focus too narrowly on a reduced set of phenomena gain apparent explanatory power at the price of realism, adequacy or, most importantly, the exclusion of important economic, social or environmental forces. There is no clearly defined pathway out of this dilemma. Much depends on the policy question and the context and scale of the food systems under consideration. We suggest a **definition of food systems** that acknowledges the functional relationships in systems and is normative in relation to a given set of core objectives, such as the SDGs. This approach must not neglect basic principles of systems theory (Box 1).

[1] For example, the 10YFP Framework of Programmes on Sustainable Consumption and Production Patterns.
[2] The Global Sustainable Development Report defined transformation as "a profound and intentional departure from business as usual" with the intentional departure being specified as "transformation toward sustainable development." United Nations, 2019, p. xx and xxii.

**Box 1: On Systems Theory and Dynamics**

Systems theory and system dynamics are established concepts that are relevant for conceptualizing food systems. **Systems theory** is the study of systems. Important conceptualizations stem from W. Forrester who is a founder of the field of system concepts and dynamics (Radzicki and Taylor 2008). Forrester argues that a system is composed of regularly interacting or interrelating groups of activities. **System dynamics** is a methodology to frame, understand, and discuss complex issues and problems. System dynamics models solve the problem of simultaneity and mutual causation by updating all variables in time increments with positive and negative feedbacks and time lags, structuring interactions and controls. The best-known system dynamics model is probably the *The Limits to Growth* (Meadows et.al. 1972).

For instance, a system that has no defined boundaries, or where the building blocks connected by linkages and feedback mechanisms are ill-defined, is a fuzzy concept. Broadly accepted definitions of food systems encompass a broad set of actors and drivers and embed the concept of sustainability. Building on a definition by FAO (2018), food systems encompass the entire range of actors and their interlinked value-adding activities involved in the production, aggregation, processing, distribution, consumption and disposal of food products that originate from agriculture, forestry or fisheries, and food industries, and the broader economic, societal and natural environments in which they are embedded. Production at the beginning of value chains, of course, includes the farming communities but also pre-production actors, i.e., from input industries such as fertilizer or seeds. The range of actors also includes science, technology and innovation actors that are partly integral to the food system, partly embedded, for instance, in the life science and health research systems. In food industries' processing, foods and non-foods result from interlinked value chains. Related to these value chains is another set of relevant food systems actors, i.e. public and private quality and safety control organisations.

**Food systems' boundaries** may be defined at different scales (local, regional, global), for different contexts (e.g., urban, rural), and separated from other systems, such as the health system. There is also increasingly a notion of a **sustainable food system** understood as "… a food system that delivers food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised" (FAO, 2018). The concept of a sustainable food system entails normative aspects, because food systems use resources which typically do not offer absolute levels of sustainability. Thus, sustainable food systems incorporate an understanding of sustainability that reflects relative change in the sense of a change toward more versus less sustainability compared to a previous situation. In that respect, the notion of **food systems transformation** is being considered. That concept has been linked to the aspirations of the 2030 Agenda and refers to the objective of pursuing fundamental change of food systems, for instance, to aim for climate neutrality and achieving the SDGs (FAO, 2020). For analytical and monitoring purposes we suggest a more neutral, evidence-based

terminology, which may distinguish between status and systems dynamics by referring to evolution, transition, and transformation.

Food systems are in a continuous state of change and adaptation. It lies in the nature of farming and food production that systems evolve. For the Food Systems Summit this means an encouragement to raise the question, what policies, innovations, and institutions are needed to remediate or mitigate negative side-effects that are inherent to the fact that agriculture, food processing, etc. always use energy, taking nutrients from the land and water to convert them into food, while simultaneously generating a significant level of greenhouse gas emissions in the process of production, which is further augmented if food is wasted. A sustainable circular bioeconomy concept as an overarching systems frame, in which food systems are embedded, may be considered in the solution-finding process.

A **food systems concept** that provides the realities of its main components and can identify the positioning of the Food Systems Summit "Action Tracks" (Food Systems Summit, 2020) is depicted in Figure 1.

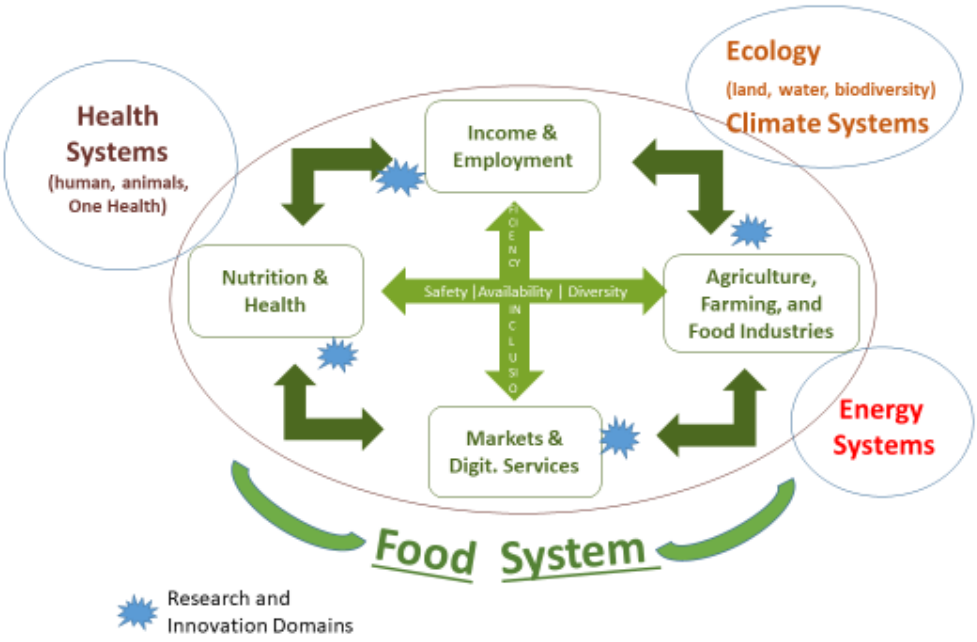


*Figure 1: The food system in the context of other systems (positive systems concept)*

Source: Adapted from InterAcademy Partnership (2018) and von Braun (2020).

Agriculture (incl. animal production and fisheries) and food industries are broadly present in the production side. However, the food system comprises also the consumption, nutrition, and health side, resource utilization, food markets and services as well as food- and agriculture-related income and labour markets in an interlinked system. The food systems concept has defined boundaries, while simultaneously being connected to neighbouring systems such as the health system, ecological systems, and the energy system. Further, the system may be impacted by external shocks, such as climate or health or economic shocks.

# 3. A Food Systems Concept for the UN Food Systems Summit and its Action Tracks

The food system as depicted in figure 1 does not capture the rich diversity of organisational and institutional patterns. In institutional terms, the food system is largely structured by private sector actors, be they farmers, food manufacturers, traders, retailers, or food service business. At the same time, there are important features of cooperative and collective action arrangements among farming communities, group formations by gender, with regard to rural savings and banking, etc. Also, there are industry clusters at large scales. Any Food Systems Summit policies and programmatic proposals need to consider the realities of institutional arrangements and organisational structures, and include the respective actors in the deliberations.

As mentioned above, systems can be conceptualized from a positive or from a normative perspective. The former concept, depicted in the previous section, attempts to design systems' structures and functions as they occur in the current real world as the basis on which a positive concept then identifies points of entry for desirable systems' changes. The latter postulates a set of objectives and aims to shape the systems to serve the stated objectives. Both concepts do aggregate and simplify real world structures and processes. Both approaches do not escape the yard sticks of scientific evidence. For theoretical clarity of underlying value judgments, however, the two approaches need to be distinguished. As the Food Systems Summit is based on stated objectives already defined in the SDGs, a normative approach is justified. Yet, normative approaches need to be put to the test by positive approaches in order not to steer into a dead end of unrealistic wishful thinking. Thus normative and positive approaches are complementary.

A normative concept and definition of food systems based on objectives embraces the **five Actions Tracks**. Like any normative approach that states objectives, it is based on value judgments. Science needs to be transparent about value judgements. Normative definitions of sustainable, healthy food systems can be organised around intentional objectives. Areas of attention for policy and programme action and for building models of food systems that are aligned with the intentions as expressed in the 2030 Agenda can be facilitated. To build upon existing efforts, we suggest a concept of food systems that may help frame action-oriented agenda setting, such as that reflected in the five Action Tracks for the Food Systems Summit in support of the SDGs. These Action Tracks are currently described as:

1. Ensuring Access to Safe and Nutritious Food for All (enabling all people to be well-nourished and healthy);
2. Shifting to Sustainable Consumption Patterns (promoting and creating demand for healthy and sustainable diets, reducing waste);

3. Boosting Nature-Positive Production at Sufficient Scale (acting on climate change, reducing emissions and increasing carbon capture, regenerating and protecting critical ecosystems and reducing food loss and energy usage, without undermining health or nutritious diets);

4. Advancing Equitable Livelihoods and Value Distribution (raising incomes, distributing risk, expanding inclusion, creating jobs); and

5. Building Resilience to Vulnerabilities, Shocks and Stresses (ensuring the continued functionality of healthy and sustainable food systems).

The five Action Tracks capture various key opportunities and challenges of food systems and relate to one or more food systems components, but *they do not define a food systems concept* as such. Therefore, the pursuit of the Action Tracks needs to be conscious of an overarching food systems concept. Pursuing each Action Track in isolation from the others would lead to inefficient solutions which neglect system-wide effects. We thus offer an approach that attempts to position the five Action Tracks in a food systems framework (Figure 2). "Ensuring Access to Safe and Nutritious Food for All (enabling all people to be well-nourished and healthy)" is an overarching systems goal, supported by the other four Action Tracks. Action Track No.1 needs to consider functional relationships with all the other tracks, and these other four need to consider the linkages with the respective other three in systemic ways.

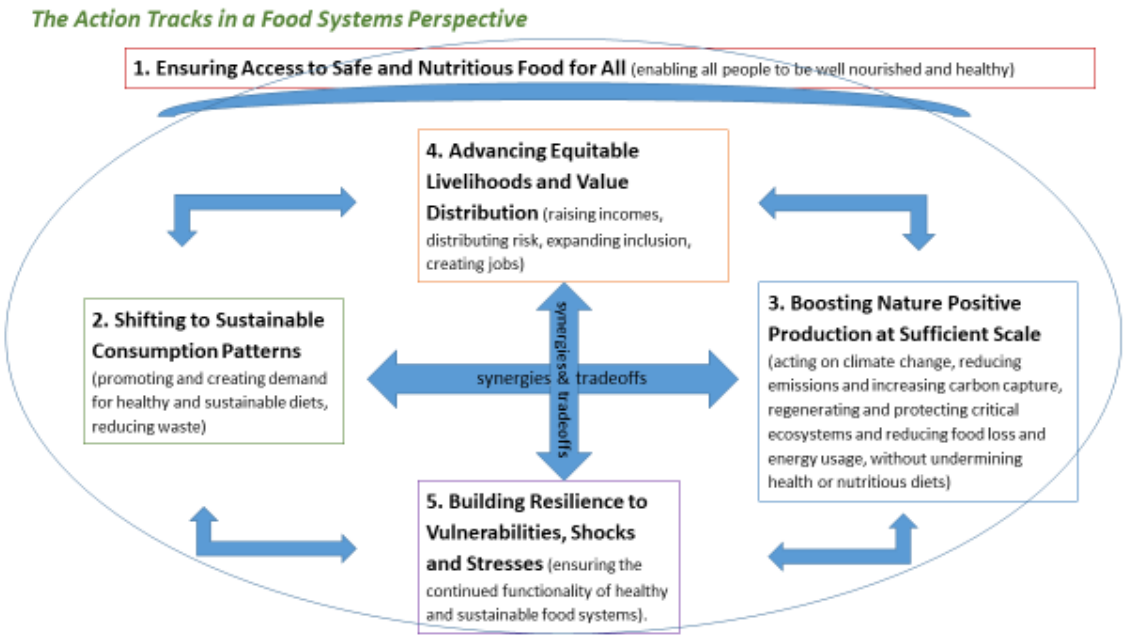


Figure 2: Action Tracks of the UN Food Systems Summit in a Normative Systems Perspective

Source: designed by authors.

Moreover, the systems perspective must be careful not to overlook some key cross-cutting issues and themes, which need due attention, for example,

- Gender; the situation of the youth as well as of the Elderly ;
- Infrastructure;
- Trade and pricing; finance;
- Policies, laws and regulations;
- Role of science and innovation for sustainable food systems (technologies and practices, including digital technologies);
- Indigenous food systems and related knowledge;
- Socioeconomic and cultural norms;
- Inclusive transformation of smallholders;
- Market structure and dynamics of the food industries.

In sum, the Action Tracks need a systems frame that defines healthy, sustainable food systems with the stated objectives.

*Objective 1: End hunger*. Sustainable food systems must provide food and nutrition for all people. It is well known that a focus only on promoting yield increases, calorie consumption, and low food prices is not sufficient. Calorie consumption alone does not constitute a healthy diet. Lower food prices can hurt producers and discourage them from investing in technologies to protect the ecosystem, especially if ecosystem services related to the food systems are not incentivized.

*Objective 2: Achieve healthy diets for all.* It is difficult to define a high-quality, healthy diet in universal terms. Nevertheless, all assessments clearly indicate that healthy diets are more diverse and expensive than energy- and nutrient-adequate diets (FAO, 2020; Hirvonen et al., 2019). The failure to ensure access to high-quality diets for everyone is holding back progress in the achievement of the SDGs. While there is no mentioning of healthy diets in any of the SDGs' targets or indicators, evidence is rapidly mounting to show that merely ensuring stable access to energy- and nutrient-rich food is not sufficient to achieve the ambitious and bracing target of SDG2.2 – "End all forms of malnutrition." It is important to understand the interactions between diets, health systems, and food systems to make progress towards the goals and targets in agriculture, inequality, poverty, sustainable production, consumption, nutrition, and health.

*Objective 3:* Achieving Objectives 1 and 2 does not automatically enable the *sustainable use of biodiversity and natural resources*, the protection of ecosystems, and the safeguarding of land, oceans, forests, freshwater, and climate, all of which are essential for protecting life in all its forms and which are a precondition for achieving social justice and robust, sustained economic development. Food systems operations must be compatible

with ecosystem services. Yet, actions to promote the sustainable use of natural resources and mitigate the effects of climate change can limit agricultural productivity. Sustainable food systems need to find ways to address this trade-off. Agroecological and agro-forestry farming practices can be steps in this direction.

*Objective 4: Eliminate poverty and increase wealth and incomes to achieve Objectives 1, 2, and 3.* Poverty and hunger are interlinked, and reducing extreme poverty has a direct impact on eliminating hunger and all forms of malnutrition. Eliminating poverty alone does not make healthy diets affordable for everyone. Moreover, the elimination of poverty is difficult to achieve while also protecting the environment and preserving ecosystems. Changing food systems needs to ensure that people with a low income can access a healthy diet by enabling them to earn living wages.

In addition to these objectives, further criteria need to remain in perspective as they are linked to broader objectives of the 2030 Agenda. They include the above mentioned cross-cutting themes, as well as the *reduction of risks and the fostering of food systems' resilience*[3]*; and – importantly – also embrace respect for cultural principles and food traditions*[4]. Change will not be achieved without respecting ethics and norms that govern food systems' operations.

[3] Food systems need to continue to function under risks and when coping with shocks and crises. This concerns places that are experiencing conflict, climatic changes and natural disasters. It is also the case globally, as food systems need to mitigate the impact of global crises, such as a pandemic, to protect food and nutrition security of people at all levels of development.

[4] See Béné et al., 2019.

# Annex 1: Food Systems Frameworks – A Selective Synopsis

### UNEP 2016 report: *Food Systems and Natural Resources*

The report from the International Resource Panel of the UN Environment Programme (IRP) calls for global resource-smart food systems to incorporate changes in the way food is grown, harvested, processed, traded, transported, stored, sold, and consumed (UNEP, 2016). It presents a conceptual framework of the interactions between food systems' activities and natural resources.

### HLPE 2017 Report: Nutrition and Food Systems

An Analysis by the Committee on World Food Security High Level Panel of Experts on Food Security and Nutrition (HLPE, 2017) furnishes a wide range of recommendations across food supply chains, food environments (the physical, economic, political and socio-cultural context in which consumers engage with the food systems), and consumer behaviour. The conceptual framework proposed in this report identifies five main categories of drivers of food systems changes: biophysical and environmental; innovation, technology and infrastructure; political and economic; socio-cultural; and demographic drivers.

### The Inter Academy Partnership: Synthesis Report on Opportunities for Future Research and Innovation on Food and Nutrition Security and Agriculture

The concept used by the InterAcademy Partnership (IAP, 2018) takes a broad perspective on agriculture, thus comprising crops, animal production, and connected value chains as well as the natural resource base of land and water use and the technological foundations of agriculture. Institutions, information, and behaviour are crosscutting issues that influence linkages in all of the domains that describe the framework. The linkages of food security and agriculture with health are broadly grouped into six domains, and all of these are influenced by climate change in various ways.

### Food systems metrics

Gustafson et. al (2016) elaborated a metrics-based methodology to assess and quantify the broad concept of sustainable nutrition security. Seven metrics were defined, each based on a combination of multiple indicators, to characterise sustainable nutrition outcomes of food systems: food nutrient adequacy; ecosystem stability; food affordability and availability; socio-cultural wellbeing; food safety; resilience; and waste and loss reduction.

**FAO: The food system wheel**

The food systems wheel framework is centred around FAO's main goals, which include poverty reduction, food security, and nutrition (FAO, 2018). These are embedded in the broader performance of the systems, referring to the three dimensions of sustainability: economic, social, and environmental. Such performance is determined by the behaviour of diverse actors, or the conduct of stakeholders in the food system (people-centric). This conduct in turn takes place in the structure of the systems, which consists of a core system, societal elements, and natural elements.

**FAO: The food system sustainable development paradigm**

This conceptual framework from FAO (2018) presents sustainable food systems as engines of growth, which create value added that has five components: salaries to workers; a return on assets (profits) to entrepreneurs and asset owners; tax revenues to the government; benefits to consumers; and impacts on the socio-cultural and natural environment. This value added sets in motion feedback mechanisms that relate to economic, social, and environmental sustainability, and directly impact poverty, hunger, and nutrition.

# Annex 2: Some Documents that Relate to Food Systems' Objectives and SDGs

### Agenda 2030 and SDG 2

"The 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015, provides a shared blueprint for peace and prosperity for people and the planet, now and into the future. At its heart are the 17 Sustainable Development Goals (SDGs), which are an urgent call for action by all countries – developed and developing – in a global partnership. They recognize that ending poverty and other deprivations must go hand-in-hand with strategies that improve health and education, reduce inequality, and spur economic growth – all while tackling climate change and working to preserve our oceans and forests" (United Nations, 2020a).

**SDG 2 aims to "end hunger, achieve food security and improved nutrition and promote sustainable agriculture" (United Nations, 2020b).**

2.1 By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round

2.2 By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons

2.3 By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment

2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality

2.5 By 2020, maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed

2.a Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular least developed countries

2.b Correct and prevent trade restrictions and distortions in world agricultural markets, including through the parallel elimination of all forms of agricultural export subsidies and all export measures with equivalent effect, in accordance with the mandate of the Doha Development Round

2.c Adopt measures to ensure the proper functioning of food commodity markets and their derivatives and facilitate timely access to market information, including on food reserves, in order to help limit extreme food price volatility
https://sustainabledevelopment.un.org/post2015/transformingourworld

***Nutrition and Food Systems: A report by the High-Level Panel of Experts (HLPE) on Food Security and Nutrition***

"At its 42nd session in October 2015, the Committee on World Food Security (CFS) requested the High-Level Panel of Experts on Food Security and Nutrition (HLPE) to prepare a report on Nutrition and Food Systems, to be presented at CFS 44 in October 2017. This topic is highly relevant to the Sustainable Development Goals (SDGs), the implementation of the 2014 Rome Declaration on Nutrition, the subsequent Decade of Action for Nutrition, and the fulfilment of the right to adequate food. "The purpose of this report is two-fold: (i) to analyse how food systems influence people's dietary patterns and nutritional outcomes; and (ii) to highlight effective policies and programmes that have the potential to shape food systems, contribute to improved nutrition and ensure that food is produced, distributed and consumed in a sustainable manner that protects the right to adequate food for all. This report is illustrated by short case studies reflecting the wide variety of practical experiences in different contexts. It also provides a set of action-oriented recommendations addressed to states and other stakeholders in order to inform CFS engagement in advancing nutrition and CFS contribution to the UN Decade of Action on Nutrition (2016–2025)." (HLPE, 2017, p. 11)

**InterAcademy Partnership (IAP): Opportunities for future research and innovation on food and nutrition security and agriculture The InterAcademy Partnership's global perspective (*Synthesis by IAP based on the four regional academy network studies)***

"With this report, global academies of sciences are expressing their concern about adverse tendencies in food, nutrition and agriculture, and identify science-based initiatives that could contribute to solutions. Academies of science have a substantial history of interest and achievement in these areas. The academies also took note of important other food and agriculture strategy and assessment papers… The present work by the InterAcademy Partnership (IAP), the global network of science academies, brings together established regional networks of academies, forming a new collaboration to ensure that the voice of science is heard in addressing societal priorities. The added value aimed for with this academies' programme is to bring the science power of academies to focus on the

protracted food, nutrition and agriculture issues. This seems increasingly called for as basic science – well represented in academies – becomes more and more relevant and integrated with applied problem-solving science in nutrition, food and agriculture. Another contribution is the emphasis on food systems and in that context a significant emphasis on health of people and the environment. (IAP, 2018). Recommendations include: internationally supporting and sharing basic and applied research for improved food, nutrition and agriculture. Translation of research to innovation requires stronger connections across disciplines and with cutting-edge technologies, linkage to science education, training and outreach. Upgrading scientific infrastructure. And

1. Developing sustainable food and nutrition systems, taking a systems perspective to deliver health and well-being, linked to transformation towards the circular economy and bioeconomy.
2. Emphasising transformation to a healthy diet and good nutrition.
3. Understanding food production and utilisation issues, covering considerations of efficiency, sustainability, climate risks and diversity of resources.
4. Capitalising on opportunities coming within range in the biosciences and other rapidly advancing sciences.
5. Addressing the food–energy–nutrients–water–health nexus, recognising that boundaries are blurred.
6. Promoting activity at the science–policy interfaces and reconciling policy disconnects.
7. Consolidating and coordinating international science advisory mechanisms.

**IPCC Special Report on *Climate Change and Land***

"This Special Report on Climate Change and Land responds to the Panel decision in 2016 to prepare three Special Reports during the Sixth Assessment cycle, taking account of proposals from governments and observer organisations. This report addresses greenhouse gas (GHG) fluxes in land-based ecosystems, land use and sustainable land management in relation to climate change adaptation and mitigation, desertification, land degradation and food security. This report follows the publication of other recent reports, including the *IPCC Special Report on Global Warming of 1.5°C* (SR15), the thematic assessment of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) on *Land Degradation and Restoration*, the IPBES *Global Assessment Report on Biodiversity and Ecosystem Services*, and the *Global Land Outlook* of the UN Convention to Combat Desertification (UNCCD). This report provides an updated assessment of the current state of knowledge while striving for coherence and complementarity with other recent reports." (IPPC, 2019).

**IPBES *Global Assessment Report on Biodiversity and Ecosystems Services***

"IPBES is to perform regular and timely assessments of knowledge on biodiversity and ecosystem services and their interlinkages at the global level. Also addressing an invitation by the Conference of the Parties of the Convention on Biological Diversity (CBD) to prepare a global assessment of biodiversity and ecosystem services building, inter alia, on its own and other relevant regional, sub regional and thematic assessments, as well as on national reports. "The overall scope of the assessment is to assess the status and trends with regard to biodiversity and ecosystem services, the impact of biodiversity and ecosystem services on human well-being and the effectiveness of responses, including the Strategic Plan and its Aichi Biodiversity Targets. It is anticipated that this deliverable will contribute to the process for the evaluation and renewal of the Strategic Plan for Biodiversity and its Aichi Biodiversity Targets." (IPBES, 2019)

**Global Sustainable Development Report (GSDR)**

The present Global Sustainable Development Report was prepared following the decision of the United Nations Member States at the 2016 high-level political forum for sustainable development (HLPF). The Report reflects the universal, indivisible and integrated nature of the 2030 Agenda for Sustainable Development. It also seeks to strengthen the science-policy interface as an evidence-based instrument to support policymakers and other stakeholders in the implementation of the 2030 Agenda across the social, economic and environmental dimensions of sustainable development. "The Global Sustainable Development Report is distinct from, and complementary to, the annual Sustainable Development Goals progress report prepared by the Secretary-General, which tracks progress across goals and targets using indicators from the global indicator framework. It does not produce new evidence; rather it capitalizes on existing knowledge across disciplines, through an 'assessment of assessments'. It highlights state-of-the-art knowledge for transformations towards sustainable development and identifies concrete areas where rapid, transformational change is possible. The Report is not only a product but also a process for advancing collaboration among actors in science, Government, the private sector and civil society in all regions of the world towards identifying and realizing concrete pathways for transformation driven by evidence. … [T]he Report follows not just the letter but also the spirit of the 2030 Agenda, with the overarching goal of advancing human well-being in an equitable and just fashion, and ensuring that no one is left behind, while the natural systems that sustain us are safeguarded. The Report uses the latest scientific assessments, evidence bases about good practices, and scenarios that link future trajectories to current actions to identify calls to action by a range of stakeholders that can accelerate progress towards achieving the Sustainable Development Goals. Those actions derive from knowledge about the interconnections across individual Goals and targets, recognizing that the true transformative potential of the 2030 Agenda can be realized only through a systemic approach that helps identify and manage trade-offs while maximizing co-benefits." (Independent Group of Scientists appointed by the Secretary-General, 2019)

# Annex 3: A bibliography on food systems (to be reviewed and expanded)


Baldos, U.L.C. & T.W. Hertel. 2015. The role of international trade in managing food security risks from climate change. *Food Security*, 7(275). https://doi.org/10.1007/s12571-015-0435-z

Balter, M. 2010. The Tangled Roots of Agriculture. *Science*, 327 (5964): 40406. http://www.sciencemag.org/cgi/doi/10.1126/science.327.5964.404.

Balz, A.G., Heil, E.A., & Jordan, I. (2015). Nutrition-sensitive agriculture: new term or new concept? *Agriculture & Food Security*, 4(1). Available at: http://www.agricultureandfoodsecurity.com/content/4/1/6.

Baumüller, H. 2016. Agricultural Service Delivery Through Mobile Phones: Local Innovation and Technological Opportunities in Kenya. In: F.W. Gatzweiler and J. von Braun (eds.): *Technological and Institutional Innovations for Marginalized Smallholders in Agricultural Development*. Springer. 143-159.

Béné, C., Oosterveer, P., Lamott, L., Brouwer, I.D., de Haan, S., & Prager, S.D. 2019. When food systems meet sustainability – Current narratives and implications for actions. *World Development*, 113 (2019) 116–130.

Black, R. E., Victora, C. G., Walker, S. P., Bhutta, Z. A., Christian, P., de Onis, M., Ezzati, M., Grantham-McGregor, S., Katz, J., Martorell, R., & Uauy, R.; the Maternal and Child Nutrition Study Group. 2013. "Maternal and Child Undernutrition and Overweight in Low-income and Middle-income Countries." Lancet 382 (9890): 427-51.

Bouis, H. E., Low, J., McEwan, M. , & Tanumihardjo, S. 2013. Biofortification: Evidence and Lessons Learned Linking Agriculture and Nutrition. Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO), Rome. http://www.fao.org/fileadmin/user_upload/agn/pdf/Biofortification_paper.pdf. Accessed November 20, 2017.

Burlingame, B., & Dernini, S., eds. 2012. Sustainable Diets and Biodiversity. Directions and Solutions for Policy, Research and Action. Rome: Food and Agriculture Organization of the United Nations (FAO).

Campbell, B.M., Vermeulen, S.J., Aggarwal, P.K., Corner-Dolloff, C., Girvetz, E., Loboguerrero, A.M., Ramirez-Villegas, J., Rosenstock, T., Sebastian, L., Thornton, P.K., & Wollenberg, E. 2016. Reducing risks to food security from climate change. Global Food Security, 11, pp. 34-43. https://doi.org/10.1016/j.gfs.2016.06.002.

CFS (Committee on World Food Security). 2012. "Coming to Terms with Terminology: Food Security, Nutrition Security, Food Security and Nutrition, Food and Nutrition Security." 39th Session, Rome, October 15-20, 2012. http://www.fao.org/docrep/meeting/026/MD776E.pdf.

Conklin, A.I., Monsivais, P., Khaw, K.-T., Wareham, N.J., & Forouhi, N.G. 2016. Dietary Diversity, Diet Cost, and Incidence of Type 2 Diabetes in the United Kingdom. A Prospective Cohort Study. PLoS medicine 13 (7), e1002085. DOI: 10.1371/journal.pmed.1002085.

Dangour, A. D., Green, R., Häsler, B., Rushton, J., Shankar, B., & Waage, J. 2012. Linking Agriculture and Health in Low- and Middle-income Countries: An interdisciplinary Research Agenda. Proceedings of the Nutrition Society 71 (2): 222-8. http://www.journals.cambridge.org/abstract_S0029665112000213.

Darmon, N., Lacroix, A., Muller, L., Ruffieux, B. 2016. Food Price Policies May Improve Diet but Increase Socioeconomic Inequalities in Nutrition. World review of nutrition and dietetics 115, S. 36-45. DOI: 10.1159/000442069.

Drewnowski, A. & Darmon, N. 2005. The economics of obesity. Dietary energy density and energy cost. The American Journal of Clinical Nutrition 82 (1 Suppl), 265S-273S.

Dubé, L., Webb, P., Arora, N.K., & Pingali, P. 2014. Agriculture, Health, and Wealth Convergence: Bridging Traditional Food Systems and Modern Agribusiness Solutions. Annals of the New York Academy of Sciences 1331 (1): 1-14. http://doi.wiley.com/10.1111/nyas.12602.

FAO (Food and Agriculture Organization of the United Nations). 2014. *Sustainable food value chain development: guiding principles*. Rome.

FAO. 2015. Designing Nutrition-sensitive Agriculture Investments. Checklist and Guidance for Programme Formulation. Rome: Food and Agriculture Organization of the United Nations (FAO). http://www.fao.org/documents/card/en/c/6cd87835-ab0c-46d7-97ba-394d620e9f38/.

FAO. 2018. *Sustainable food systems: concept and framework*. Brief. Rome

FAO. 2020. *A Framework for Promoting Food Systems Transformation Aligned to the 2030 Agenda and the Sustainable Development Goals*. Rome.

FAO, IFAD, and WFP (Food and Agriculture Organization of the United Nations, International Fund for Agricultural Development, and World Food Programme). 2020. (and various years) The State of Food Insecurity in the World 2014. Strengthening the Enabling Environment for Food Security and Nutrition. Rome: FAO.

Gallón, L. 2019. Systemic Thinking. In: W. Leal Filho, A. Azul, L. Brandli, P. Özuyar, T. Wall (eds). Quality Education Encyclopedia of the UN Sustainable Development Goals. Springer, Berlin. https://doi.org/10.1007/978-3-319-69902-8_58-1.

Gatzweiler, F.W. and von Braun, J. (eds.). 2016. Technological and institutional innovations for marginalized smallholders in agricultural development. Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-25718-1

Gerster-Bentaya, M. 2013. Nutrition-sensitive Urban Agriculture. Food Security 5 (5): 723-37. http://link.springer.com/10.1007/s12571-013-0295-3.

Gupta, A. (2016). “Grass roots Innovation”. Penguin Random House, India Gurgaon.

Gustafson, D., Gutman, A., Leet, W., Drewnowski, A., Fanzo, J., & Ingram, J. 2016. Seven Food System Metrics of Sustainable Nutrition Security. Sustainability, 8(3): 191. doi:10.3390/su8030196.

Haile, M.G., Wossen, T., Tesfaye, K., & von Braun, J. 2017. Impact of climate change, weather extremes, and price risk on global food supply. Economics of Disasters and Climate Change, 1(1), pp. 1-17. https://doi.org/10.1007/s41885-017-0005-2.

Hawkes, C. & Ruel, M.T., eds. 2006. Understanding the Links between Agriculture and Health. Washington, DC: International Food Policy Research Institute (IFPRI). http://www.ifpri.org/2020/focus/focus13.asp.

Herforth, A., Jones, A., & Pinstrup-Andersen, P. 2012. Prioritizing Nutrition in Agriculture and Rural Development: Guiding Principles for Operational Investments. Health, Nutrition and Population (HNP) Discussion Paper. World Bank, Washington, DC.

HLPE. 2013. Investing in smallholder agriculture for food security. A report by the High-Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome

HLPE. 2017. *Nutrition and Food Systems. A report by the High-Level Panel of Experts on Food Security and Nutrition of the Committee in World Food Security*. Rome (also available at http://www.fao.org/3/a-i7846e.pdf). (Accessed June 9th, 2020).

Hoddinott, J., Maluccio, J.A., Behrman, J.R., Flores, R., & Martorell, R. 2008. Effect of a nutrition intervention during early childhood on economic productivity in Guatemalan adults. The Lancet, 371(610), 411-416.

Hölscher, K., Wittmayer, J.M., & Loorbach, D. 2018. Transition versus transformation: What's the difference? Environmental Innovation and Societal Transitions, 27, 1-3. doi:10.1016/j.eist.2017.10.007

IFPRI. 2016). 2016 Global Nutrition Report - From Promise to Impact: Ending Malnutrition by 2030. Washington DC.

Imamura, F., Micha, R., Khatibzadeh, S., Fahimi, S., Shi, P., Powles, J., & Mozaffarian, D. 2015. Dietary quality among men and women in 187 countries in 1990 and 2010. A systematic assessment. The Lancet Global Health 3 (3), e132-e142. DOI: 10.1016/S2214-109X(14)70381-X.

Ingram, J. 2011. A food systems approach to researching food security and its interactions with global environmental change. Food Security, 3(4): 417–431.

IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services). 2019. *Global Assessment Report on Biodiversity and Ecosystem Services* [online]. [https://ipbes.net/global-assessment. (Accessed 9 June 2020).

IPCC. 2011. Renewable Energy Sources and Climate Change Mitigation: Special Report of the Intergovernmental Panel on Climate Change. Cambridge University Press.

IPCC. 2019. Summary for Policymakers. In*:* P.R. Shukla, J. Skea, E. Calvo Buendia, V. Masson-Delmotte, H.-O. Pörtner, D.C. Roberts, P. Zhai, R. Slade, S. Connors, R. van Diemen, M. Ferrat, E. Haughey, S. Luz, S. Neogi, M. Pathak, J. Petzold, J. Portugal Pereira, P. Vyas, E. Huntley, K. Kissick, M. Belkacemi, J. Malley, eds. *Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems*. Geneva, Switzerland (also available at https://www.ipcc.ch/site/assets/uploads/sites/4/2020/02/SPM_Updated-Jan20.pdf).

InterAcademy Partnership. 2018. *Opportunities for future research and innovation on food and nutrition security and agriculture: The InterAcademy Partnership's global perspective.* Trieste and Washington, DC, Schaefer Druck und Verlag GmbH. https://www.interacademies.org/sites/default/files/publication/iap_fnsa_global_web_complete_28nov.pdf

Johnston, J.L., Fanzo, J.C., & Cogill, B. 2014. Understanding Sustainable Diets: A Descriptive Analysis of the Determinants and Processes That Influence Diets and Their Impact on Health, Food Security, and Environmental Sustainability. Advances in Nutrition 5 (4): 418-29.

Just, D.R.; Gabrielyan, G. 2016. Why behavioral economics matters to global food policy. Global Food Security 11 (Supplement C), pp. 26-33. DOI: 10.1016/j.gfs.2016.05.006.

Kalkuhl, M., von Braun, J., & Torero, M., eds. 2016. Food Price Volatility and Its Implications for Food Security and Policy. Cham, Springer International Publishing. http://link.springer.com/10.1007/978-3-319-28201-5.

Keding, G.B., Schneider, K., & Jordan, I. 2013. Production and Processing of Foods as Core Aspects of Nutrition-sensitive Agriculture and Sustainable Diets. Food Security 5 (6): 825-46. http://link.springer.com/10.1007/s12571-013-0312-6.

Khoury, Colin K.; Achicanoy, Harold A.; Bjorkman, Anne D.; Navarro-Racines, Carlos; Guarino, Luigi; Flores-Palacios, Ximena et al. (2016): Origins of food crops connect countries worldwide. In Proc. R. Soc. B 283 (1832), p. 20160792. DOI: 10.1098/rspb.2016.0792.

Khoury, Colin K.; Bjorkman, Anne D.; Dempewolf, Hannes; Ramirez-Villegas, Julian; Guarino, Luigi; Jarvis, Andy et al. (2014): Increasing homogeneity in global food supplies and the implications for food security. In Proceedings of the National Academy of Sciences of the United States of America 111 (11), pp. 4001-4006. DOI: 10.1073/pnas.1313490111. Supplementary material.

Kim, S., Q. Deng, B. M. Fleisher, and S. Li 2014. "The Lasting Impact of Parental Early Life Malnutrition on Their Offspring: Evidence from the China Great Leap Forward Famine." World Development 54: 232-42.

Kimenju, S.C., Rischke, R., Klasen, S. and Qaim, M. 2015. Do supermarkets contribute to the obesity pandemic in developing countries? Public Health Nutr., 18 (17): 3224-33.

Lesk, C., Rowhani, P., and N. Ramankutty. 2016. Influence of extreme weather disasters on global crop production. Nature, 529, pp. 84-87. https://doi.org/10.1038/nature16467

Lowder, S. K., Skoet, J., & Singh, S. 2014. What do we really know about the number and distribution of farms and family farms in the world? Background paper for The State of Food and Agriculture 2014. ESA Working Paper, 14-02. Rome, FAO. Available at: http://www.fao.org/docrep/019/i3729e/i3729e.pdf.

Mackey, T. K., and B. A. Liang. 2012. "Lessons from SARS and H1N1/A: Employing a WHO-WTO Forum to Promote Optimal Economic-Public Health Pandemic Response." Journal of Public Health Policy 33 (1): 119-30.

Malabo Montpellier Panel. 2017. Nourished: How Africa can build a future free from hunger and malnutrition. Dakar. August 2017.

Masset, E., L. Haddad, A. Cornelius, and J. Isaza-Castro. 2012. "Effectiveness of Agricultural Interventions that Aim to Improve Nutritional Status of Children: Systematic Review." BMJ 344 (d8222). http://www.bmj.com/cgi/doi/10.1136/bmj.d8222.

McBratney, A., Whelan, B., Ancev, T. & Bouma, J. 2005. Future Directions of Precision Agriculture. Precision Agriculture 6(1), 7-23. doi:10.1007/s11119-005-0681-8

Meadows, D.H., D.L. Meadows, J. Randers, W.W. Behrens III. 1972. *The Limits to Growth. A Report for the Club of Rome's Project on the Predicament of Mankind*. New York, Universe Books.

Meenakshi, J. V., N. L. Johnson, V. M. Manyong, H. DeGroote, J. Javelosa, D. R. Yanggen, F. Naher, C. Gonzalez, J. García, and E. Meng. 2010. "How Cost-Effective is Biofortification in Combating Micronutrient Malnutrition? An Ex ante Assessment." World Development 38 (1): 64-75.

Mellor, J. 2017. Agricultural Development and Economic Transformation. Promoting Growth with Poverty Reduction. Palgrave Studies in Agricultural Economics and Food Policy. Cornell, NY.

Micha, Renata; Khatibzadeh, Shahab; Shi, Peilin; Andrews, Kathryn G.; Engell, Rebecca E.; Mozaffarian, Dariush. 2015.: Global, regional and national consumption of major food groups in 1990 and 2010. A systematic analysis including 266 country-specific nutrition surveys worldwide. In BMJ open 5 (9), e008705. DOI: 10.1136/bmjopen-2015-008705.

Moe, C. L., and R. D. Rheingans. 2006. "Global Challenges in Water, Sanitation and Health." Journal of Water and Health 4 (Suppl. 1): 41-58.

Naylor, Rosamond L. 2016: Oil crops, aquaculture, and the rising role of demand. A fresh perspective on food security. In Global Food Security 11 (Supplement C), pp. 17-25. DOI: 10.1016/j.gfs.2016.05.001.

Nelson, G.C., Rosegrant, M.W., Palazzo, A., Gray, I., Ingersoll, C., Robertson, R., Tokgoz, S., Zhu, T., Sulser, T.B., Ringler, C., Msangi, S., and L. You. 2010. Food security, farming, and climate change to 2050: scenarios, results, policy options. Washington, DC: IFPRI.
http://www.ifpri.org/cdmref/p15738coll2/id/127066/filename/127277.pdf

Nesheim, M.C., Oria, M. and Yih, P.T. 2015. *A framework for assessing effects of the food system.* Committee on a Framework for Assessing the Health, Environmental, and Social Effects of the Food System; Food and Nutrition Board; Board on Agriculture and Natural Resources; Institute of Medicine; National Research Council. Washington, DC:,The National Academies Press. http://www.nycfoodpolicy.org/wp-content/uploads/2014/05/A-Framework-for-Assessing-Effects-of-the-Food-System.pdf

Nkonya, E., Mirzabaev, A. & von Braun, J., eds. 2016. Economics of Land Degradation and Improvement - A Global Assessment for Sustainable Development. Springer. Available at:
http://link.springer.com/book/10.1007/978-3-319-19168-3

Parsons, K., Hawkes, C., & Wells, R. 2019. *Understanding the food system: Why it matters for food policy.* Rethinking Food Policy: A Fresh Approach to Policy and Practice, Brief 2. Centre for Food Policy, City University of London. https://www.city.ac.uk/__data/assets/pdf_file/0008/471599/7643_Brief-2_What-is-the-food-system-A-food-policy-perspective_WEB_SP.pdf

Pechey, Rachel; Monsivais, Pablo. 2016. Socioeconomic inequalities in the healthiness of food choices. Exploring the contributions of food expenditures. In Preventive Medicine 88 (Supplement C), pp. 203-209. DOI: 10.1016/j.ypmed.2016.04.012.

Pinstrup-Andersen, P. 2013. Nutrition-sensitive food systems: From rhetoric to action. The Lancet, 382(9890), 375-376. Available at: http://dx.doi.org/10.1016/S0140-6736(13)61053-3

Pontifical Academy of Sciences and Global Alliance for Improved Nutrition (GAIN). 2018. Final Statement of the Workshop on Food Safety and Healthy Diets. The Vatican.
http://www.pas.va/content/accademia/en/events/2018/food/statement.html

Popkin, Barry M.; Adair, Linda S.; Ng, Shu Wen. 2012. Global nutrition transition and the pandemic of obesity in developing countries. In Nutrition reviews 70 (1), pp. 3-21. DOI: 10.1111/j.1753-4887.2011.00456.x.

Prüss, A., D. Kay, L. Fewtrell, and J. Bartram. 2002. "Estimating the Burden of Disease from Water, Sanitation, and Hygiene at a Global Level." Environmental Health Perspectives 110 (5): 537-42.
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1240845/pdf/ehp0110-000537.pdf

Purnell, Jason Q.; Gernes, Rebecca; Stein, Rick; Sherraden, Margaret S.; Knoblock-Hahn, Amy. 2014. A systematic review of financial incentives for dietary behavior change. In Journal of the Academy of Nutrition and Dietetics 114 (7), pp. 1023-1035. DOI: 10.1016/j.jand.2014.03.011.

M.J. Radzicki and R.A. Taylor. 2008. Origin of System Dynamics: Jay W. Forrester and the History of System Dynamics. In: *U.S. Department of Energy's Introduction to System Dynamics*.

Rakib, M. and J. A. Matz. 2016. The Impact of Shocks on Gender-differentiated Asset Dynamics in Bangladesh, The Journal of Development Studies, 52(3), pp. 377-395, https://doi.org/10.1080/00220388.2015.1093117

Richardson, K.J., Lewis, K.H., Krishnamurthy, Kent, C., Wiltshire, A.J., and H.M. Hanlon. 2018. Food security outcomes under a changing climate: impacts of mitigation and adaptation on vulnerability to food insecurity. Climatic Change, 147(1-2), pp. 327-341. https://doi.org/10.1007/s10584-018-2137-y

Robles, M., Torero, M., von Braun, J., 2009. When Speculation Matters? , IFPRI Issue Breif 57.

Ruel, M. T., and H. Alderman. 2013. “Nutrition-sensitive Interventions and Programmes: How Can They Help to Accelerate Progress in Improving Maternal and Child Nutrition?” Lancet, 382 (9891): 536-51. http://www.thelancet.com/pdfs/journals/lancet/PIIS0140-6736(13)60843-0.pdf.

SAM (European Commission’s Scientific Advice Mechanism) . 2019. *A scoping review of major works relevant to scientific advice towards an EU sustainable food system. Scoping Review Report.* http://ec.europa.eu/research/sam/pdf/meetings/hlg_sam_032019_scoping_report_sustainable-food.pdf

SAPEA (Science Advice for Policy by European Academies). 2020. *A sustainable food system for the European Union*. Berlin, SAPEA. https://doi.org/10.26356/sustainablefood.

Schulz, Theodor W. 1964. Transforming Traditional Agriculture. New Haven: Yale University Press.

Sen, Amartya. 1982. Poverty and Famines. An Essay on Entitlement and Deprivation. Oxford: Clarendon Press.

Smith, L.E., Stoltzfus, R.J., and A. Prendergast. 2012. Food chain mycotoxin exposure, gut health, and impaired growth: a conceptual framework. Advances in Nutrition, 3(4), pp. 526-31. https://doi.org/10.3945/an.112.002188

Springmann, M., Mason-D’Croz, D., Robinson, S., Garnett, T., Godfray, H.C.J., Gollin, D., Rayner, M., Ballon, P., and P. Scarborough. 2016. Global and regional health effects of future food production under climate change: a modelling study. The Lancet, 387(10031), pp. 1937-1946. https://doi.org/10.1016/S0140-6736(15)01156-3.

Tendall, D. M., J. Joerin, B. Kopainsky, P. Edwards, A. Shreck, Q. B. Le, P. Kruetli, M. Grant, and J. Six. 2015. “Food System Resilience: Defining the Concept.” Global Food Security, 6: 17-23.

Thompson, B., and L. Amoroso, eds. 2014. Improving Diets and Nutrition: Food-based Approaches. Rome: Food and Agriculture Organization of the United Nations (FAO) and CAB International. http://www.fao.org/3/a-i3030e.pdf

Thow, Anne Marie; Downs, Shauna; Jan, Stephen. 2014. A systematic review of the effectiveness of food taxes and subsidies to improve diets: understanding the recent evidence. In Nutrition reviews 72 (9), pp. 551-565. DOI: 10.1111/nure.12123.

Timmer, C.P. 2010. Preventing food crises using a food policy approach. The Journal of Nutrition 140, 224S-228S.

Tschirley, D., T. Reardon, M. Dolislager, & Snyder, J. 2015. The Rise of a Middle Class in East and Southern Africa: Implications for Food System Transformation. Journal of International Development 27: 628- 646.

UNEP. (United Nations Environment Programme) 2011. *Towards a green economy: Pathways to sustainable development and poverty eradication*. Nairobi.

UNEP. 2016. *Food Systems and Natural Resources. A Report of the Working Group on Food Systems of the International Resource Panel*. H. Westhoek, J. Ingram, S. Van Berkum, L. Özay, and M. Hajer. https://www.resourcepanel.org/reports/food-systems-and-natural-resources. (Accessed June 9th, 2020).

UNICEF (United Nations Children’s Fund) and Government of India. 2015. “Rapid Survey on Children in India 2013/14.” The Economist. July 2, 2015. http://www.economist.com/blogs/graphicdetail/2015/07/daily-chart-0

United Nations. 2019. Independent Group of Scientists appointed by the Secretary-General. 2019. *Global Sustainable Development Report 2019: The Future is Now – Science for Achieving Sustainable Development*. New York, United Nations. https://sustainabledevelopment.un.org/globalsdreport/2019

United Nations. 2020a. *Sustainable Development Goals* [online]. New York, USA. [Accessed 12 September 2020] https://sdgs.un.org/goals

United Nations. 2020b. *Sustainable Development Goal 2* [online]. New York, USA. [Accessed 12 September 2020]. https://sdgs.un.org/goals/goal2

van Meijl, H., Havlik, P., Lotze-Campen, H., Stehfest, E., Witzke, P., Pérez Domínquez, I., Bodirsky, B.L., van Dijk, M., Doelman, J., and T. Fellmann. 2018. Comparing impacts of climate change and mitigation on global agriculture by 2050. Environmental Research Letters, 13(064021), https://doi.org/10.1088/1748-9326/aabdc4

von Braun, J., and F. W. Gatzweiler, eds. 2014. Marginality. Addressing the Nexus of Poverty, Exclusion and Ecology. Dordrecht: Springer Netherlands. http://link.springer.com/10.1007/978-94-007-7061-4.

von Braun, J. 2015. Bioeconomy - Science and Technology Policy to Harmonize Biologization of Economies with Food Security. In D. Sahn (ed.) The Fight Against Hunger and Malnutrition: The Role of Food, Agriculture, and Targeted Policies. Oxford University Press, New York, 240-262.

von Braun, J., 2015b. "Food and Nutrition Security The Concept and its Realization." In Bread and Brain, Education and Poverty, edited by A. M. Battro, I. Potrykus, and M. Sanchez Sorondo, 69-85. Vatican City: Pontifical Academy of Sciences, Scripta Varia 125.

von Braun, J. 2017. Agricultural change and health and nutrition in emerging economies. *In* P. Pingali and G. Feder (eds.), *Agriculture and rural development in a globalizing world*. Earthscan Food and Agriculture Series. London: Routledge.

WBGU (German Advisory Council on Global Change). 2011. *World in transition: A social contract for sustainability*. Berlin.

Webb, P., and E. Kennedy. 2014. "Impacts of Agriculture on Nutrition: Nature of the Evidence and Research Gaps." Food and Nutrition Bulletin 35 (1): 126-32.

Welthungerhilfe and Concern International. 2020. Global Hunger Index. Bonn and Dublin. https://www.globalhungerindex.org/results/

Wheeler, T. and J. von Braun. 2013. Climate change impacts on global food security. Science 341(6145), pp. 508-513, https://doi.org/10.1126/science.1239402

WHO (World Health Organization). 2013. Research Priorities for the Environment, Agriculture and Infectious Diseases of Poverty. Technical Report of the TDR Thematic Reference Group on Environment, Agriculture and Infectious Diseases of Poverty. Geneva: WHO. http://apps.who.int/iris/bitstream/10665/78129/1/WHO_TRS_976_eng.pdf.

WHO and UNICEF (World Health Organization and United Nations Children's Fund). 2013. Progress on Sanitation and Drinking-Water 2013 Update. Geneva: WHO.

World Bank, 2007. World development report 2008: Agriculture for development. World Bank.

WHO. 2017. *Obesity and overweight*. Fact sheet. [online] http://www.who.int/mediacentre/factsheets/fs311/en/