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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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Abstract

The UN Food Systems Summit seeks to alter food systems to be healthier, more sustainable, and more equitable. This paper aims to inform the public and stakeholders interested in the Food Systems Summit 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 food systems thinking and the broad set of actors and drivers, embedding the concept of sustainability within it. Annexes to the paper draw attention to selected food systems studies and important publications and policy papers that draw on concepts of food systems.[1]

[1] Helpful comments on an earlier draft by colleagues in the Scientific Group and by Koen Deconinck of the Trade and Agriculture Directorate of OECD are gratefully acknowledged.

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1. Introduction

The UN Food Systems Summit convenes to bring about actions that promise *change* towards achieving healthier and more sustainable and equitable food systems. As we head 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 this context, drivers and mechanisms of change of food systems need clarification. Conceptualizing *systems' change* is relevant for policy opportunities and for setting ambitious goals for the Food Systems Summit.

Change in food systems comes about through external and internal forces as well as feedback mechanisms between these forces. These feedback mechanisms may be short-term, but often come with long delays, such as the impact of greenhouse gas emissions manifesting in climate change. Population growth, urbanization, and migration are fundamental drivers and shape the changes in food systems. Changes in consumer habits, for instance as a result of rising incomes, are another driver of great importance. Science, innovation, and technology greatly impact food systems' change. 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 food systems.

Food systems have been continuously subject to change and adaption since they evolved with humankind, 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 world population will possibly be stabilizing at about 9 to 10 billion people only by the end of this century (Lutz 2020). Drivers of the change processes are developments within science and related innovations as well as their interlinkages with policies, both of which are linked to the interests, needs, and accomplishments of farming communities, the food industry, and consumers' demand. 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). Food systems are not just technically functioning mechanistic clock works, but are embedded in values and cultures, and that need to be considered when "systems transformations" are proposed.

With this paper we aim to inform the interested Food Systems Summit public. Our goal is to assist in the understanding of food systems, their dynamics, their indirect effects, responses to exogenous influences, and impacts of policies through system linkages. Lastly, we seek to relate these concepts in helpful ways to the purpose of the 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 important here, as some of the conflicting issues about food systems' changes can be remedied by innovations. We can note at the outset that there is an accelerating momentum worldwide, including in the United Nations, to adopt systems approaches to bring consumption and production patterns together to achieve sustainable development.[2]

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] At the Rio+20 UN Conference on Sustainable Development in 2012, Heads of State converged around the idea that fundamental changes in our production and consumption patterns are indispensable to achieving long-term sustainable development. The realization that a global shift towards SCP would require the commitment of diverse actors across the globe spurred Heads of State at Rio+20 to adopt the 10-Year Framework of Programmes on Sustainable Consumption and Production Patterns (10YFP). See at: 10YFP Framework of Programmes on Sustainable Consumption and Production Patterns.

2. A General Food Systems Concept

Criteria

The food system includes the related resources, inputs, production, transport, processing and manufacturing industries, retailing, and consumption of food as well as its impacts on environment, health, and society. The food system is also closely related to people's values and cultures. 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, by 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 actions that must consider synergies and trade offs, and 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, i.e. food systems' change 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, context or geography or not.[3] 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 may 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 the exclusion of important economic, social or environmental forces. There is no clearly defined pathway out of this dilemma. Much depends on the relevant policy question as well as on the context and scale of the food systems under consideration.

We distinguish between *systems theory and systems thinking* and 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 should not neglect basic principles of *systems theory* (Box 1). For instance, a system that has no defined boundaries or whose building blocks connected by linkages and feedback mechanisms are ill-

[3] 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).

defined, is a fuzzy concept. *Food systems' boundaries* may be defined at different scales (local, regional, and global), for different contexts (e.g., urban, rural), and separated from other systems, such as the health system. However, at least as important as this established theoretical foundation is advancement of *systems thinking,* which entails broadening perspectives around food systems (such as planetary health), and within food systems (such as the important roles of culture and values) (Box 1).

Box 1: On Systems Theory and Systems Thinking

Systems theory and system dynamics are established concepts that may assist in conceptualizing food systems, yet are conceptually rather restrictive. 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. The best-known system dynamics model is probably *The Limits to Growth* (Meadows et al. 1972).

Systems thinking is a way of looking at the world rather than a description of how the world is. The term "food systems" invites us to think about a broader set of valued outcomes such as nutrition and health; livelihoods, planetary health; think about a broader set of factors that can influence these outcomes; and think about synergies and trade-offs between all of these. People's values matter for how food systems thinking is shaped and in turn may shape policies. [4]

Definition of Food System

The definition of food systems embraces 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 (building on definitions by FAO (2018) and others). Production at the beginning of value chains, of course, includes farming communities but also pre-production actors, for example input industries producing fertilizers 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 life science and health research systems. In food industries' processing, foods and non-foods result from interlinked value chains. Other relevant food systems actors are related to these value chains, for example, public and private quality and safety control organisations.

[4] An important emphasis placed on food and agriculture are intimately connected to people's values. People differ in the values they hold relative to food and agriculture, and these value differences correlate with their behaviour as consumers and as citizens (further on these important aspects see OECD. 2020)

Moreover, we understand a *sustainable food system* understood as one that delivers food security and nutrition for all in such a way that the economic, social, cultural, and environmental bases to generate food security and nutrition for future generations are safeguarded. 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. 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.

Concept of Food Systems

Conceptualizing food systems entails to define systems boundaries and systems building blocks and linkages among them, while simultaneously being connected to neighbouring systems such as the health, ecological and energy system (see figure 1). The concept here is in support of developing sustainable food and nutrition systems, to deliver health and well-being, linked to transformation towards the circular bioeconomy.

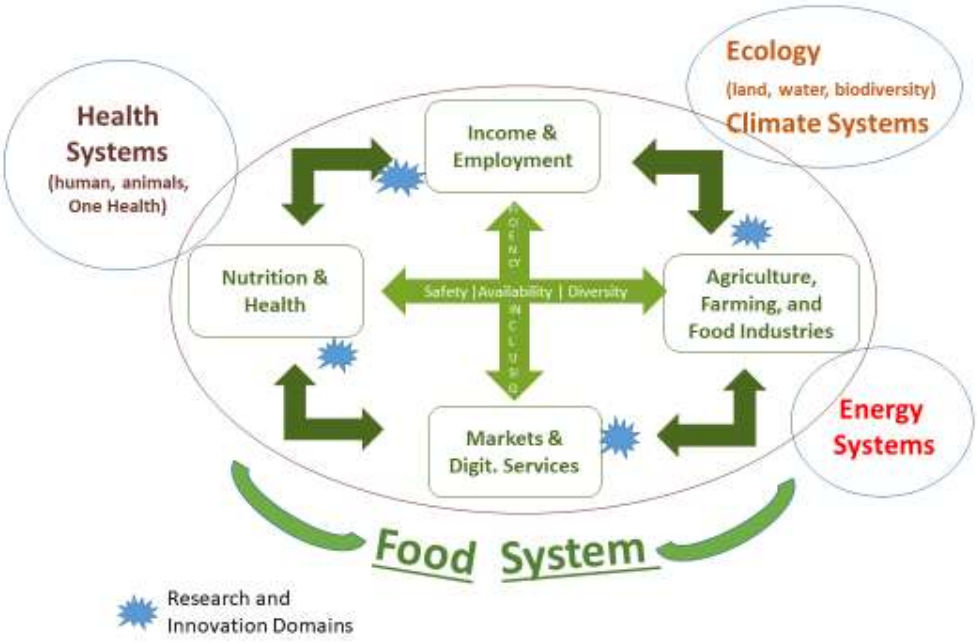

Figure 1: The food system in the context of other systems (positive systems concept)

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

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 of which policies, innovations, and institutions are needed to remediate or mitigate negative side-effects. These 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. Therefore, a sustainable circular economy concept as an overarching systems frame, in which food systems are embedded, should be considered in the solution-finding process.

Further food systems components and drivers need mentioning, but are not depicted in figure 1. For instance, the system may be impacted by external shocks, such as climate, health or economic shocks. Moreover, wars and violent conflict increasingly disrupt food systems. Therefor food systems concepts must consider political and economic forces of its disruptions, and need a political economy perspective.[5]

Considering Culture and Values

Considering and respecting values and their differences is important for the Food Systems Summit in order to facilitate agreements on actions. Yet, differences do exist even around broad societal issues with relevance to food systems. This is for instance demonstrated by findings from the World Values Survey, a large-scale project to quantify cross-country differences and trends over time in people's values and attitudes.[6] The 2011-14 World Values Survey asked respondents whether they think protecting the environment should be the priority, or whether economic growth and jobs should be prioritized. In some countries a majority of respondents prioritizes economic growth and jobs, while in some other countries a majority of respondents prioritizes the environment. In yet other countries the shares of respondents are roughly evenly matched. Interestingly, there is only a weak correlation between countries' overall level of economic development and the share of respondents prioritizing economic growth over protecting the environment. Moreover, even in countries with a clear preference for either option, there is typically a large minority choosing the other option; a national consensus is rare. This hints at the challenges of finding consensus among and within countries on food systems actions. Change will not be achieved without respecting ethics and norms that govern food systems' operations. The discourse on food systems must

[5] Per Pinstrup-Andersen, Derrill D. Watson 2011.Food Policy for Developing Countries: The Role of Government in Global, National and Local Food Systems. Cornell University Press.

[6] Inglehart, R., C. Haerpfer, A. Moreno, C. Welzel, K. Kizilova, J. Diez-Medrano, M. Lagos, P. Norris, E. Ponarin & B. Puranen et al. (eds.). 2014. World Values Survey: Round Six - Country-Pooled Datafile Version: http://www.worldvaluessurvey.org/WVSDocumentationWV6.jsp . Madrid: JD Systems Institute.

not abstract from the issue of culture and values, making it seem as if it is merely a technical question. This especially - but not only - applies to the greatly divers indigenous food systems, and the culture and knowledge embedded in them. Different societies may make different choices, based on their cultural traditions and local circumstances. For transformative policy approaches to be acceptable they will need to take into account values and cultural traditions.

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

Positive and normative Food Systems Concept

In institutional terms, the food system is largely structured by private sector actors, including farmers, food manufacturers, traders, retailers, or food service businesses. At the same time, there are important features of cooperative and collective action arrangements among farming communities, like 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 and their values 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' change. The *normative concept* postulates a set of objectives and aims to shape the systems to serve the stated objectives. Both concepts aggregate and simplify real world structures and processes. Neither of these approaches escape the yardsticks 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 clearly 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.

Action Tracks in the Food System

A normative concept and definition of food systems based on objectives embraces the *five Actions Tracks* listed below. 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 and 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 to frame action-oriented agenda setting, such as the one 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).

We note that some elements of the headings of the Action Tracks, such as "nature positive", imply a narrative that may be surprising and new, not rooted in the established research literature or in terminology of SDGs. We do not further elaborate the details of the Action Tracks here, as this is done by the Scientific Group teams with background papers available at https://sc-fss2021.org/ . Yet, if food systems shall deliver on the stated objectives (i.e. the SDGs), the Food Systems Summit needs to be open to new thinking, to new concepts, and to establishing new institutional and organizational arrangements. Addressing symptoms of systems failures will not be sufficient.

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 solution proposals 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). All the Action Tracks have their strong justification and they are not in a hierarchical relationship: We expect food security and nutrition; livelihood improvements; production with environmental sustainability; we want resilience across those three objectives (i.e. low variability, and a quick recovery from negative shocks); and we know that consumption patterns are a powerful lever for change. "Ensuring Access to Safe and Nutritious Food for All (enabling all people to be well-nourished and healthy)" is supported by the other four Action Tracks, yet there are also feed backs from improved nutrition to the other four Tracks. The Action Tracks need to consider functional relationships among them in systemic ways.

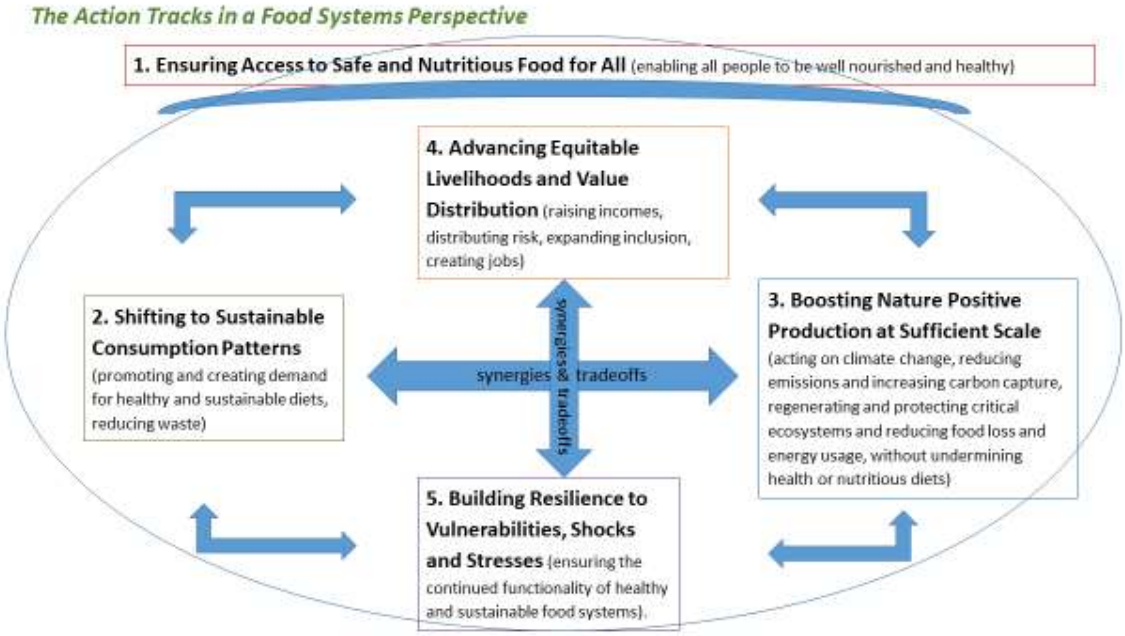

Figure 2: Action Tracks of the UN Food Systems Summit (a normative systems perspective)

Source: Designed by authors.

Cross-cutting Systems Issues and Main Objectives

The systems perspective must not 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 sustainable food systems, that deliver health and nutrition within the scope of the following four 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 insufficient. 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 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.[7] 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 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 SDGs and their related 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 directly impacts the elimination of 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-

[7] Lynnette M Neufeld, Sheryl Hendriks, Marta Hugas.2020) Healthy diet: A definition for the United Nations Food Systems Summit 2021. A paper from the Scientific Group for the UN Food Systems Summit. Draft for discussion. November 25th, 2020 https://sc-fss2021.org/

cutting themes, as well as the reduction of risks and the fostering of **food systems' resilience**;[8] and – importantly – also embrace respect for cultural principles and food traditions.[9]

[8] Food systems need to continue to function under risks and when coping with shocks and crises. This concerns regions that are experiencing conflict, climatic changes and natural disasters and is also globally the case, 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.

[9] 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*

The 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 food systems), and consumer behaviour. The conceptual framework proposed in this report identifies five main categories of drivers of food systems' change: biophysical and environmental; innovation, technology and infrastructure; political and economic; socio-cultural; and demographic.

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.

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). In turn, this conduct takes place in the structure of the systems, which consists of a core system as well as societal 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).

The individual indicators are expressed as follows:

> "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"

The relevant targets read:

> "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[10]

The High-Level Panel of Experts (HLPE) on Food Security and Nutrition: *Nutrition and Food Systems*

"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. 1/11)

[10] For further information see https://sustainabledevelopment.un.org/post2015/transformingourworld.

InterAcademy Partnership (IAP): ***Opportunities for future research and innovation on food and nutrition security and agriculture: The InterAcademy Partnership's global perspective***[11]

"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, p. 1)

Recommendations include: internationally supporting and sharing basic and applied research for improved food, nutrition and agriculture. Moreover, the translation of research to innovation requires stronger connections across disciplines and with cutting-edge technologies, linkages to science education, training, and outreach to upgrade the scientific infrastructure. Further recommendations for international scientific priorities are listed below:

"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." (IAP 2018, p. 2)

[11] Synthesis by IAP based on the four regional academy network studies.

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, p. 6)

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)

Independent Group of Scientists appointed by the Secretary-General: *Global Sustainable Development Report 2019: The Future is Now – Science for Achieving Sustainable Development*

"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, p. xix-xx)

Annex 3: A Bibliography on Food Systems (to be reviewed and expanded)

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