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TOWARDS SUSTAINABLE FOOD SYSTEMS: A HOLISTIC, INTERDISCIPLINARY AND SYSTEMIC APPROACH

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ABSTRACT

One of the biggest challenges facing humanity is achieving sustainable food security in the face of population growth, resource scarcity, ecosystem degradation and climate change. Transitioning towards sustainable food systems (SFS) is a must for achieving sustainable development. This review paper highlights the need to adopt a holistic, multidimensional, interdisciplinary and systemic approach for better understanding food systems, which is a prerequisite for fostering transition towards sustainability. A better understanding of food systems means comprehending issues at play from 'farm to fork' *i.e.* production (crop, animal, seafood), processing, trade and distribution, and consumption. For gaining a full awareness also cross-cutting issues such as gender, innovation and technology should be considered. Such a deep knowledge and consequent corrective actions are crucial to address the multiple challenges and dysfunctions of the current global food system such as food insecurity, obesity, food waste, climate change, biodiversity loss, land degradation, water depletion, deforestation, market concentration and food heritage erosion. It is fundamental to foster transition towards sustainable and resilient food systems to achieve sustainable food and nutrition security for present and future generations. All dimensions (environment, economy, society and culture, nutrition and health) of food sustainability should be tackled while considering policy and governance. Different food consumption and production models can help speeding up journey towards sustainability. These include, *inter alia*, organic agriculture and different alternative food systems allowing to link consumption and production such as urban agriculture, community-supported agriculture and short food chains. While the challenge is titanic, there is a menu of options that can be jointly used to foster shift towards SFS such as sustainable and eco-functional intensification, sustainable diets, food loss and waste reduction. Nevertheless, a holistic and systemic approach is necessary to develop a systems thinking for generating interdisciplinary knowledge needed to support transition towards sustainable food systems.

Keywords: *food systems, sustainability, systemic approach, multidimensionality, systems thinking.*

INTRODUCTION

The world faces the challenge to achieve sustainable food security in the face of human population growth, resource scarcity, ecosystem degradation, and climate change (*e.g.* Mathijs, 2012; Gladek et al., 2016). Over recent years, and particularly since the global food price spikes of 2007-2008 (IFPRI, 2008), the scientific and policy communities have trained their attention on multiple problems within global food systems (*e.g.* Ericksen, 2008; FAO, 2009a; Lang, 2009; IAASTD, 2009; Foresight, 2011; FAO, 2012; WWW-UK, 2013; Searchinger et al., 2013; Garnett, 2013; IPES-Food, 2015; Gladek et al., 2016).

The current global food system lies at the center of a nexus of global environmental, economic and social problems, stretching from poverty to climate change and environmental degradation (Gladek et al., 2016). Global food system is having a big impact on the natural environment and resources. Therefore, alternative pathways are needed to provide for the needs of our growing population without compromising human or ecological health (UNEP, 2016). Although sufficient food can be produced, even for a much larger population, structural changes are needed to convert current systems and consumption patterns (Gladek et al., 2016; UNEP, 2016). In fact, about a third of food produced is currently wasted along the food chain (Gustavsson et al., 2011) while a larger percentage of the population is overweight than undernourished (FAO et al., 2015) and land resources are increasingly allocated towards non-food uses (cf. biofuels) (FAO, 2009b). In order to achieve global food security goals, sustainability must be the benchmark of a food systems reform including environmental, nutritional, social, cultural and economic dimensions (IPES-Food, 2015). Nothing less is required than a redesign of the whole global food system to bring sustainability to the fore (Foresight, 2011).

Nevertheless, despite the mobilization of the political and scientific communities around various food systems issues, the task remains incomplete. The challenge, therefore, is to produce a joined-up picture of food systems and their related issues through an integrated approach based on the nexus of different disciplines, sciences, policies, practices and governance tools, trying to understand how they shape global food systems and their ongoing transformations. The present review paper highlights the need to adopt an interdisciplinary, holistic and systemic approach to generate the new types of knowledge and science that can support the transition towards sustainable food systems.

EVOLUTION OF THE GLOBAL FOOD SYSTEM: GENERAL TRENDS AND PERSPECTIVES

A food system is defined as the sum of all the diverse elements and activities which, together, lead to the production and consumption of food, and their interrelations. In July 2014 the High Level Panel of Experts on Food Security and Nutrition (HLPE) provided the following definition for a food system: "*A food system gathers all the elements (environment, people, inputs, processes,*

infrastructures, institutions, etc.) and activities that relate to the production, processing, distribution, preparation and consumption of food and the outputs of these activities, including socio-economic and environmental outcomes". Food system interfaces further with a wide range of other systems (energy, transport, etc.), and faces various constraints. Food system is a "descriptive" concept and does not preclude that a food system will necessarily perform well or generate appropriate food security outcomes, as well as a range of other socio-economic and environmental outcomes (HLPE, 2014). The concept of food systems, or of food and nutrition systems (Sobal et al., 1998), has given way to numerous definitions and conceptualizations. There have also been various attempts to create typologies of food systems. Many of them are constructed on a historical perspective (Malassis, 1996); others refer to the relationships between production and consumption or to distinction between producers and consumers (Esnouf et al., 2013). To a certain extent, most of food systems are interconnected and their sum constitutes "a global food system".

As known, food demand is responding to the growing population size. Global food and agricultural production have increased significantly since the end of WWII. Global yields have steadily increased since the 1950s. There is more food produced today per person than ever recorded. In fact, more than enough food is currently produced for the global population, yet modern agro-food systems failed to resolve the problem of food insecurity (Gladek et al., 2016). While the world currently produces enough food for its citizens, about 795 million people are undernourished (FAO et al., 2015).

Major shifts in dietary patterns are occurring, including a move from basic staples to more diversified diets. Drivers include urbanization, increasing incomes, market liberalization and trade policies (Kearney, 2010; WWW-UK, 2013). These shifts in dietary patterns have considerable health but also environmental consequences (WWW-UK, 2013). Demand for livestock products has increased in the last 50 years and looks set to continue to grow, again with the majority of this increase envisaged to come from developing countries (FAO, 2009c). Over the last four decades fish consumption has been rising in line with the general trends of increased world food consumption (WWW-UK, 2013).

Furthermore, for the last decades food has been cheaper in real terms, and more readily available, than probably at any time in history, which partly explains why food policy has received less prominence in national and international decision-making than in earlier times. Yet, it cannot be said to have a functioning global food system when people today still do not have access to adequate and sufficient food or are over-fed (Godfray et al., 2010).

The global food system is experiencing a significant confluence of pressures. Global population size is increasing from nearly seven billion today to eight billion by 2030, and probably to over nine billion by 2050; competition for land, water and energy is intensifying, while the negative effects of climate change is becoming increasingly evident (Foresight, 2011; Capone *et al*., 2014). These pressures or drivers of change (global population increases, changes in the size and nature of per capita demand, climate change, future governance of the food system,

competition for key resources, changes in values and ethical stances of consumers) would present substantial challenges to food security (Foresight, 2011). Delivering global food security in the face of climate change is one of the greatest challenges facing the shaping of a climate-smart global food system, and increasingly public policy must seek to deliver on a number of different but aligned objectives with less resources (World Bank, 2015).

FOOD SYSTEMS: CROSS-CUTTING ISSUES AND MULTIPLE CHALLENGES

Agriculture (including crop production, animal production, forestry and fishery) is essential for the production of food but it can have a big impact on the natural environment with the potential to damage biodiversity, water quality and soils and to exacerbate climate change. Therefore, it is crucial to balance competing demands and to minimize the food system footprint. In the 21st century, agriculture faces multiple challenges: it has to produce more food to feed a growing population with a smaller rural labor force, more feedstocks for a potentially huge bioenergy market, contribute to overall development in the many agriculture-dependent developing countries, adopt more efficient and sustainable production methods and adapt to climate change (FAO, 2009). Moreover, unsustainable food consumption patterns are putting increasing stress on ecosystems. Food consumption and production patterns are among the most important drivers of environmental pressures (*e.g.* biodiversity loss, land degradation, declining soil fertility, unsustainable water use). There are trade-offs between agricultural output and ecosystem services; increasing yield often comes with an environmental consequence. There are also trade-offs between different ecosystem services (WWW-UK, 2013).

From persistent undernutrition to burgeoning obesity rates, from land evictions to agriculture's soaring environmental footprint, from dwindling fish stocks to mounting food waste, there has rarely been so much attention on the problems within food systems (IPES-Food, 2015). A better understanding of the functioning and governance of food systems is crucial to address the multiple nutritional, environmental, economic and social challenges and dysfunctions of the current global food system including food insecurity, obesity and overweight, micronutrient deficiencies, food loss and waste, climate change, biodiversity loss, land degradation and erosion, water resources scarcity, deforestation, phosphate depletion, market concentration and food heritage and culture erosion. According to Godfray *et al.* (2010), current food and farming systems have succeeded in supplying large volumes of foods to global markets, but are generating numerous negative outcomes: degradation of land, water and ecosystems; high GHG emissions; biodiversity losses; persistent hunger and micro-nutrient deficiencies alongside the rapid rise of obesity and diet-related diseases; and livelihood stresses for farmers around the world.

Food systems are directly dependent on and at the same time have big impact on the natural environment. The global food system is the largest contributor to both environmental and humanitarian impacts. Global food system is the largest user of

water and land resources as well as the largest contributor to greenhouse gas emissions (GHE), biodiversity depletion and deforestation thus making it the primary single contributor to the transgression of many planetary boundaries (Gladek et al., 2016). It is estimated that food system emissions, from production to consumption, contribute 19-29% of global GHE (Vermeulen et al., 2012). However, the agri-food sector is also the world's largest economic sector and is therefore deeply entwined with poverty (Gladek et al., 2016).

To achieve the international targets set by the United Nations Secretary-General Zero Hunger Challenge and Sustainable Development Goals, we must re-think the way in which food system activities are structured and carried out. Ensuring access to nutritious food for all is at the core of this change and this will often depend on the way markets function at the local, national, regional and global levels, on the social safety nets created for vulnerable groups of the population (e.g. the urban poor and smallholder farmers), and on their access to infrastructure, finance, knowledge and technology. In this context, food system governance plays a fundamental role. According to Hopkins et al. (1982), the food arena is characterised by the presence of numerous actors with often different and even competing and contradictory agendas (Hopkins et al., 1982). The governance of global food system is seen to be challenged. Concerns have been raised regarding the exclusion of smallholders and poor countries from market opportunities derived from globalization. However, research has shown that the governance mechanisms are mutually entrenched as a response to policy, social and economic dynamics (Guldbrandsen, 2012; Bernstein and Cashore, 2007). Anyway, globalization will continue exposing the food system to novel economic and political pressures (Foresight, 2011) with implications also in terms of its governance. For that, Foresight (2011) report stresses the importance of crafting food system governance to maximize the benefits of globalization and to ensure that they are distributed fairly

MULTIDIMENSIONALITY OF SUSTAINABLE FOOD SYSTEMS

A transition to sustainability is necessary for a new management of food systems. Since food systems develop within a limited and sometimes shrinking resource base, they need to make use of natural resources in ways that are environmentally, economically, socially and culturally sustainable to conserve the global ecosystem. Growth of food systems must be inclusive, must target objectives beyond production (including efficiencies along the food chains) and must promote sustainable practices and diets (HLPE, 2014).

Food is variably affected by a whole range of factors including food availability, food accessibility and food choice, which in turn may be influenced by geography, demography, disposable income, urbanization, trade liberalization, globalization, religion, culture, transnational food corporations, food industry, and consumer attitude and behavior (Capone *et al.*, 2014).

FAO (2012) pointed out that ending hunger requires that food consumption and production systems achieve more with less resources which encompasses fostering sustainable intensification of food production, encouraging sustainable food

consumption and reducing food loss and waste. In order to understand which is the impact of the different factors on the food system, the *Guidelines on Sustainability Assessment of Food and Agriculture* (SAFA) Systems, elaborated by FAO, provide an international reference for sustainable management, monitoring and reporting in food and agriculture at all levels of the supply chain. SAFA defines what sustainable food and agriculture systems are, including environmental integrity, economic resilience, social well-being and good governance (FAO, 2014).

According to the HLPE (2014) "*A sustainable food system (SFS) is 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*". The unsustainability of food systems is the main reason for the existence of food insecurity and malnutrition; if food systems do not perform adequately in their environmental, economic and social dimensions, food security and nutrition are threatened.

The definition demonstrates the importance of seeking sustainability in three dimensions —environmental, economic and social — at every stage of a food system, from agricultural production, processing, and retailing, to consumption. A food system's sustainability is also influenced by culture factors interacting with the other three mentioned dimensions; culture should be added as other dimension of sustainability to be adequately explored (FAO, 2009).

It is thus important that policy measures to achieve sustainability in food systems adopt a multidimensional, gender-sensitive and integrated approach in all the stages including transport, storage, processing, wholesale and retail, consumption and food waste management. Also important is to ensure a fair, equitable and inclusive market mechanism at the national, regional and international levels for economic viability of rural livelihoods in general and small-scale farmers in particular (UN, 2016).

The emphasis at an overarching level is therefore to assist in creating the policy-enabling conditions for sustainable food systems approaches to develop. It is important to promote multi-stakeholder dialogue for coordinated action at national level that considers interactions and outcomes across the food system. Political incentives must be shifted in order for these alternatives to emerge.

TOWARDS SUSTAINABLE FOOD SYSTEMS: NEW APPROACHES AND PARADIGMS NEEDED

Creating the enabling conditions for the shift to more sustainable food systems will require systems based approaches that can consider the range and complexity of interactions prevalent in the production, distribution and consumption of food. These links between food production, distribution, consumption, and nutritional health and the underlying social-economic, cultural and institutional elements, ultimately affect the quantity, quality and affordability of food, as well as health and wellbeing. Fostering transition towards SFS implies also gaining a better understanding about multifaceted and complex relations between food systems, diets, and food and nutrition security (Capone et al., 2016). The good news is that

agriculture, food security, nutrition and sustainability are increasingly discussed in the same context (Lang, 2009).

Food is strongly linked to health and sustainable development. However, food consumption patterns, which are important drivers for agricultural and food systems, are often neglected in the research and policy areas of food security. Technical fixes alone will not solve the food security challenge and adapting to future demands and stresses requires an integrated food system approach, not just a focus on agricultural practices improvement (Capone et al., 2014). Foresight (2011) stressed the critical importance of interconnected policy-making; not only policy in all areas of the food system should consider the implications for volatility, sustainability, climate change and hunger but also policy in other sectors (cf. energy, water supply, land use, the sea, ecosystem services, biodiversity) outside the food system also needs to be developed in much closer conjunction and coordination with that for food.

Sustainable food systems embrace the interconnectedness of all the food-related activities and the environment within which these activities occur (production, distribution and consumption of food) operating at local, regional, national, and global levels. There is no one model of a sustainable food system, but a set of principles that constitute sustainability. Therefore, approaches to allowing this shift should evolve from the particular contextual conditions of the food system under consideration (UN, 2016). However, there has been a tendency among scientists and policymakers to address the problems related to food systems as individual pieces of the puzzle, and to overlook their interrelations. To address food and nutrition challenges, food systems have to be considered in their entirety, acknowledging the interdependency of consumption and production (IPES-Food, 2015). According to Foresight (2011), substantial changes will be required throughout the different elements of the food system and beyond if food security is to be provided for a predicted nine billion people.

The need for a systems-based approach towards research dealing with food systems has been emphasized in several reports by different bodies (e.g. the third and fourth EU Standing Committee on Agricultural Research - SCAR, Expo 2015 EU Scientific Committee). Meeting the challenges facing the agricultural and food and non-food systems means dealing with complexity and working in an integrated manner (EC, 2016). The system-based and holistic approach implies to go beyond the research undertaken at the level of the components of the system to better understand the interactions between those components. Therefore it is necessary to take due account of the different disciplines and science (IPES-Food, 2015). This implies also the development of knowledge and methods enabling integrated assessments of system performance across, space, time and the full range of dimensions (economic, environmental, social and cultural).

In this context, sustainable diets concept has started to be explored to recommend diets healthier for the environment as well as for consumers. With the food globalization process and the increased industrialization of agricultural systems, the sustainable diets' concept was affirmed in the international debate on sustainable development (FAO & Bioversity International, 2012; Capone *et al*., 2014).

A systems and integrated approach has been applied to organic agriculture where standards regulate production, processing and labelling and market access is subject to scrutiny (Azadi, 2011) or to the urban food supply chains which include horticulture, livestock, fisheries, forestry, and fodder and milk production increasingly spreading to towns and cities (e.g. UNEP, 2016a). In particular, urban food system is less visible than such other systems, but, despite its low visibility, it nonetheless contributes significantly to community health and welfare (Pothukuchim and Kaufman, 1999).

CONCLUSION

The 2030 Agenda for Sustainable Development clearly shows that transition towards environmentally, socially and economically sustainable food systems is a must for achieving sustainable development. It is of paramount importance to foster transition towards sustainable and resilient food systems that achieve sustainable food and nutrition security for present and future generations. While the challenge is and will remain titanic, there is a menu of options that can be jointly used to foster transition towards SFS such as sustainable and eco-functional intensification (cf. improving productivity sustainably), sustainable diets, food loss and waste reduction, and innovative governance and trade arrangements that improve access to sufficient, nutritious and safe food for all.

A transition is needed towards SFS based on fairness, transparency, integrity and trust. Food production and food processing technology should meet the highest environmental, quality and safety standards and only minimally alter the intrinsic qualities of food. Food loss and waste should be reduced to a minimum and consumers should be better informed about the production processes and their environmental and societal impacts, so that they can make informed choices. The key of this necessary transition is a sustainable systems-based approach to the global food system governance.

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