Conclusions: Promises and Challenges for Sustainable Agri-Food Systems

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University of Waterloo
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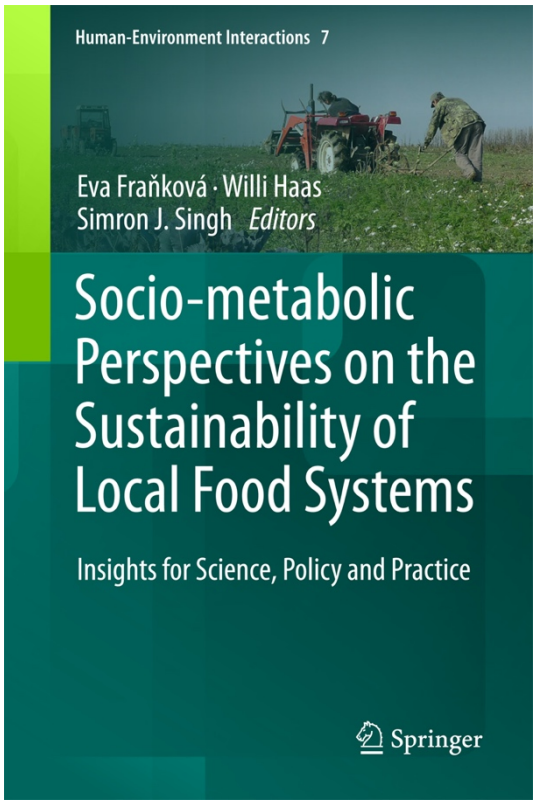

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Chapter 12

Conclusions: Promises and Challenges for Sustainable Agri-food Systems

Simron Jit Singh, Willi Haas, Eva Fraňková

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Abstract

This chapter summarizes the main sustainability challenges (in terms of sience and policy) of the current dominant agri-food system and presents insights derived from the cases in the volume. We return to the two main questions asked in the introductory chapter of the book. How useful is the socio-metabolic approach in studying the sustainability of local food systems (LFS)? To this, we identify three main methodological contributions:

(1) That classic indicators (of material and energy flows) derived from the sociometabolic approach offers greater insights as well as lend power and rigour when combined with social, ecological, political and other dimensions;

(2) Multi-dimensional and multi-scalar analyses can contribute not only to sustainability assessment of a particular LFS but also to broader theoretical and conceptual debates regarding sustainability and potential localisation of LFS;

(3) Socio-metabolic studies on the local level provide detailed understanding of the particular LFS while revealing potential leverage points for intervention for improved system performance with respect to sustainability.

Besides methodological insights, the chapter derives key lessons from the cases in the book, in particular the promising characteristics of both the historical and current local food system. We identify the following points as important:

(1) A close proximity between the producers and consumers holds a very strong potential for systemic change of the current dominant agri-food system, but also the other way round, the growing distance obscures the sustainability challenges;

(2) LFS proves better in closing nutrient cycles on local and regional levels. This issue is also related to the importance of the multifunctionality of land use, and livestock use, in both the historical and the current LFS.

As seen in our case studies, LFS cannot be seen as a panacea to address all sustainability challenges of the current dominant agri-food system, however, they hold great potential and therefore deserve further exploration.

Keywords: Sustainability Sustainable development goals (SDGs), Agri-food system, Local food system, Social metabolism

S.J. Singh
School of Environment, Enterprise and Development (SEED),
University of Waterloo Environment 3 Building,
200 University Avenue West, N2L 3G1 Waterloo, ON, Canada
e-mail: Simron.Singh@uwaterloo.ca

W. Haas
Faculty for Interdisciplinary Studies,
Institute of Social Ecology, Klagenfurt University,
Schottenfeldgasse 29, 1070 Vienna, Austria
e-mail: willi.haas@uni-klu.ac.at

E. Fraňková
Department of Environmental Studies,
Faculty of Social Studies, Masaryk University,
Joštova 10, 602 00 Brno, Czech Republic
e-mail: eva.slunicko@centrum.cz

12.1. The Challenge

Looking back at the valuable, both theoretical and empirical contributions in this book, it is a humbling experience to crystalize these insights into a few pages. Let's first begin by summarizing the scientific and policy challenges we have addressed so far. Existing literature as well as the contributions in this book provides strong evidence that our current global agri-food system is unsustainable (Jurgilevich et al. 2016). In ecological terms it consumes fossil fuel, water, and topsoil at unsustainable rates. It contributes to environmental degradation, via air and water pollution, soil depletion and diminishing biodiversity. Meat production contributes disproportionately to these problems (Horrigan, Lawrence, and Walker 2002). In terms of health, the world has been moving headlong towards an unhealthy pattern of food consumption for decades. In low and middle income countries food intake from animal sources has grown rapidly with remarkable declines in physical activity for populations with income growth (Ng and Popkin 2012). As a result, it is estimated that over 12 million deaths in 2010 were attributable to unhealthy diets and physical inactivity across the globe (Lim et al. 2012). At the same time nutritional deficiencies stay at very high levels, which caused 0.4 million deaths in 2015 (Wang et al. 2016) and food security is by far not granted by the present food system (Alder et al. 2012) as dramatically shown by the newly unfolding famines in Southern Sudan (Burns 2017).

That said, the challenge to influence dietary patterns in a modern world to achieve more sustainable choices by consumers is not trivial. In liberal democracies, especially when it comes to food issues, politicians have little interest in prescribing citizens what to buy and eat. At the same time, the obvious possible driver for obesity, by health scholars categorized as an epidemic, can be found in the food system due to the increased supply of cheap, palatable, energy-dense foods, improved distribution systems to make food much more accessible and convenient, and more persuasive and pervasive food marketing (Cutler, Glaeser, and Shapiro 2003; Kitchen et al. 2004). Further, convenience food has enabled consumers to make choices without sparing much thought. No wonder, most consumers in the industrialized world are not aware or lost in confusing information on the entire food chain and the poor social, environmental and animal welfare standards associated with their decisions (Jurgilevich et al. 2016).

In September 2015, representatives of all the 193 states of the United Nations (UN) embarked on an ambitious *Agenda 2030* with the launch of the Sustainable Development Goals (SDGs, UN 2015). The 17 goals are not mutually exclusive, and in the spirit of sustainability, none of the goals can be seen as stand-alone. For example, good health and wellbeing cannot be secured without climate action, or zero hunger. The 17 goals cut across a number of critical global environment and social issues that mandates any sustainability agenda for cross-

sector, stakeholder driven, inter-and-multidisciplinary approaches at multiple scales. The topic of this book is at the core of at least 8 of these goals: zero hunger (goal 2), good health and wellbeing (3), reduced inequalities (10), sustainable cities and communities (11), responsible consumption and production (12), climate action (13), life below water and on land (14 and 15 respectively).

However, as it stands, the Sustainable Development Goals (SDGs) have a long way to go, and the global food system has not provided its share in their accomplishment. Many sustainability scholars do not believe in small adjustments, they rather call for its fundamental change (Gliessman 2014). Public health scholars come to the same conclusion that a fundamental change is urgently needed; they argue that increases in obesity seem to be driven mainly by the global agri-food system (Swinburn et al. 2011) and similarly, the key for reducing cardiovascular disease requires changes in the globalized food system (Anand et al. 2015) and yet meeting the nutrition and NCD[1] targets in the SDGs will take concerted actions to taking on the broader food system (Hawkes and Popkin 2015).

In dealing with the complexity of the problem, many studies adopt a rather reductionist perspective, focussing either on the social or natural part of agri-food systems, and very often only on a narrow aspect of either. However, grasping something as simple and complex as "food" requires a whole system approach – beyond the agricultural fields alone, and often even beyond agro-ecology – to have an emphasis on Society-Nature interactions in general. These interactions are best analysed from a socio-ecological systems perspective, that focus on the inextricable connection between the biophysical as well as cultural dimensions. Moreover, attention needs to be given to both temporal and spatial scales.

In defining "sustainability" of agri-food systems, Enric Tello and Manuel González de Molina (chapter 2) argue that "agri-food systems are sustainable when they can meet human needs while maintaining the basic funds and ecosystem services of agroecosystems and cultural landscapes in both a reproducible way and a healthy ecological state, at local, regional and global scales." In pursuing this definition, the authors suggest to include societal, political, economic, and also historical perspective of agri-food production. Such an approach implies a large and complex research agenda to develop concrete criteria and indicators capable to capture this complexity. This calls for large collaborative efforts, drawing on scholars versed in interdisciplinary research fields as political ecology, social/human ecology, industrial ecology, ecological economics, landscape ecology, agro-ecology and environmental

[1] Noncommunicable diseases (NCDs), known also as chronic diseases include for example cancer, cardiovascular diseases, diabetes, poor mental health and respiratory diseases. For nine global targets to reduce NCDs see https://ncdalliance.org/global-ncd-targets (2017-07-16).

economists, those with an ability to link and integrate a range of methods. This volume is a small step towards this goal.

12.2. Why socio-metabolic perspectives on local food systems are important?

We believe the sociometabolic approach offers a very useful framework to capture the complexity of this endeavour. The seven cases in this book (chapters 5 – 11) applied the concept of "social metabolism" (SM), tracking flows of matter and energy both within and through their systems boundaries. The first significant strength of the contributions lies in the fact that most authors applied the social metabolism approach to gain insights beyond classic indicators of material and energy flows. For example, chapter 5 looked at the long-term evolution of agro-ecological landscapes in terms of labour productivity vis a vis food and fuel requirements, diversity in land use and species richness, and the socioeconomic and political implications of growing dependency on external resources, including land grabbing and, more generally, ecological unequal exchange between Spain and countries in the Global South. These insights suggest not only growing imbalance between available local resources, regional diets, and type of agricultural production, but also breaking of regional nutrient cycles into one-way global flows that do not allow organic replenishment of the nutrients. Another historical study (chapter 6) dealing with the issue of nutrient balance used the social metabolism approach to draw attention also to another two "great challenges" of pre-industrial agriculture – social inequality in distribution of critical resources, and unstable provision of food for the local farming community.

Thus, the multi-dimensional and multi-scalar analysis of social metabolism cannot be underestimated. This approach allows understanding the impacts of food related policy at different dimensions such as of diets, regulations, landscapes, land uses and international trade. Whether the cases focus on historical (long term) metabolism or contemporary, the SM approach underlines the importance of material closing loops locally to offset flows induced from elsewhere. Many of the SM indicators are simple and cost-effective and allow us to track the performance of the system over time. The system boundary in each case incorporates both the social and ecological dimensions, and lends to derive a number of pressure indicators (focussing on the interaction between society and nature), and at times state indicators (focussing on either the social or the ecological dimension).

There are a number of sustainability indicators for agri-food systems (see FAO 2013), while many others serve as proxies. For example, Soil Organic Matter (SOM), as argued by Tiziano Gomiero (chapter 3) does not only relate to soil fertility, but also to soil biodiversity, its water-holding capacity, and resistance

to erosion, thus providing plenty of information with relatively small effort. Several chapters present energy-related indicators. Chapter 2 introduces a very innovative adaptation of Energy Return On Investment (EROI) indicators to agroecosystems enabling one to analyse not only external inputs and outputs (as in traditional EROI calculations), but to capture also internal energy flows significant both in traditional and industrialized agroecosystems. Chapter 3 introduces the specific concept of power expressing the rate or speed at which required energy (in terms of food but also in other required forms) is available to society. And chapter 4 offers a conceptual and operational model of integrating energy loops and information into landscape and biodiversity modelling.

As such, chapters 2 to 4 stress the function of indicators to express not only the volume and speed of energy and material flows, but also their relation to concrete, agroecologically relevant funds, such as soil fertility, managed land, population/workforce etc. Also, they stress the need to understand the identity of the phenomena to be captured by concrete indicators. Whereas for example the significance of fossil fuel consumption might be adequately expressed in energy terms, and its further impact in terms of CO_2 emissions, for biocides the same units of analysis are possible (in sociometabolic studies it is common to express their use in terms of embodied energy and CO_2 emissions), however, their sustainability relevant identity includes also their toxicity. Thus adequate indicators should inform us not only about their energy demand and emission impact, but also their poisonous potential.

The wide variety of sustainability indicators covered in the case studies allow for the second important strength of the socio-metabolic approach, its potential to contribute to broader academic debates on sustainability and localisation of agri-food systems. One example is the recent debate on the land sparing and land sharing strategies (as introduced in chapters 1, 2 and 4). Most chapters in this volume, both the theoretical and empirical ones argue in favour of the latter, the land sharing approach. From the agroecosystem perspective, local scale matters as both agroecological processes and peasant knowledge has co-evolved, rooted in specific place, and thus cannot be easily moved to other places where we might consider them more "efficient" as supposed by the land sparing approach. Some of our cases provide insights into household and neighbourhood dynamics and their decision-making processes, as well as the ways local communities respond to higher-level interventions (such as subsidies, markets, prices, climate, infrastructure, etc.). The cumulative effect of these decisions not only alters the local, but also scales up to the global.

Regarding scale, there is another example of theoretical argumentation where the sociometabolic approach provides important insights. Within the critique of localisation, one line of argumentation pursues the notion that scale is socially constructed, and thus one cannot assume certain outcomes from applying

certain scale (Born and Purcell 2006).[2] The biophysical insight contradicts such constructivist position; once considering closing the nutrient cycles and other biophysical flows within certain agroecosystem, the physical scale does matter and is decisive for the sustainability outcome. As argued theoretically (chapter 2) and in terms of agroecosystem modelling (chapter 4) but also shown empirically (e.g. chapter 5), the level of nutrient re-cycling on the local and regional level is directly dependent on the scale and related type of farming activities. In each of these chapters, either the cycles are integrated within the local agroecosystem (with implications for ecosystem functioning, biodiversity etc.), or is not, as in the case of current feedlots in the Vallès county in Spain where significant amounts of feed are imported from various countries worldwide implying global, opened flows of nutrients.

Clearly, it is not to say that local scale is sustainable always in every aspect. Chapter 6 warns us effectively against this pitfall, together with a related one of assuming the traditional organic agriculture to be sustainable by definition. On the basis of detailed historical analysis, we learn the lessons on sometimes negative long-term nitrogen balance related to high pressure on land by the local farming community, often due to limited access to land and unequal social relations in the form of manorial tithes and taxes exerted on the peasant community by the landlords.

These insights lead us to another, third strength of socio-metabolic studies – the fact that they are context specific, they urge a greater insight into the system under consideration. Without this knowledge, it would be difficult to establish an effective systems boundary. For example, local-level analysis articulates how the biophysical interacts with the cultural (taboos, beliefs, institutions, practices, etc.). Clearly, materials and energy do not flow on their own, rather they are deliberately organised and reproduced by society through communication, contingent on their system of meaning. With site-specific studies, the peasant's know-how, narratives, identities, tastes as well as biophysical attributes of landscapes, livestock, seeds, plants and irrigation systems become alive and relevant. Thus, it is through narratives, the characteristics of a farming system become evident, and how it functions within given structural and socio-economic constraints and opportunities (including historically).

In several cases, the SM approach proved useful for identifying leverage points for intervention. One example is described in chapter 10 that focusses on the functional system, tracking materials in the supply-chain, revealing different narratives, and thus different logics that shape the assessment of performance of three different organic tomato supply chains (local, mixed and global one) in

[2] In their own words (Born and Purcell 2006:195): "scale is socially produced: scales (and their interrelations) are not independent entities with inherent qualities but strategies pursued by social actors with a particular agenda. It is the content of that agenda, not the scales themselves, that produces outcomes such as sustainability or justice."

Catalonya, Spain. Despite all being certified as organic, the authors argue that their identity is so different that a straightforward comparison is not meaningful. Still, the supply-chain approach is useful to identify critical points for intervention (such as the efficiency of the distribution with the local system) and thereby opens the possibility to improve their sustainability performance.

A few of the cases reported bottom-up movements in the Global North (e.g. Greece and Spain) and South (Cambodia) where local practitioners and activists were able to identify leverage points for intervention using the SM approach. Depending on the context, these cases either serve as examples of the "quiet sustainability" or "social innovation". The argument is, that when it comes to a sustainability transition with respect to agri-food systems, we are not to expect a top-down transition driven by huge investments, national level policies and infrastructure. But as some of our cases suggest, will require multi-level transitions based on compatibility with culture, markets, institutions, regulation and the local socio-ecological context. New regimes are constantly being created in terms of local food systems, coupled with energy, waste management and livelihoods, and opportunities for new niches are abundant.

12.3. Further insights from our case studies

What conclusions, beyond methodological ones, can we derive from our cases on the sustainability of local, and above all localiz*ed* agri-food systems? Several key issues come to the forefront in this respect. First, we argue that the close proximity between the producer and consumer could foster a transition to healthier dietary patterns in quantity and quality. We believe that this proximity offers a reset on how we perceive our food. As we have seen in chapters 5 and 9 with respect to the Mediterranean cases (historical situation in the Vallès County in Spain and current case of the Samothraki Island in Greece), smaller distance between the producers and consumers resulted in a diet that is typically more "healthy" from today´s perspective – less meat, more proteins from legumes, more fresh and less processsed food. Here we find a "relatively high adherence to Mediterranean diet", with some deviations,such as – in the current case of Samothraki – higher consumption of white bread, sugar and coffee, alcohol and – to a lesser extent – meat. Even if the current economic situation is difficult, health and localness are more important factors in making food choices than price. Thus, food quality, tradition and meaning is still significant for people in large parts of the world. This meaning is preserved when consumers and producers are tied as a community, where one influences the other in terms of activities, rituals, and seasons.

On the other hand, as in the present situation of the Vallès county, the producer-consumer disconnect affects food choices, as consumers remain oblivious of how they trigger unsustainable processes far away, such as land grabbing, social

inequalities, and nutrient imbalance, to name a few. LFS would not only mean to "know" about these consequences and possibly include them into consumption choices – but to re-connect to local diets, to local farming communities and agroecosystems, to local biophysical conditions. In the case of Vallès, for example, this would mean that in 1999, meat production would have had to be 5.3 times lower if it had to be adjusted to the local biophysical capacity in terms of growing the required amount of animal feed.

Another, related issue of critical relevance is the vast nutrient losses associated with an increasing nutrient imbalance throughout the globe. While rich countries accumulate nutrients in their soil, poor countries lack access to nutrients and their soil suffers poor Phosphorus access and low agricultural production (Schoumans et al. 2015). The livestock sector and the production of meat is one of the most nutrient-intensive agricultural sectors. The associated trade of inputs, feed and products shifts nutrients between continents and entails a vast virtual trade of land, and water, not embedded in the product but needed at the production site. Thus, the high Japanese import of meat implies that half of Japan's virtual nitrogen is lost in the US (Galloway et al. 2007). This global re-distribution of nutirents is inherent to industrialized agriculture in which a spatial division leads to an animal and plant production concentrated in separate areas. This causes excess manure in places where soils are already saturated with nutrients (Csatho and Radimszky 2009; Taghizadeh-Toosi et al. 2014).

Traditional systems followed a multifunction approach to livestock and farming (as discussed conceptually in chapters 2 and 4, and empirically in chapters 5,6,7). The case studies clearly show that the more integrated LFS (heterogeneous land-uses, integration of cropland, pastures and woodland with livestock system on local scale) have more closed nutrient cycles – both in traditional organic systems, but also the case for current organic system discussed in chapter 7. To ensure sufficient nutrient input for the soils, a significant internal biomass turnover within the farm system has to be ensured – the case studies describe concrete both traditional and current practices how to ensure this (chapters 5,6,7,8) – using green fertilizers (leguminous nitrogen fixing plants as part of the crop rotation scheme, buried biomass from post-harvest leftovers, compost, etc.), animal manure and possibly also humanure, chapter 5 describes specific practices of biomass re-use in the Vallès county, Spain called "formiguers" – small charcoal kilns where fresh biomass is burried and burnt to create charcoal that is incorporated into the soil.

From a biophysical perspective, for agri-food systems to be more sustainable, nutrient cycles are to be more closed on the local and regional level, and less dependent on the fossil fuel-based inputs. From evidence, localised LFS fulfil this requirement better than the globalised ones. Not only this, there are additional benefits in retaining local nutrients. For example, chapter 8 introduces small-scale community based use of modern technologies – a biogas

system producing energy both for cooking and lightening. On a larger – city and regional – scale, the concrete institutional and economic possibilities of re-integration of biomass residues into the farm production process are explored and assessed in chapter 11, suggesting a combination of small household and neighbourhood composting schemes, bigger composting facilities on the city level, and composting at decentralized network of peri-urban farms as optimal. The importance of closing of nutrient cycles for agroecological functioning of agroecosystems, heterogenous land-uses and related farm-associated biodiversity, energy efficiency of farming systems, importance of site-specific peasant knowledge, potential for democratisation and more balanced power relations across the agri-food value chain are critical.

Despite its strengths, we do not claim that the concept of "local food system" is a panacea to solve all problems related to the global agri-food system mentioned above. But it does provide promises for significant improvements as well as hints at future pathways to be explored. Already, a number of initiatives and efforts can be seen across the globe in different forms and at all scales, some more visible than others. On the conceptual level, a few key terms have become important for interpreting some of these efforts (also in this volume). For example, "leapfrogging" is discussed in chapters 6, 8 and 9. Combination of the local practices and models captured in these particular case studies opens up the possibility of avoiding the often one-way intensification and industrialisation path that sometimes seem (under socio-economic and demographic pressures) as inevitable. Often, these locally embedded practices combine traditional knowledge with new methods of cultivation, distribution and institutional arrangements. Through the combination of the old and the new, not pursuing either extreme, such LFS are somewhere in between, or "half-way through" the intensification path, trying to balance and make use of both types of agri-food systems (chapters 5, 8, and 9). Possible advantages, and also trade-offs of such a position are discussed in chapter 7. In seeking sustainable models of food production and consumption, we also stress the importance of existing practices that are not motivated by purposeful sustainability concerns, that we refer to as "quiet sustainability". For example, chapters 5, 7 and 8 describe existing practices and techniques that by their nature comply with sustainability, although not purposeful.

In conclusion, it is easier to say what is *not* sustainable. How a more sustainable agri-food system should look like, and above all, how to achieve this goal still remains a major challenge. The cases in this volume are indeed comforting, but too few to generalize or offer firm insights for science and policy. From what we've seen, LFS are promising, but in all cases discussed in this book their sustainability depends on how exactly they are specifically implemented. Thus, they are in the first place not as comforting as large-scale technological solution which are often sold as silver bullets but which in most circumstances like the

green revolution do not live up to their promises. Against this backdrop, to engage in pathways based on LFSs is a very rich but demanding option. In terms of policy, it needs a shift in principle, from policy directed towards international agro-markets and transnational companies to an adaptive reflexive governance approach dealing with a network of interrelated agri-food systems.

Such an approach requires social and societal learning that proceeds in a stepwise fashion moving from single to double to triple-loop learning (Pahl-Wostl 2009). Inherent to this approach is a continous adaptation to new circumstances which makes it difficult to predict developments and to control processes, but it promises higher resilience as well as higher sustainability. It requires a governance structure with willingness to learn from LFS, to manage uncertainty and risk as well as to understand and change structural constraints for promising cases of highly sustainable agri-food systems. In this a major role needs to be attributed to non-state actors like the local food initiatives. Scholars argue that such poly-centric systems are assumed to have a higher adaptive capacity and to be less vulnerable to disturbance (Pahl-Wostl 2009, Casado-Asensio et al. 2014, Jordan and Lenschow 2010, Mickwitz et al. 2009, Sonnino et al. 2014, Voß 2005). Thus, going along the path of a more localised food system means an explorative process of subsidarity making use of top-down, bottom-up, network and side-by-side governance elements for making our all food sustainable after all.

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