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SUSTAINABILITY IN FOOD NETWORKS

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Abstract

Sustainability in food networks has become a dominant issue in the development of the food sector in light of the challenging scenarios one might expect in the future. Products, enterprises, chains, consumers, and regions are all affected by this discussion. Environmental, social and economic pressures require the development of strategies on how to best meet the challenges and to move the sector with its global presence and its many SMEs towards a status which is sustainable and robust enough to remain so even if future scenarios might deviate from today's expectations (dynamic sustainability). The paper outlines a framework for research on sustainability developments, sustainability assessments, consumer communication, and the transition of enterprises and chains towards improvements in sustainability.

Keywords

Sustainability, food networks, LCA methodology

1 Introduction

A sustainable development of our world and society means a development that meets the needs of the present without compromising the ability of future generations to meet their own needs[1]. It is one of the major challenges to achieve sustainable use and production of our renewable resources, including food, to protect both the environment and human health. The food system highly impacts sustainability and the environment through, e.g., consumption of energy and sweet water, waste production, or pollution from production and food transportation.

Sustainability is currently one of the most pressing issues for industry as well. A large number of initiatives have been started by industry and retailers alike; major industry groups have established task forces dedicated to sustainability issues, including the Sustainable Agriculture Initiative (SAI[2]) by major food processors.

To achieve an enduring sustainability and environment-friendliness of the food system, sustainability as an all-encompassing approach must build on long-term and sustainable acceptance by consumers, the society, and food chain actors alike. The challenge in achieving sustainability for environment protection is to build on an economically viable and socially acceptable development[3] With this perspective, the understanding of sustainability does focus on assuring sustainability regarding products which have to evolve from a limited and diminishing resource base, enterprises and chains which have to remain competitive, consumers which need to receive food that is affordable, safe to eat, of nutritional value and fitting their dietary and lifestyle preferences, and regions representing the social, economic, and natural environment in which the food system has to act.

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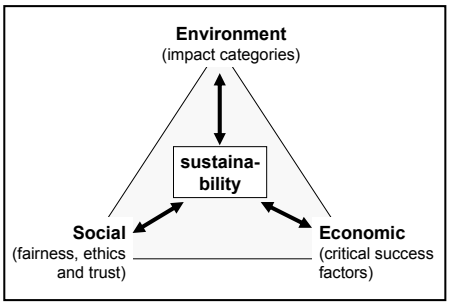
[1] As defined by the Brundtland-Report of the World Commission on Environment and Development: Our Common Future, 1987, http://www.un-documents.net/wced-ocf.htm

[2] See European Technology Platform Food for Life, Key Challenge 5 "Achieving sustainable food production".

[3] See *Sustainable Agriculture Platform*, www.saiplatform.org

This identifies the concurrency and multi-dimensionality of today's view on sustainability which integrates the three dimensions (see Figure 1): environment (e.g., natural resources, soil, water, emissions, fossil and total energy, biodiversity), society (e.g., food quality and safety, health and obesity, social and ethical conditions, animal welfare, fairness), and economy (e.g., performance of food chains, sustainable food products, affordability for consumers)[4] to assure long-term success.

Figure 1: Sustainability triangle



Studies on the sustainability of the food system and the methodologies applied have classically focused on environmental impacts of products or services to identify deficiencies and improvement potentials in areas such as carbon emissions, waste reduction, reduced water use, or transport reduction. There is no doubt that enhanced tools and methods for the assessment and management of these environmental impacts are needed[5]. However, the wider view requires the development of new, holistic methods and models for food chain analysis and food chain management concepts, which inherently incorporate consumer needs.

Potential solutions and strategies for the improvement of sustainability of food chains need to balance the interests of society and consumers, of the environment, and of food chain enterprises to provide a successful path towards long-term advancement sustainability. Research needs to support policy and food enterprises in their decision making and acting by providing balanced and tailored sustainability strategies and solutions. Sustainability improvements, which require coordinated initiatives at different stages of the food chain or which have different effects at different stages (positive/negative) require support for conflict resolution and coordination to be effective.

Crucial prerequisite for long-term sustainability is to support consumer choice for sustainably produced and at the same time affordable food. This requires transparency along the food chain and the suitable communication of sustainability to consumers.

2 Improvements in sustainability

The baseline for any discussion of sustainability is the identification of possible and probable future scenarios. Their specification is setting the stage for any further analysis. Sustainability of the food sector, the indicators for sustainability performance, and initiatives for improving the sustainability status of chains and the sector as a whole are all directly linked with the food sector's interaction with the natural, social, and economic environment inherent in the scenario specification. Sustainability research needs to develop elaborated views of future global and regional food system scenarios capturing major ongoing scenario initiatives and considering global and regional drivers and barriers of future developments as basis for the

4 See FP7 Cooperation Work Programme: Food, Agriculture and Fisheries, and Biotechnology.
5 See FP7 Cooperation Work Programme: Food, Agriculture and Fisheries, and Biotechnology.

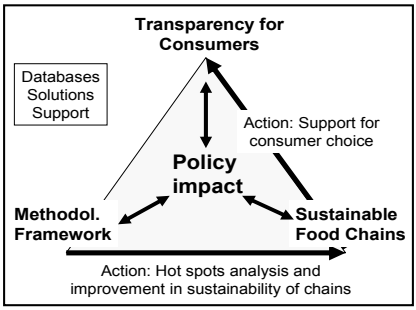
identification of robust sustainability strategies, which are resistant to global changes (INGRAM ET AL., 2006; DUCHIN, 2005).

The scenarios with their consequences on the food system provide the background against which sustainability strategies need to be assessed for performance and robustness. In the development of strategies towards reaching improved and robust sustainability status of food chains research has to cope with a number of specific complexities inherent in the food system:

1. The multi-dimensionality of sustainability requires highly multidisciplinary competence from a broad professional background reaching from methodology and technology to human behaviour and ethics: it includes, but is not limited to, environmental research, fairness in trade, third-world development issues, life-cycle assessment methodology, food system analysis and simulation, food chain management, food production, processing and packaging, food transport logistics, consumer behaviour towards sustainable food, food chain transparency, and socio-economic impact assessment;
2. The food system is global in its sourcing and distribution activities. Furthermore, sustainability issues have a global perspective as well (climatic change, social issues, food quality etc.). This requires joint international efforts from different research angles.
3. Adoption of sustainability strategies by food chains is crucial for the improvement of the sustainability status of chains, countries, and regions. As food chains might involve global food companies as well as of SMEs from different countries and as sustainability improvements might involve coordination across chains and be based on a chain encompassing sustainability assessment, coordination and support mechanisms need to be developed which suit these complex infrastructures.
4. The diversity of food products from different product lines but all with origin in agriculture and with focus on the satisfaction of consumer needs in households requires a holistic view of a variety of food chains and product lines. This is aggravated by the increase in convenience products where products from different product lines (e.g., meat, vegetables. dairy) are integrated into a single sales product for consumption.

This range of considerations requires multidisciplinary research, the coverage of major food product lines, and the incorporation of consumer and household research. The mapping of detailed information about the sustainability of different food chains (captured in sustainability maps) in food production, food processing, food packaging, transportation and trade could help identifying major deficiencies in sustainability in food chains and processes ("hot-spots") as well as priorities for improvement actions. The design of robust (with high adaptation potential against changes in scenarios) technological and managerial sustainability improvement strategies and solutions will facilitate the successful transition of food chains towards the identified reference food chain alternatives. The development of methods and signals for communicating "sustainability of food" with the consumer could support consumers' "informed" buying decisions towards more sustainable food production.

Figure 2: Strategic action lines



3 Road towards sustainability

The food sector to proceed towards long-term sustainability serving environmental, socio-economic and consumer needs asks for extensive and highly multi-disciplinary research integrating state-of-the-art methodologies and dealing with a number of crucial issues:

1. Methodologies for analysis: For understanding the sustainability status of food chains and opportunities for its improvement one needs advanced methodologies for the analysis of food chains and their guidance towards sustainability, involving an integrated life cycle assessment methodology that builds on tools, parameters, and performance indicators for the environmental, social, and economic pillars of sustainability, including issues like fair and ethical trade as well as economic performance,
2. Status and improvement potentials or opportunities: An analysis of the sustainability status and of improvement needs and potentials (hot-spots) of major European and international import/export food chains considering the organizational (global vs. regional etc.), social (cooperatives etc.) and technological varieties of global and European food chains would identify differences and sustainability "hot spots" for improvement priorities in enterprises and/or chains.
3. Technologies and solutions: Improvements in the sustainability status of chains requires the identification of new technological (waste reduction, water and energy use reduction etc.), organizational (logistics, fairness of trade etc.) and managerial (e.g. book and claim etc.) solutions that eliminates "hot spots" in existing activities along the food chain within food production, food processing, packaging, and transportation. If based on the principles of robust design against variations in scenarios they allow continuous improvement for a dynamic stability of food chains towards sustainability.
4. Simulation of new chains: The formulation of comprehensive, dynamic food chain simulation modelling tools could support the identification of new food chain organizations through either the recombination of partial chains (e.g. production, packaging, transport, processing) with best-practice sustainability status or the identification of new, innovative, advanced food chain organizations, processes and activities currently not yet realized in production, processing, packaging, or transportation for more sustainable food chains;
5. Transition support: The transition towards improved sustainability requires easy-to-understand transition support packages for enterprises and chains with strategies for (a) improvements in technology, organization and management and for (b) balancing interests along the food chain (conflict resolution).

6. Consumer transparency: Any improvements in the sustainability status of chains, needs to find acceptance and appreciation with consumers. The challenge is to enable decisions to buy and consume sustainably produced food through the provision of transparency which requires (a) the identification of consumer attitudes towards sustainability indicators and signalling alternatives and (b) the establishment of a transparency system along the food chain.
7. Impact and continuity: The assessments of the impact of sustainability strategies on the sustainability status of countries and regions considering different food system scenarios could provide policy decision support.

A substantial amount of knowledge and applications have been developed for these issues during recent years. However, the knowledge is scattered. One needs to collect available expertise, integrate it and advance it into a novel and comprehensive approach for the development of sustainability in food chains. This integration allows the development of a comprehensive view on food chain oriented life cycle assessment, the development of food chain "sustainability maps", including crucial areas for improvement (hot-spots) in, e.g. waste disposal, energy consumption, animal welfare, food safety etc., encompassing various food chains and product lines, the identification of food production systems, which are more sustainable and at the same time robust and resistant to disturbances, strategic management technologies for food chain development towards increased sustainability, and transparency on sustainability indicators across food chains for consumers.

4 Advanced Sustainability Life Cycle Assessment (S-LCA) methodology for food system analysis

In the holistic systems approach the environmental parameters of sustainability need to be augmented with social and economic parameters (DUCHIN, 2005; AIKING ET AL., 2004; OZCAGLAR-TOULOUSE, 2006). To date, a variety of social and ethical indicators have been developed for the food sector and supply chains, focusing on separate dimensions, for example: the ethical trade initiative (ETI) (labour standards), fair trade (terms of trade), animal welfare standards, integrated pest management (IPM). However, there has been no comprehensive set of social and ethical indicators developed in relation to food yet. Irrespective of this, the specification of parameters can build on a variety of established international indicator sets for sustainability as well as on actual developments in industry focusing on, e.g., 'food miles', 'carbon foot print' or 'fair miles'.

Life cycle assessment (LCA) is generally acknowledged as the most appropriate tool to assess the environmental sustainability of products and technologies throughout their life cycle. It has been standardized by the Society for Environmental Toxicology and Chemistry (SETAC) and the International Organization for Standardization (ISO 14040:2006), and adopted by UNEP, and the European Commission[6].

In principle, efforts have been realized for assessment methods in all pillars of sustainability (environmental impact: Life Cycle Assessment (LCA), Input-Output Life Cycle Assessment; social: Social Life Cycle Assessment (S-LCA), Social Accounting Matrix; economic: Total Cost Accounting, Activity Based Costing, Life Cycle Costing (LCC)). First initiatives integrating the three sustainability pillars such as the Global Reporting Initiative are available.

Needed is to develop an integrated, life-cycle oriented sustainability assessment and documentation methodology for food chains building on the environmental, social (GEIBLER ET AL., 2006), and economic pillars of sustainability. Some preliminary work and agenda

6 http://lca.jrc.ec.europa.eu/

setting for this is being carried out in the FP6-CALCAS[7] project, but a real operational implementation is still due.

5 Analysis of food system sustainability status

Many factors in food production, processing, packaging, transportation, and trade currently contribute to deficiencies in the sustainability status of food chains: wasted food from overproduction or wrong allocation, packaging waste, energy and freshwater consumption, CO2 emissions from food production and transport, deficiencies in food safety or unfair trade relationships are only a few examples. Attempts to analyze the sustainability of food chains are usually limited (as the 'food miles' concept) to a rather narrow focus. In addition, there is no overview available on the sustainability situation on the food sector as a whole, which considers the three dimensions of sustainability and the vast variety of diverse food chains. Furthermore, attempts to analyse the sustainability of food chains do not sufficiently account for scenarios and their regional diversity.

This gap could be filled by providing an extensive mapping on the sustainability and hot spots status of various diverse food chains and their interrelation with scenario developments of the future. The analysis could build on present knowledge regarding the hot spots and sustainability status of chains and complement it where necessary through life cycle analysis using the integrated, multi-dimensional LCA methodology and complementary approaches of selected food products in selected food chains.

This mapping could also provide the basis for the identification of best practice food chains that could serve as references and of sustainability deficiencies with priority for improvement (hot spots) at four different levels: deficiencies relating a) to the whole food chain (e.g. deficiencies in knowledge on sustainability advancement options), b) to food enterprises and their relationships, c) to households, and d) to processes (production, packaging, processing, transportation). An analysis will have to cover both, the actors within a chain and the relationships between the actors in order to include social aspects such as fairness and ethical trade. It could incorporate case studies but also surveys for stabilizing case study results.

The analysis of priority areas for improvements could guide the analysis of technological and organizational improvement opportunities, identify 'best practice' solutions but also support to 'engineer', in a simulation approach, virtual 'best practice solutions' that build on a recombination of best chain elements from different chains (production elements combined with distribution alternatives) and the integration of best solutions (e.g. from transport) from international data bases. These results could, if feasible, determine a first set of improvement strategies.

6 Sustainability strategies and solutions

In the transition of food chains towards increased sustainability the key challenge is to develop technological and management strategies and solutions to increase sustainability at the identified 'hot-spots' which lead to a sustainability increase of the whole chain and are robust and resistant against global changes in the sense of 'dynamic stability'. In the area of how to achieve sustainability in the food system, there is only very few and scattered knowledge available. In addition, there is no integrated strategy development process available supporting the challenge of strategy development for the total food chain.

Needed is the establishment of knowledge on robust reference strategies for 'dynamic stability' to achieve sustainability within food production, food processing, food packaging, transportation, trade, or consumption and the integration into improvement strategies for total chains based on the principles of robust design and dynamic stability, i.e., incorporating

7 http://fr1.estis.net/sites/calcas/

adjustment potential with regard to changes in scenario developments. It might (and probably will) incorporate technologies and organizational opportunities that influence hot spots indirectly by initiating changes in certain stages of the chain that will affect hot spots in other stages, e.g. households. A similar difficulty concerns changes in logistics where trading partners have to cooperate or new trading concepts like the 'book and claim' concept involving trade of certificates that could support fair trade initiatives but requires cross-country coordination efforts.

The rapid identification and engineering of new, innovative, advanced food chain organizational alternatives not yet realized in current food chain activities, building on new technologies (new analytical methods etc.), for more sustainable food chains requires the availability of comprehensive, dynamic food network simulation modelling tools and their application (LABARTHE ET AL., 2007).

7 Transparency on sustainability towards consumers

The appropriate communication of sustainability aspects to consumers could support efforts to increase the perceived value (expressed as willingness-to-pay) of sustainably produced food which, in turn, could offset some of the additional costs enterprises might have to face in their path towards improvements in sustainability.

Currently, many scattered labels for communicating food sustainability to the consumer exist: the "European Eco Label" for organic products, the "Fair trade" label, "Food miles" in the UK, and various labels for regional origin all intend to lead consumer behaviour towards sustainability of food choices and thereby eventually towards sustainability of food chains (TEISL et al., 2005; DEFRA, 2005; GALLASTEGUI, 2002). Each of them communicates specific aspects of sustainability. However, holistic sustainability labelling or certification schemes for food are rare (and new) and the international literature contains little research evidence on consumer expectations and responses to this kind of information (HARRIS, 2007). There is scattered evidence pertaining to consumer priorities, needs and behaviour in this area, but next to nothing is published on European consumers' attitudes, purchasing motives and responsiveness to sustainable food, including cultural differences across Europe, which is a crucial barrier for sustainable food to succeed in the market.

For effectively reaching the consumer one needs to analyse how consumers in various regions understand, value, and behave towards sustainable food, develop a transparency concept that allows 'informed decisions' without overburden consumers with information, and identify consumption patterns (e.g. meat based protein diet) that might effectively discriminate against certain food chain sustainability strategies (as, e.g., towards increased production of plant based protein) which has a direct consequence for the selection of most promising strategies towards improvements in sustainability. Focus groups with consumers and interviews with key stakeholders involved in the management, governance and promotion of sustainability messages in food supply chains including food manufacturers, brand managers, marketing and advertising managers, retailers, caterers, certification bodies could provide information on European consumers' attitudes (including trust), knowledge and their behaviour to food sustainability issues (see also BHASKARAN et al., 2006).

8 Transition support towards increased sustainability, impact assessment, and policy support

To reach an impact, strategies need to be adopted by enterprises, either as isolated activities or as chain encompassing initiatives along the total food chain and even integrating households. Whatever is being implemented, it has to be assured, that the sustainability status of the total food is being improved. This requires, in principle, a chain encompassing life cycle analysis for any initiative designed for improvements in sustainability. The transitions towards

improvements in sustainability through technological and organizational solutions that enterprises and chains can adopt ('applications') may be facilitated by a managerial approach that guides the transition process of enterprises and chains in the implementation of sustainability improvement strategies (BIEBELER ET AL., 2005). A new chain encompassing dynamic Balanced Sustainability Scorecard (BSSC) approach (MOELLER ET AL., 2005) could provide managerial support for enterprises and chains in the development process towards improved sustainability.

The identification and provision of technological and managerial solutions could be provided through chain reference models with linkages to data base information on 'best practice' sustainability solutions that could show development opportunities, priorities, and the need for cooperative action.

In order to avoid potentially arising conflicts along food chains regarding the implementation costs and benefits, all technological and managerial solutions will need to distinguish between sustainability initiatives limited to single enterprises and initiatives that require the coordination along the chain and the balancing of interests, costs and benefits.

A comprehensive regional sustainability assessment regarding different scenarios, could support policy decision making in the direction of "better regulations" for the advancement of sustainability in the total food chain, but also in regional development. A crucial problem for analysis is the limitation in the statistical data base not only regarding the sustainability status of enterprises and chains but also regarding the chain relationships active in certain regions. An approach to bypass this problem in regional analysis is to identify the type and size of enterprises to be found in regions, specify the 'typical' sustainability status they are in, the stages of the chain they are linked to, and their number. This is the core information on which an assessment of the impact of changes in production or trade will have to build. It allows the identification of 'virtual' chains active in the region and the conclusion from individual chain results to the regional impact.

9 Conclusions

Sustainability of the food system is a pressing issue in light of expected changes in future scenarios the system might have to face. The analysis of the sustainability status of chains and the sector, as well as the development and adoption of appropriate strategies for improvements in sustainability requires the engagement of many research disciplines. The development of new methodologies for sustainability assessment, the identification of appropriate technological, organizational and managerial opportunities for sustainability improvements and the formulation of managerial support for transition management are challenges which need to build on integrated efforts by research, policy, and enterprises to reach success.

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