Ecological Economics 131 (2017) 52–63

Contents lists available at ScienceDirect

Ecological Economics

journal homepage: www.elsevier.com/locate/ecolecon

A new agri-food systems sustainability approach to identify shared transformation pathways towards sustainability

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ARTICLE INFO

Article history:
Received 9 November 2015
Received in revised form 14 July 2016
Accepted 17 August 2016
Available online 30 August 2016

1. Introduction

Today both external and internal changes put increasing pressure on the sustainability of one of the most important production systems that shape our society, the agri-food system. External pressures on this system result from demographic, economic and environmental changes such as globalisation, climate change, and scarcity of resources (Dicks et al., 2013; Foresight, 2011). Internal pressures arise from asymmetric price transmission, changes in market relations and internal trends such as upstream (e.g. input suppliers) and downstream (e.g. retail) concentration and market integration. Furthermore, increasing complexity and changing consumer demands also affect the internal organization of the agri-food chain (Campbell, 2005; Potter and Tilzey, 2005). As a result, the agri-food system is urged to react and transform towards sustainability.

Agri-food systems are shaped through the interaction of different systems such as natural systems (e.g. land, water), institutional systems (e.g. sector federation of farmers, food manufacturers, retailers), and social systems (e.g. social movements, consumer groups) (Francis et al., 2003; Lamine, 2011). However existing sustainability studies focus mostly on only one aspect of sustainability with a strong emphasis on the ecological aspect (Binder et al., 2010; Ness et al., 2007; Von Wirén-Lehr, 2001), such as resource use efficiency (Duru et al., 2015; Francis et al., 2003) and lack to embed the agri-food system in the wider socio-ecological environment (Francis et al., 2003; Hammond and Dubé, 2012; Lamine, 2011). Therefore, we need a systems approach to apply holistic system thinking since it allows multilevel, multiscale and multi-actor approaches to understand the dynamics of the agri-food system and its interdependencies with other systems (Binder et al., 2010; Darnhofer et al., 2010b; Haberl et al., 2009; Lamine, 2011; Sutherland et al., 2015). Recent literature discusses scientific theories on systems approaches, such as socio-technical transitions (Grin et al., 2010) and agri-ecological principles (Holt-Giménez and Altieri, 2013). Nonetheless, upscaling of new alternative food systems and adaptation of the mainstream agri-food system is lacking as case studies are only found for small but promising initiatives such as transition towns (Hopkins, 2008), urban agriculture (Mougeot, 2006), and short food supply chains (Renting et al., 2003). Therefore, we aim to develop a systems approach that overcomes this limitation by focussing on the transformation of the mainstream agri-food system.

Moreover, research projects often struggle with the implementation of scientific theory into practice and effective realisations of actions are lacking. This well-known observed knowledge-action gap (O'Brien, 2012; Schwilch et al., 2012; Von Wirén-Lehr, 2001) could be prevented by combining scientific with local knowledge and capturing different visions and perceptions of various stakeholders. Hence, a transdisciplinary process that focuses on action is required (Brandt et al., 2013; Jahn et al., 2012; Lang et al., 2012; Mobjörk, 2010). Moreover, since sustainability is a normative, subjective and evolving concept (Grosskurth and Rotmans, 2005; Hermans et al., 2011; Jahn et al., 2012; Pope et al., 2004; Pretty, 1995), there is not one possible pathway nor one "sustainable" system state of the agri-food system (Fischer et al., 2012; Foley et al., 2011; Schiefer et al., 2015). Also, a sustainable agri-food system is a complex adaptive system evolving through time, i.e. a self-organizing system that has to be analysed as a whole and is formed by various actors (Folke et al., 2005; Klerkx et al., 2010; Liu et al., 2007). Therefore, co-creation of system, target and transformation knowledge between researchers and societal actors is indispensable (Grosskurth and Rotmans, 2005; Hermans et al., 2011; Lang et al., 2012; Mobjörk, 2010; Pretty, 1995). Co-creation of knowledge is a collaborative process of knowledge production between academic and societal actors. System knowledge encompasses the concepts, i.e. the indicators that allow to understand the system. Target knowledge represents the

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http://dx.doi.org/10.1016/j.ecolecon.2016.08.019

transformative direction for the agri-food system by combining expectations, and transformation knowledge describes how to transform from the current system to the targeted system by including the identification of possible pathways while taking established regulations, practices and power relations into account (Hirsch Hadorn et al., 2008; Pohl and Hirsch Hadorn, 2007; Wiek et al., 2006).

Although multiple frameworks exist to study sustainable development (Binder et al., 2013; Duru et al., 2015; Kulig et al., 2010; Ness et al., 2007; Singh et al., 2012) including composite indicators (Alam et al., 2016; Cobb, 1989; Gómez-Limón and Sanchez-Fernandez, 2010; Hueting, 1974; Pearce and Atkinson, 1993; Wackernagel and Rees, 1996) and indicator sets (Bélanger et al., 2012; CSD, 2001; EEA, 1999; Garrigues et al., 2012; Labuschagne et al., 2005; Lawn, 2003; OECD, 1993, 1998), most sustainability frameworks focus solely on system and target knowledge, and rarely address transformation knowledge (Binder et al., 2010). Moreover, a primary focus of sustainability frameworks is to assess sustainability, to study a posteriori transitions or to formulate a long term vision. A framework that combines system thinking and a transdisciplinary co-creation of system, target and transformation knowledge focussing on the agri-food system level is lacking. To address this scientific challenge, we develop and validate a conceptual and methodological framework to guide a transformation towards a more sustainable agri-food system focussing on dynamic transformation pathways without defining sustainable end points.

Therefore, this paper proposes and applies the agri-food systems sustainability approach (AFSSA), an approach that combines factual knowledge with various stakeholders' perceptions to identify shared transformation pathways towards sustainability and develop a strategic and action plan. Section 2 describes AFSSA, consisting of two segments, i.e. the AFSSA framework and AFSSA implementation. Section 3 embodies an in-depth case study to validate AFSSA. Our focus area is Flanders, the northern region of Belgium, where the Flemish research, policy and food industry actors all acknowledge the need to transform. Section 4 discusses the main lessons learned of AFSSA and Section 5 concludes.

2. A New Agri-Food Systems Sustainability Approach (AFSSA)

To initiate a transformation towards sustainability, we developed the agri-food systems sustainability approach (AFSSA) using the so called soft systems methodology. This methodology makes use of knowledge co-creation (Hessels and van Lente, 2008; Pohl et al., 2010) and mobilizes stakeholders who recognize that they face a joint problem and who are willing to negotiate their conflicting goals and different perspectives in order to agree collectively on action (Checkland, 1999; Reed et al., 2009; Röling and Jiggins, 1997; Uphoff, 2014).

To address the challenges mentioned in the introduction, the approach should fulfil the following prerequisites (i) integrate all sustainability dimensions (Binder et al., 2010; Fernandes and Woodhouse, 2008; Peano et al., 2015), (ii) comprise the whole agri-food system with its inherent complexity (Green and Foster, 2005), (iii) capture different stakeholders' perspectives and visions (Lang et al., 2012; Mobjörk, 2010), and (iv) provide support to decision makers about future actions and sustainability practices (Darnhofer et al., 2010b; Vandermeulen and Van Huylenbroeck, 2008). Based on these prerequisites, we reflected on existing frameworks. Some existing frameworks were disregarded based on their level analysis (e.g. Earth Systems Analysis that studies the dynamics of the earth system (Schellnhuber et al., 2005) or the sustainable livelihood approach that focuses on the community level with specific livelihood strategies (DFID, 1999)). Other frameworks focus on the influence of the ecological system to the social system instead of vice versa (e.g. Turners vulnerability framework (Turner et al., 2003)) or lack an action perspective and are more analysis-oriented (e.g. ecosystem services (Costanza et al., 1997; de Groot et al., 2002) and the multi-level perspective framework (Geels and Schot, 2007)). Furthermore, we choose to use a set of indicators instead of a composite indicator since sustainable development is multidimensional and aggregation of all dimensions in a meaningful way is still problematic today (Kulig et al., 2010).

AFSSA consists of both an AFSSA framework and implementation. The AFSSA framework describes the current state of sustainability of a dynamic agri-food system at a certain point in time. This framework addresses the prerequisites (i), (ii), and (iv). Equally important is the AFSSA implementation coping with prerequisite (iii) and (iv).

During the entire research process, different forms of triangulation were used to validate the results (Golafshani, 2003; Koro-Ljungberg, 2008). Firstly, data triangulation was performed by using data derived from different stakeholders. Secondly, methodological triangulation was ensured by the use of different methods to collect and analyse data (e.g. scientific and popularizing literature, interviews, and expert meetings). Lastly, triangulation of researchers was guaranteed for the data analysis and interpretation as these were done by four researchers.

2.1. AFSSA Framework

Based on an extensive literature review on frameworks related to the sustainability of the agri-food system (e.g. Binder et al., 2013; Ness et al., 2007; Pope et al., 2004; Reed et al., 2013; Singh et al., 2012) we selected and modified two existing frameworks to develop the AFSSA framework. The choice of these frameworks is based on their action perspective (i.e. to reduce the environmental impact of human activities), their profound theoretic background (model-based), their systems perspective and their level of analysis (i.e. the agri-food system) (Binder et al., 2013; Kulig et al., 2010).

A first relevant framework to describe the current state of sustainability of a production system is the four capital framework of Ekins, 1992; Ekins et al., 2008 represented in the linear throughput model of Lawn (2001, 2007). It is based on ecological economics and extends the set of traditional economic resources to various forms of capital. Capital is defined as an asset which produces future benefits in the form of goods and services (Ekins et al., 2008; Maack and Davidsdottir, 2015). The framework states that net-psychic income or human well-being - the 'uncancelled' benefit of a socio-economic activity such as job satisfaction or leisure time - depends on the service flows of four capitals which need to be maintained over time for future generations (Ekins et al., 2008; Kulig et al., 2010; Maack and Davidsdottir, 2015). The first is natural capital, which includes (non-)renewable goods and services provided by ecosystems with three main functions, i.e. a source function (e.g. soil), a sink function (e.g. assimilation of greenhouse gasses), and ecosystem services (e.g. climate regulation). The second is human capital, the individual knowledge and skills, education and labour. A third capital is social capital, which are networks, norms, values, trust and attitudes that facilitate cooperative actions within a production process. Fourth, manufactured capital are manmade goods such as machineries and infrastructure (Costanza and Daly, 1992; Costanza et al., 2007; Lawn, 2007; Pretty, 2008). At last, financial capital is not considered distinctly but can be seen as part of social capital as we focus on the production process. Moreover, financial capital is more an accounting concept with a mobilizing role rather than a source of productivity itself (Ekins et al., 2008; Pretty, 2008).

A second framework considered as relevant is the Driver-Pressure-State-Impact-Response (DPSIR) framework, elaborated by the European Environmental Agency (EEA) program (EEA, 1999). Drivers (D) are environmental conditions or human activities that put direct or indirect pressure (P) on the state (S) of the socio-ecological environment in terms of quality and quantity. This results in an impact (I) on the current state which induces societal responses (R) (EEA, 1999). DPSIR proved its applicability in sustainability research in the agricultural sector (Kuldna et al., 2009; Odermatt, 2004; Wiek et al., 2014; Zhou et al., 2013).

We combined the various capital assets with the DPSIR framework to develop what we call the AFSSA framework. Table 1 gives