REFEREED ARTICLE

Adopting a Farming Systems Research Approach to carry out an economic and environmental analysis of food supply chains

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ABSTRACT

Agricultural systems are complex, because managers need to cope with interlinked and dynamic ecological, social, political and economic aspects. Understanding and analysing such systems requires researchers to adopt a holistic approach to grasp the links between those aspects. Holistic approaches within agricultural research – known as Farming Systems Research (FSR) support researchers in sharing knowledge and different perspectives concerning the research process and problems. Sharing knowledge and perspectives enables to holistically understand and conceptualise complex systems, as well as to structure and manage research projects.

The aim of this paper is to suggest and present a guideline for agricultural researchers to carry out an economic and environmental analysis of food supply chains with a FSR approach. We describe how participants of the EU-project SOLIBAM (Strategies for Organic and Low-input Integrated Breeding and Management) used the guideline to structure, manage and carry out an economic and environmental analysis of the food supply chains of concern. The FSR approach enabled the participants to jointly define and model the structure of the supply chains, identify the requirements for data collection and collect data.

KEYWORDS: Organic food; local food; agro-food system; systems thinking

1. Introduction

Agricultural managers face complexity and uncertainty in decision making and problem solving. Complexity is caused by the inter-connectedness of ecological, social, political and economic aspects within agricultural systems (Wilson and Morren, 1990). Fragmented and uncertain information about the system, stakeholders' divergent views concerning management activities and different interests and goals, as well as a lack in understanding of the whole system cause uncertainty (Bosch et al., 2003; Fountas et al., 2006; Bosch et al., 2007).

Agricultural researchers face similar complexity especially because their activities and results are rarely integrated with the agricultural system of concern. This often leads researchers to seek generic understandings of the system in order to come up with solutions and recommendations. Those solutions and recommendations however may differ from managers' needs and objectives (Bosch et al., 2003).

Agricultural researchers furthermore face complexity caused by the variety of organisations that participate in research projects (e.g. universities, research centres, non-agricultural ministries and non-governmental organisations), participants' multiple objectives and interests, as well as differing backgrounds, the globalisation of knowledge sharing and the need to develop and maintain partnerships (Byerlee, 1998; Gibon et al., 1999).

Some studies emphasised the need for a 'new way of thinking' and a holistic approach to agricultural research. As a response researchers suggested the application of Systems Thinking (ST) in order to understand the natural and human aspects involved in agricultural systems. ST enables researchers to view complexity from different perspectives, share knowledge and achieve a common understanding of complex agricultural systems (Wilson, 1988; Wilson and Morren, 1990; Bosch et al., 2003; 2007).

The application of ST in agricultural research, known as Farming Systems Research (FSR) has been found useful to understand and optimise agricultural systems, and to develop, test and introduce new technologies (Byerlee et al., 1982; Norman and Gilbert, 1982; Simmonds, 1985; Fox et al., 1990; Bawden, 1991; Keating and McCown, 2001; Le Gal et al., 2011). FSR – especially including hard and soft ST – has also been carried out with the purpose of structuring and managing agricultural research projects (Dillon, 1976; Collinson, 1981; Byerlee et al., 1982; Bosch et al., 2007). This paper intends to make a further contribution to this area.

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The aim of this paper is to suggest and present a guideline for agricultural researchers to carry out an economic and environmental analysis of food supply chains with a FSR approach. For this purpose, we report and illustrate how participants of the EU-project SOLIBAM (Strategies for Organic and Low-input Integrated Breeding and Management) (SOLIBAM, 2010) have used the guideline to structure, manage and carry out an economic and environmental analysis of SOLIBAM food supply chains.

2. Systems Thinking

Systems are sets of interrelated elements that form a whole and together they behave differently as when isolated (Schiere et al., 1999). The whole is framed by boundaries that define systems as subsystems of some wider system – their environment, which influences and may change the system (Ackoff, 1971). Ackoff (1971) classified systems as 'abstract systems' (e.g. languages and philosophy), 'concrete systems' (e.g. objects), 'closed systems' (systems without environment), 'static systems' (e.g. a table) and 'dynamic systems' (e.g. an automobile). In this classification he defined organisations as "purposeful systems that contain at least two purposeful elements which have a common purpose" (p. 669). Street (1990) and van der Vorst (2000) described agro-food supply chains as systems composed of interlinked organisations that produce, process and distribute food. Supply chains include suppliers, producers, customers and end-consumers, also transporters, warehouses and retailers, depending on the specific configuration (van der Vorst et al., 2007).

Organisations have been defined as 'open systems' (von Bertalanffy, 1969), as social and living systems that maintain themselves in a steady state by taking from and giving to the environment. Open systems show behaviour – they act, react and respond to changes in the environment and are controlled by human beings. The human beings involved attempt to change the rules of interaction in order to achieve a higher level of order and organisation and co-evolve with their environment (Ackoff, 1960; von Bertalanffy, 1969). The behaviour of open systems produces outputs and leads to consequences according to the pursued goals. While pursuing common goals the human beings within the system are able to adapt to the changing environment, learn, store information and use the new knowledge for changing and improving the system (Ackoff, 1971).

Systems Thinking (ST) supports researchers and practitioners in looking at everything in the world and the world as a system and "as if it were composed of systems" (Wilson and Morren, 1990, p.70). It is an approach for looking at systems from a whole perspective and understanding how the parts of the system are related to each other (Ackoff, 1971; Georgiou, 2003).

ST has been found useful to understand open systems as it enables to identify the relationships between the different elements; the influence of the external environment on the system; the cycles of input; the transformation processes within the system that create the outputs and the emergent properties (Ackoff, 1971; OConnor and McDermott, 1997; Georgiou, 2003). The emergent properties result from the interaction between the elements of a system and define its unique identity (Georgiou, 2003).

ST has been used in all fields of science. Its roots reach back to thinkers such as Nicholas of Cusa, Paracelsus and Marx, further evolved within biology, the study of living organisms and through the perception of "individual organisms as a sum of cells" (von Bertalanffy, 1969). Ludwig von Bertalanffy extended this perception to other disciplines, e.g. the inquiry within and understanding of organisations, behavioural and social science, and general complexity.

The first applications of ST in practice were carried out by the allied during the Second World War in order to tackle real world problems, optimise military operations and after the war to manage governmental and industrial engineering projects (Jackson, 2003). Such applications belong to the stance of hard ST (Checkland, 1981) which relies on quantitative, optimisation techniques. It is based on the idea that the world is a system composed of subsystems (Checkland and Scholes, 1990, p. 25) and that complexity can be shaped to fit models in order to reduce it (Wilson and Morren, 1990, p. 109; Munro and Mingers, 2002). Peter Checkland criticised hard ST for being inappropriate for dealing with the complexity in human affairs and management situations, therefore he developed Soft Systems Methodology (SSM) during the 80s as the first soft ST approach (Chekland and Scholes, 1990). Soft ST aims at managing relationships and making sense of problem situations in order to understand, improve and change them (Checkland and Holwell, 1998, p. 48). The goals of inquiry are considered to change constantly and stakeholders priorities to be conflicting (Wilson and Morren, 1990, p. 111). Complexity is approached from different points of view and a wide ranging perspective (Checkland and Holwell, 1998, p. 48). Soft ST relies on qualitative and participatory approaches, as well as systemic modelling that aims at including different human perceptions and values (White and Lee, 2009; Mingers, 2011). Soft ST has been criticised for having limited potential to ensure a proper participation of all stakeholders in decision making, also to consider disadvantaged stakeholders that are affected by the decisions, but not involved in the agreement. Besides, it has been argued that soft ST is inadequate for dealing with conflict between interest groups, a lack of common interest between stakeholders, difficulties to achieve consensus and an unequal distribution of power. Critical ST has been introduced as a response to this critique. Critical ST enables researchers and practitioners to critically choose and combine different ST methods, methodologies and techniques depending on the problem situation of concern (Jackson, 2001, 2003).

3. Systems Thinking in agriculture

Systems thinking, especially hard ST has had a long tradition within agricultural research and practice (Wilson and Morren, 1990 and Bawden, 1991 review the use of ST in agriculture). The use of ST in agricultural research, known as 'Farming Systems Research' (FSR) (Dalton, 1975; Shaner et al., 1982; Jones and Street, 1990; Schiere et al., 1999; Keating and

McCown, 2001) has been carried out in order to holistically analyse, describe and understand complex links within agricultural systems. This understanding, usually in a model format (Wilson and Morren, 1990; Keating and McCown, 2001) has been found useful for further inquiry, e.g. to predict the outcomes of different strategies; develop, test and introduce new technologies; as well as to optimise the performance and increase the productivity of systems (Byerlee et al., 1982; Norman and Gilbert, 1982; Simmonds, 1985; Fox et al., 1990; Bawden, 1991).

FSR has usually been restricted to microeconomic analysis (Fox et al., 1990) and supported by, e.g. (i) economic decision analysis for representing whole systems, identifying static input-output transformations, formulating recommendations and optimising production, (ii) dynamic production modelling that simulates the dynamics of production processes, (iii) bio-economic modelling which is useful for economic decision analysis and (iv) simulation modelling for decision support (Keating and McCown, 2001).

Similar to the evolvement of ST, farming systems researchers began to criticise hard approaches. They recognised the need for soft approaches in order to deal with value-laden complexity, ensure stakeholders' involvement and active participation in decision making, problem solving and innovation (Wilson and Morren, 1990; Ison et al., 1997; Cardoso et al., 2001; Goma et al., 2001; Stoorvogel et al., 2004).

Researchers have applied hard and soft approaches in structuring, managing and carrying out agricultural research projects (Biggs, 1994; Bosch et al., 2003; 2007). Bosch et al. (2007) described how they had used qualitative and systemic group techniques, e.g. brainstorming sessions, farm visits, discussions and workshops to conceptualise and design a research project. These group techniques supported the researchers in identifying the requirements for pursuing the research objectives and collecting data, as well as in carrying out the analysis.

Byerlee et al. (1982, p. 900) defined the collection of data as a "sequential process in which information becomes more and more detailed and focused at each subsequent step in the process". They recommended starting the survey rounds with an exploratory and qualitative approach in order to get a broad picture of the agricultural system and indentify the research priorities. Field interviews and observations may help researchers better understand the system of concern and identify the requirements for a more detailed data collection. The next survey rounds serve to collect quantitative data and focus on key variables that refer to the research questions and objectives. Quantitative data are useful to gain insight into the productivity and efficiency of the system. This insight enables researchers to identify possible weaknesses to improve and strengths to evolve, furthermore to support the development of new systems (Hart, 1982).

The combination of hard and soft approaches in FSR has also been found useful for interpreting and integrating research results and formulating policy recommendations (Bosch et al., 2007). This because soft approaches enable researchers to consider stakeholders perspectives, needs and wishes (Checkland and Scholes, 1990) concerning the system of focus.

A similar FSR approach including hard and soft ST was adopted by participants of the EU-project SOLIBAM (Strategies for Organic and Low-input Integrated Breeding and Management) in order to structure, manage and carry out an economic and environmental analysis of food supply chains.

SOLIBAM aims to "...develop specific and novel breeding approaches integrated with management practices to improve the performance, quality, sustainability and stability of crops adapted to organic and low-input systems..." A major objective is to assess economic and environmental impacts of SOLIBAM strategies (novel breeding approaches integrated with management practices) "in order to identify farm businesses, consumer preference, food supply and legislation related issues that are likely to influence their adoption" (SOLIBAM, 2010). The results are supposed to be integrated in practice and recommendations for the introduction of SOLIBAM strategies to be formulated.

To analyse SOLIBAM food supply chains from an economic and an environmental perspective the participants were first concerned with the definition of those supply chains. Second, the participants were required to identify, understand and model the structure of the supply chains of concern. Modelling would enable the participants to identify the requirements for structuring the collection of data and carrying out the analysis. A systemic approach was adopted in order to share knowledge and different perceptions among the participants, moreover to holistically understand the structure of the food supply chains and manage the research project. The FSR adopted is shown in Table 1 and some steps are illustrated next.

The FSR approach (Table 1) was conceptualised within the EU-project SOLIBAM. The participants conceptualised the research process and the food supply chains of concern by discussing in the group, carrying out brainstorming sessions and drawing on agro-food (e.g. Lyson and Green, 1999; Morgan and Murdoch, 2000; Sonnino and Marsden, 2006; Milestad et al., 2010) and FSR literature (Byerlee et al., 1982; Norman and Gilbert, 1982; Simmonds, 1985; Biggs, 1994; Gibon et al., 1999; Bosch et al., 2007). The data requirements were identified, the framework for data collection developed and the data collected during group discussions, enterprise visits and surveys.

The FSR approach (Table 1) beginning with holistically describing and understanding the complexity of agro-food systems to collecting data for socio-economic and environmental analysis is illustrated next.

4. Holistically describing and understanding the complexity of agro-food systems

First, SOLIBAM participants were concerned with the definition of the food supply chains of concern. This concern led to a discussion about the overall structure of the agro-food system. The aim was to holistically understand the agro-food system. A holistic understanding would enable to narrow down the perspective (OConnor and McDermott, 1997) on SOLIBAM food supply chains in order to define their nature, to identify their characteristics and formulate a definition. A literature review provided input for gaining an understanding

Table 1: The use of Farming Systems Research for economic and environmental analysis of food supply chains – the example of the EU-project SOLIBAM

Farming Systems Research (Byerlee et al., 1982; Norman and Gilbert, 1982; Simmonds, 1985; Biggs, 1994; Gibon et al., 1999; Bosch et al., 2007)	**EU-project SOLIBAM**
• Holistically describe and understand the complexity of agricultural systems	• Locate SOLIBAM food supply chains within the agro-food system to identify their characteristics
• Formulate the problem	• Identify, describe and understand the structure of SOLIBAM food supply chains with focus on: - the supply chain partners (number and type) - the connections between the supply chain partners - the activities carried out by each partner - the inputs that are transformed into outputs - the external elements that influence the supply chain, e.g. the labour market, consumer attitude, control authorities and the climate
• Model the system of concern to: - predict the outcomes of different farming strategies - optimise the performance of the system - increase the productivity of the system - involve stakeholders - make decisions - improve and innovate structures and processes	• Model the structure of SOLIBAM food supply chains to visualise the internal and external elements and their connections (Fig. 3)
• Collect qualitative data to identify the data requirements	• Identify the data requirements among the project participants • Develop the framework for data collection in collaboration with project participants
• Collect quantitative data	• Collect quantitative data during surveys and interviews with stakeholders – examples of necessary data: - building and machinery inventory (price, technological features, interest rate, insurance and life time) - fuel (quantity and price) - feed (quantity and price) - fertilisation (quantity and price) - plant protection (quantity and price) - crop rotation (% of crop to the total area) - work processes (number of passes and machinery used) - labour (number of man-hours and wage) - sold product quantities (volume/number and price) - distances between suppliers and consumers
• Calculate a solution	• Assess the financial impact (e.g. gross margins, net income, net present values and internal rate of return) • Assess the environmental performance indicators (e.g. N-leaching, phosphorus applications, C02-emissions, odour, chemical treatment index and animal welfare) • Asses the degree of product diversity and biodiversity • Assess the supply chain internal distribution of net benefits
• Test the model and the solution	• Compare SOLIBAM strategies to other agricultural practices, e.g. other organic, low-input and conventional practices
• Implement the solution	• Formulate recommendations for implementing the SOLIBAM strategies and developing regulations among partners. Consider the involvement of stakeholders and their perspectives.

of the agro-food system and discussing possible alternatives for its conceptualisation.

The literature distinguishes between 'conventional/alternative' (Morgan and Murdoch, 2000; Sonnino and Marsden, 2006) and 'global/local' (Lyson and Green, 1999; Milestad et al., 2010) food systems. A major difference between 'conventional/alternative' concerns the nature of the relationships between food suppliers and consumers. Conventional food systems rely on long-distance relationships that limit direct communication not only between suppliers and consumers, but also between the suppliers themselves. Alternative food systems, on the other hand are built on trust, familiarity and direct relationships that enable sharing of value-laden information between suppliers and consumers, as well as learning and collaboration among suppliers (Hinrichs, 2000; Morgan and Murdoch, 2000; Sonnino and Marsden, 2006).

Similarly, the distinction 'global/local' refers to the relationships between the people involved (Hinrichs, 2000; Milestad et al., 2010). The definition of 'global' includes aspects such as mass production and uniform diets; fewer, larger and low diversified farms; economic self-interest and maximisation of profit; and the dominance of marketing and supply firms over farmers and local communities. The term 'local', in comparison refers to aspects such as diversity in production, distribution and marketing; the support of local diets; economic returns to the farming sector and the development of social capital; the distribution of power among individuals and families; community building; and short distances between suppliers and consumers (Lyson and Green, 1999; Ilbery et al., 2006; Ilbery and Maye, 2006).

The aspects of 'local' and 'alternative' food systems are connected with each other. 'Alternative' has been related to local food systems, as well as local production, distribution and consumption of often organic food and short food supply chains (SFSCs) (Hinrichs, 2000; Marsden et al., 2000; Sonnino and Marsden, 2006). SFSCs are classified as (i) ''face-to-face'' supply chains, in which consumers directly purchase products from the suppliers, e.g. at farmers markets and street stands, and in farm shops; (ii) ''spatial proximity'' supply chains, where production and distribution of food occur locally, e.g. through local shops, box schemes, restaurants, hotels, schools and the internet; and (iii) ''spatially extended'' supply chains, in which food is produced in a specific region, but also distributed outside the region, e.g. through the internet and (inter)national channels (Marsden et al., 2000). Especially, the distribution of food within ''face-to-face'' supply chains enables direct communication among suppliers and between suppliers and consumers. Suppliers and consumers experience the value of social ties as they get to know each other, share feelings, opinions and perceptions (Marsden et al., 2000; Sage, 2003).

Following the literature review, SOLIBAM workshops and group discussions the agro-food system was conceptualised as consisting of a 'global' and an 'alternative' food system (Figure 1). The distinction 'conventional/alternative' (Morgan and Murdoch, 2000; Sonnino and Marsden, 2006) and 'global/local' (Lyson and Green, 1999; Milestad et al., 2010) food systems implies an explicit connection between 'alternative' and 'local', but not necessarily between 'conventional' and 'global'. The main reason for drawing this distinction is that organic food is not only produced, processed and distributed within the local, alternative food system by small-scale enterprises (Milestad et al., 2010), but also within the global food system by large, more conventionally oriented enterprises. The alternative food system, besides, does not only include local organic, but also local non-organic food enterprises (Ilbery and Maye, 2005). Local non-organic food enterprises are not certified organic (EC 834/2007), but are small-scale and produce, process and distribute food based on sustainability principles.

This conceptualisation enabled the participants to focus on the subsystems of the agro-food system and think about SOLIBAM food supply chains as embedded within the system.

5. Formulating the problem: identifying and describing food supply chains

During project meetings and brainstorming sessions the participants formulated a definition of SOLIBAM food supply chains and defined them as: short, local, diverse and sustainable; based on ethical aspects, as well as collaboration, direct contact, mutual trust and confidence among the supply chain partners. Besides, the supply chains were characterised as consisting of small-scale enterprises that produce organic vegetables, cereals, flour, bread and/or dairy products that are directly sold to consumers (e.g. at farmers' market) or to cooperatives, local shops and restaurants.

The discussion concerning the definition of SOLIBAM food supply chains led the participants to consider where to locate the supply chains within the overall agro-food system (Figure 2). The participants felt that locating the supply chains within the broader agro-food system would support them in comparing

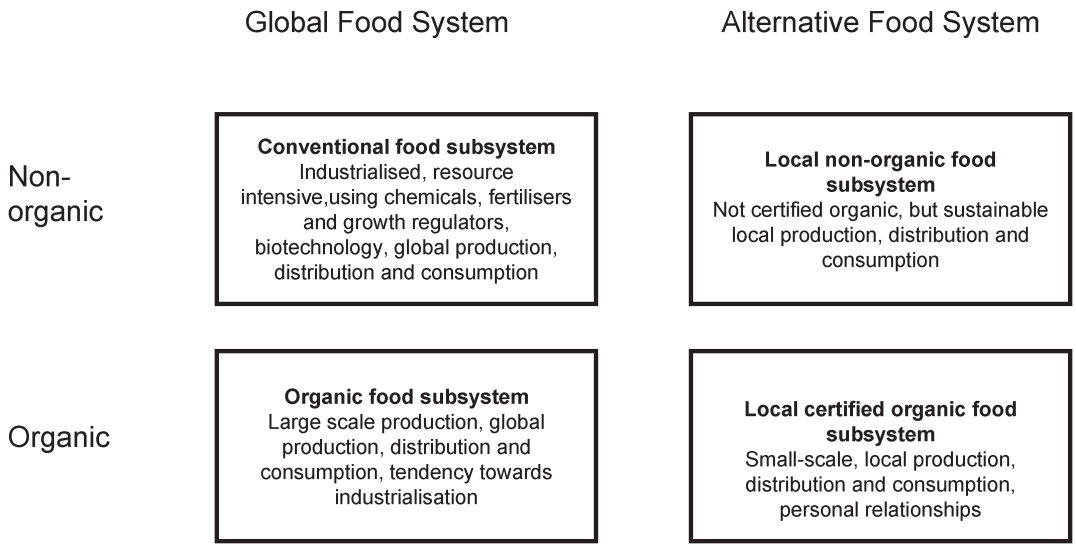

Figure 1: The agro-food system – conceptualised within the EU-project SOLIBAM

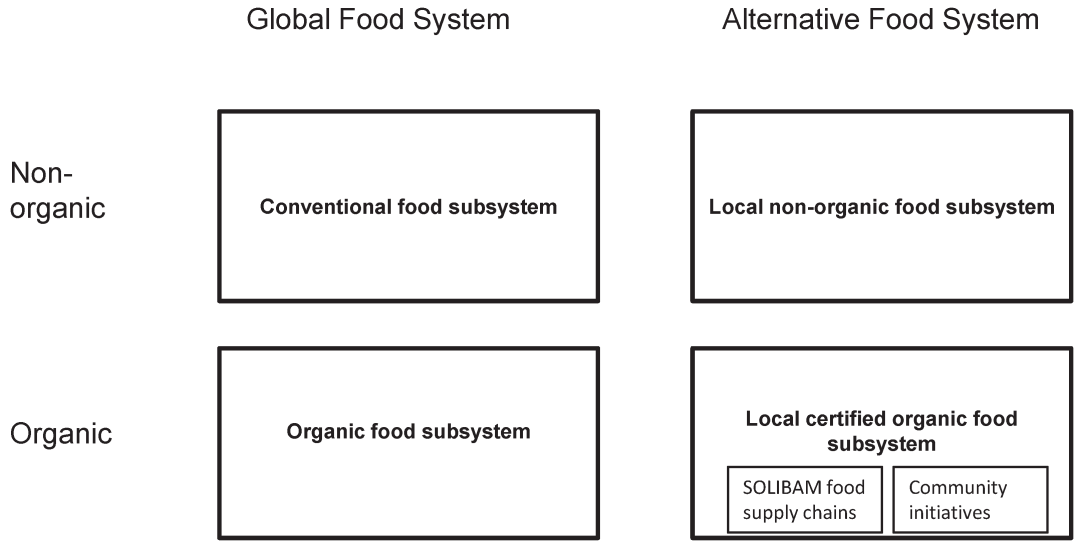

Figure 2: The location of SOLIBAM food supply chains within the overall agro-food system

SOLIBAM strategies with current organic and non-organic agricultural practices. This comparison would help illustrate and emphasise the results of the economic and environmental analysis and support the recommendations for the adoption of the innovative strategies.

In figure 2 SOLIBAM food supply chains are represented as a subsystem of the 'local certified organic food subsystem'. This subsystem may also include other local certified organic subsystems that are not structured as supply chains, but that are formed by 'community initiatives' (e.g. Community Supported Agriculture and Community Gardens). Within community initiatives consumers are involved and participate in growing food, which they directly purchase at the farming site. Besides, consumers and producers engage in community building, e.g. joint learning and decision making, recreation and mental well being (King, 2008). Supply chains, on the other hand consist of interlinked organisations that produce, process and distribute food. Moreover, consumers do not participate in food production, but purchase food from suppliers and retailers (van der Vorst et al., 2007).

6. Modelling food supply chains

During enterprise visits and group discussions SOLIBAM participants modelled the structure of SOLIBAM food supply chains by adopting a systemic view. This is illustrated with an example of a food supply chain in France (Figure 3).

The example shows a farm which cultivates cereals (wheat, rye, einkorn wheat and barley), peas and grassland. Barley, peas and grass are used for feeding livestock. The farm purchases production factors such as fuel, the tractor and equipment for haymaking from the agri-supply industry and shares other equipment within a CUMA-network (a farmers' cooperative). Own manure is used for fertilisation and seed is provided by a 'Participatory Plant Breeding' (PPB) network. In PPB networks farmers, researchers, seed producers and traders collaborate with the aim to develop new varieties adapted to local field circumstances and users' needs (Ceccarelli and Grando, 2009).

The farmer produces and sells flour, meat and dairy products (e.g. yogurt, cheese, butter and cream) to a cooperative for organic food (biocoop France), meat to an organic shop and a restaurant, moreover flour and dairy products directly to consumers at the farm and farmers' markets. The supply chain is here represented as a system composed of interrelated elements and framed by boundaries. The links between the elements enable material, information and financial flows – the emergent properties that characterise the identity of the system. These flows need to be coordinated and controlled by the humans involved in the system in order to meet demand and achieve competitiveness (Stadtler, 2005). The environment surrounding the supply chain provides resources such as solar energy, water, CO_2, minerals and soil that go into the production processes, the transformations from inputs into outputs (the products sold). Other factors, e.g. national and international control authorities, the labour market, demography, norms, believe, consumer attitude, finance and investment also influence the supply chain and contribute to the transformations.

Modelling the food supply chains enabled the participants to identify the partners involved, the activities they carry out and the products they supply. The identification of these elements was necessary in order to clarify the data requirements for economic and environmental analysis, build a framework for data collection and collect data.

7. Collecting data, calculating and implementing solutions

Based on the supply chain models SOLIBAM participants identified the data requirements for economic and environmental analysis during workshops and group discussions. To identify the data requirements qualitative surveys (as suggested in Table 1) were not necessary. Some project participants have been collaborating with the enterprises involved for many years,

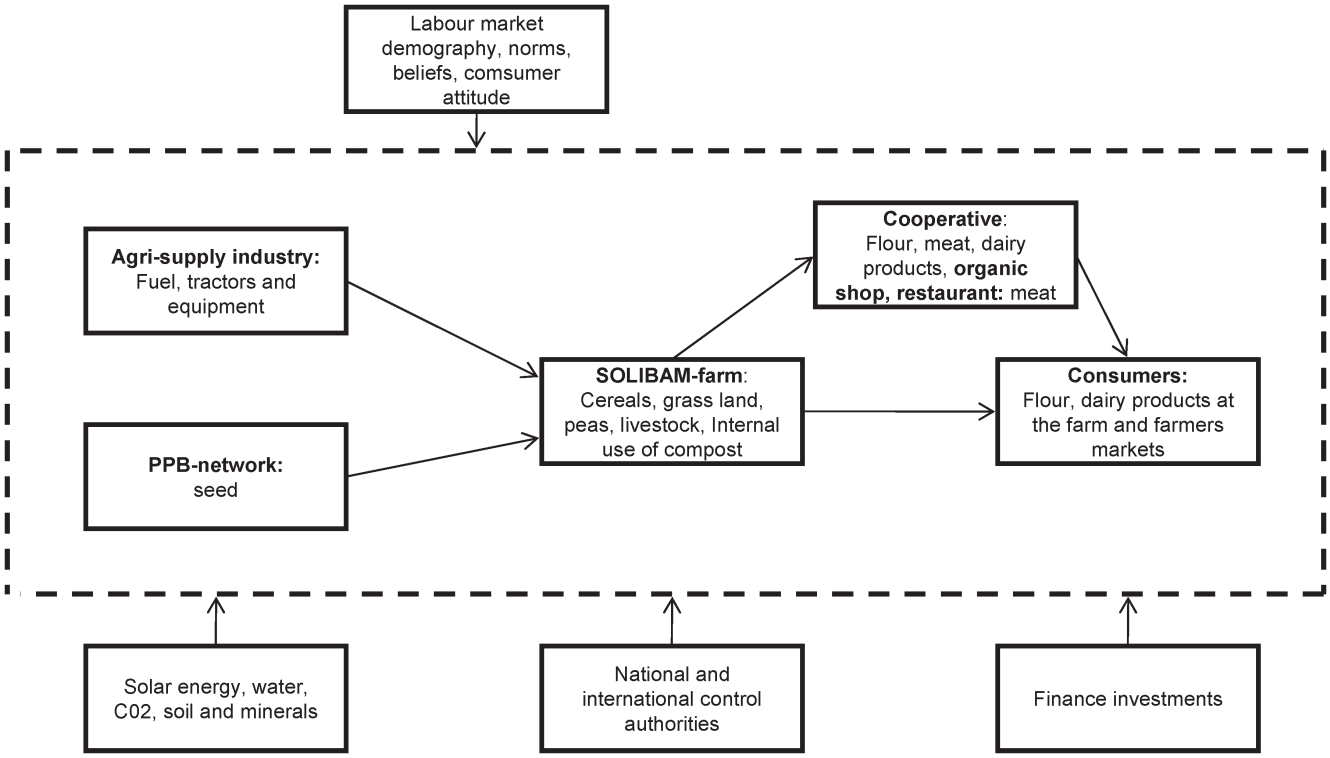

Figure 3: A systemic view on food supply chains – an example of a SOLIBAM food supply chain in France

thus were aware of the specific features within the individual enterprises.

Data were collected during enterprise surveys, and the analysis and formulation of recommendations for implementing SOLIBAM strategies will follow (EU-SOLIBAM runs until 2015). Following the steps to calculate and implement a solution (see Table 1), researchers can analyse the products supply chains and formulate recommendations from a whole system, as well as from an individual partner's perspective. The analysis approaches, e.g. gross margin and net income calculations, and emission assessment allow shifting the analytical lens from a whole system to an individual partner's perspective by adapting the mathematical formulas respectively.

8. Discussion and conclusion

This paper has reported and illustrated how SOLIBAM participants used a FSR approach including hard and soft ST to structure, manage and carry out an economic and environmental analysis of food supply chains. The FSR approach (Table 1) enabled the participants to holistically understand and conceptualise the agro-food system (Figure 1) and narrow down the perspective on the supply chains of concern. Subsequently, the participants defined SOLIBAM food supply chains, located them within the broader agro-food system (Figure 2) and modelled their structure (Figure 3). Modelling the supply chains supported the participants in identifying the data requirements for economic and environmental analysis, build a framework for data collection and collect data.

The FSR approach was carried out during project workshops, group discussions, brainstorming sessions, enterprise visits and surveys. These enabled the participants to share knowledge and experiences (Bosch et al., 2003; 2007), to look at the research objectives and approach from different perspectives and holistically understand (Wilson and Morren, 1990; Keating and McCown, 2001; Bosch et al., 2007) the food supply chains of concern.

As described in previous studies FSR is useful for developing and conceptualising research problems and projects (Byerlee et al., 1982; Norman and Gilbert, 1982; Simmonds, 1985; Biggs, 1994; Gibon et al., 1999; Bosch et al., 2007), because it allows for consideration of interlinked aspects within the agricultural system, as well as interlinked activities within the research project (Bosch et al., 2007). This paper has contributed to those FSR studies by providing a further example of how FSR has been used to conceptualise a research project (the economic and environmental analysis of SOLIBAM food supply chains) and the problems encountered (the need to holistically understand the agro- food system; locate, define and model the SOLIBAM food supply chains).

The aim of this paper was to suggest and present a stepwise FSR approach to economic and environmental analysis of food supply chains (Table 1), which may be used as a guideline for similar research. This guideline suggests how to achieve understanding of food supply chains, model their structure, collect data for economic and environmental analysis and carry it out.

Drawing on the above illustration of the FSR approach and the SOLIBAM experience it can be suggested that considering the guideline for economic and environmental analysis of food supply chains is useful. This because FSR – especially when comprising soft and hard approaches supports researchers in systematically tackling the complexity within agricultural

systems (Bosch et al., 2003; Fountas et al., 2006; Bosch et al., 2007) and research projects (Byerlee, 1998; Gibon et al., 1999; Bosch et al., 2003). The adoption of soft approaches such as group discussions and brainstorming sessions enabled SOLIBAM participants to share different knowledge about the food supply chains of concern, thus to achieve a better common understanding of the research problem. Group discussions also helped the participants consider different perspectives on how to structure, manage and carry out the research project. The use of hard approaches such as the calculation of gross margins and emissions will enable the participants to identify the economic and environmental performance of SOLIBAM innovations and assess their impact on the supply chains, as well as the partners involved.

The guideline shows how economic and environmental analysis of food supply chains may be carried out and identifies steps to follow. Following those steps may not only help researchers structure and manage their analysis, but also consider alternative courses of action (Biggs, 1994). As Biggs (1994) emphasised it is important that researchers develop approaches, strategies and guidelines that account for the requirements of their specific research project and problems. A focus on the requirements of specific research projects and problems is important in order to achieve a detailed understanding of the system to be analysed and to integrate the results in recommendations for practice and policy making (Bosch et al., 2003; 2007).

It is hoped that the guideline presented within this paper provides inspiration for similar economic and environmental analysis of food supply chains, as well as for further development of research approaches, strategies and guidelines.

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