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THE POWER OF LOCAL
– sustainable food systems around the Baltic Sea

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Interdisciplinary Synthesis of the BERAS project

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Baltic Sea Region
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Centrum för uthålligt lantbruk CUL

The Power of Local
- sustainable food systems around the Baltic sea
Interdisciplinary Synthesis Report of the BERAS project

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Introduction to the BERAS project

Artur Granstedt

Excessive nutrient inputs to the Baltic Sea produce many harmful effects. A jarring reminder of this is the extensive blue-green algal blooms that surface in warm summer weather. Eutrophication and the accompanying increase in organic matter lead to excessive consumption of oxygen when the organic matter decomposes. Anoxic conditions are appearing, with increasing frequency, over vast areas of the Baltic Sea and the Gulf of Finland. Earlier studies have intimated that the serious situation in the Baltic Sea is a direct consequence of agricultural specialisation after WW II, pollution from industry, and poor waste management. Underlying all this is the unsustainable lifestyle prevailing in the drainage basin of the Baltic Sea.

Reduced use of nutrients and non-renewable energy aswell as elimination of pesticides would lead to less pollution of air, water and soil. However, solving the problem requires more than scientific knowledge and technical skills. Our priorities need to change and we need to be willing to pay for a clean environment. With this in view, not only ecological but also economic and sociological aspects were included in the BERAS project. It was not clear in the beginning how these different disciplines should be integrated. Now, in this final paper, we suggest what form this integration might take.

The aim of the BERAS project was to evaluate and demonstrate the potential of ecological recycling agriculture, in combination with local and regional processing, distribution and consumption, to achieve reduced use of limited resources, gross reduction in discharges of nitrogen and phosphorus to the Baltic Sea, and cut-backs in emissions of greenhouse gases in line with environmental policy goals set at national and EU levels. The environmental, economic and social implications were studied. Local initiatives underway in small rural communities participated in the project as a means of improving their ongoing activities. They represented integration of animal and crop production, local consumption, shorter transport distances and, hence, decreased consumption of limited resources and significant reductions in emissions of harmful chemicals from agriculture. The environmental and socio-economic consequences of these local initiatives, as well as the opportunities and obstacles facing the various actors in the food system, were analysed. Experiences were exchanged and actors cooperated with and learned from one another. Better understanding of the potential for and consequences of a larger-scale changeover to such systems throughout the region was sought, and relevant knowledge and skills were developed. To ensure solid conclusions useful for actors and decision-makers, an effort was also made to add an interdisciplinary dimension to the project.

The BERAS project included five Work Packages (WP). The first WP (1) provided for the exchange of experiences of selected local ecological food initiatives and recycling farms within and among the project countries. Obstacles were identified and learning promoted. The second WP (2) studied what environmental benefits over conventional food systems can be achieved through local ecological food consumption, processing and ecological recycling agriculture (ERA). Energy use, greenhouse gas emissions, surplus and emissions of reactive nitrogen (air/water pollution) and surplus of phosphorus compounds were quantified and related to food consumption. Although most of the studies were done in Sweden and Finland, the results can be utilised by all participating countries. The third WP (3) assessed the possibilities for switching to ERA and the economic consequences of this by evaluating market aspects, economic consequences at the societal level and consequences from the perspective of a natural resource economy. The fourth WP (4) looked at social consequences including rural development and job opportunities. The fifth and final WP (5) drew together the lessons learned in order to present recommendations for implementation and dissemination.

Studies were located in all EU member states around the Baltic Sea (for partners see Acknowledgements). Food systems, especially their socio-economic character, and the role and structure of agriculture differ markedly from country to country. As a consequence, the degree of locality and recycling as well as the obstacles to their development vary. Case food systems in all participating countries were selected, together with about 50 case farms characterised by a high degree of plant nutrient recycling, a good balance between animal and crop production and a low dependence on purchased fodder. Together the farms were representative of a major part of the basic ERA food production in each country.

The BERAS project was partly funded under the EU INTERREG III B programme, with a total budget, including national funding, of 2,156,000 EURO. Additional funding was provided by the governments of Estonia, Latvia and Poland.

Preface

Helena Kahiluoto

The interdisciplinary synthesis of the mostly multidisciplinary BERAS project is presented in this report. The disciplinary research, and experiences gained in the initiatives are described in the workpackage reports (see List of workpackage reports of the BERAS project) and summarised in the Executive Summary.

After the initiation of the BERAS project it became evident that the multidisciplinary approach that was adopted would not lead to common, multiperspective conclusions and answers in regard to the hypotheses and questions underlying the study. Rather, there were signs of disintegration, with specific disciplinary interests dominating the research.

As a means of ensuring solid conclusions useful for actors and decision-makers, an effort was made to intensify the interdisciplinary work in the project, despite some doubts about the fruitfulness and feasibility of such an approach. The interdisciplinary interaction was primarily directed toward answering a set of common questions, which integrated all the disciplinary perspectives representing the dimensions of sustainability. Another aim was to influence the disciplinary work so as better to serve the goals of the project. In addition, it represented a collective learning experience in interdisciplinary work on food systems.

The point of departure for the interdisciplinary work was three common research questions. These had been implicitly embraced by the project already. The interdisciplinary research questions provided the common framework for the interdisciplinary research, and the conceptual framework was built on them. Although the conclusions are largely based on discussions among the many contributors to the BERAS project, the authors and editors are responsible for the interdisciplinary interpretations and conclusions presented in this report. The disciplinary groups retain the scientific responsibility for their respective areas.

The interdisciplinary work lead to conclusions that would not have been possible if the disciplines had worked separately. Consideration of the interactions among the ecological, economic and social dimensions of sustainability turned out to be crucial for sound conclusions regarding any one dimension. Thus, the usefulness of the interdisciplinary exercise was demonstrated, and ways of improving the process were elaborated.

Acknowledgements

The interdisciplinary synthesis was part of the Baltic Ecological Recycling Agriculture and Society (BERAS) project. Funding of the project was provided by the Baltic Sea Region EU Interreg IIIB and numerous national sources.

We are most grateful to our many collaborators in the project. The partners, representing eight countries around the Baltic Sea, were from Denmark: Danish Institute for Agricultural Science; Nature Management and Water Environment Division, Fyn County; from Estonia: Center for Ecological Engineering Tartu; Estonian Biodynamic Organisation; from Finland: Ruralia Institute, Mikkeli, University of Helsinki; Department of Economics and Management, University of Helsinki; MTT Agrifood Research Finland, Partala; South Savo Regional Environment Centre; Juva Municipality; from Germany: Department of Land Use Systems and Landscape Ecology, Leibniz-Centre for Agricultural Landscape Research (ZALF); from Latvia: Department of Field Management, Latvian University of Agriculture; Association of Organic Agriculture Organisations in Latvia; from Lithuania: Department of Applied Ecology, Lithuanian University of Agriculture; Faculty of Social Sciences, Klapeida University; from Poland: Institute of Soil Science and Plant Cultivation; Polish Ecological Club; from Sweden: Department of Ecology & Crop Production Sciences, Swedish University of Agricultural Sciences (lead partner); Department of Urban and Rural Development, Swedish University of Agricultural Sciences; the Biodynamic Research Institute Foundation, Rudolf Steiner University College; Kalmar County; Södertälje Municipality.

We wish to address our thanks to all participants in the interdisciplinary discussions and workshops. Particularly thanks are owed to the WP coordinators John Sumelius and Kari Vesala and to Stefan Bäckman, Veronica Krumalova and Markus Larsson, who commented on the preliminary formulation of the results and discussion. We are also grateful to Marko Nousiainen, Pentti Seuri, Annamari Hannula and Tuula Eriksson who discussed conclusions allowed by their results.

We are indebted to the innumerable actors of the case food systems and farms, who devoted so much time and effort to achieving our common goals. We are further grateful to the Finnish sister project Local Food System: Impacts and Learning Challenges (LOFO) for fruitful interaction and cooperation. And finally, we are most grateful to Kathleen Ahonen for improving the English language and to the Centre of Sustainable Agriculture (CUL), Swedish University of Agricultural sciences, for publication of this report.

Authors and editors

Baltic Sea Region
INTERREG III B

Helena Kahiluoto

Abstract

This report presents the interdisciplinary synthesis of the multidisciplinary BERAS study. The research questions for the interdisciplinary work were as follows: Do localisation and recycling in rural food systems enhance sustainability, and what are the prerequisites for this? What are the obstacles to and the means for promoting sustainable localisation and recycling? Thus, what would sustainable localisation and recycling look like in Baltic rural food systems? There was also a methodological interest in developing interdisciplinary approaches for research on food systems.

Food system provided the integrating framework for the various stages of the food chain, production of inputs, waste management, the actors within the chain and in interaction with it. It included ecological, economic, and socio-cultural and value dimensions. The sustainable development of food systems was sought in all the dimensions of sustainability simultaneously. Localisation was interpreted as an increased share of the rural local demand being met with local resources with maintained export to urban areas. The geographic dimension of locality was considered relative. Recycling of nutrients from consumption to agriculture and from animal husbandry to crop production to reduce emissions was also seen as a means of localising inputs and enhancing the diversity of local production. Case food systems and farms in eight Baltic countries were studied on the basis of actor interviews and workshops, as well as through analysis of environmental and economic parameters. The interdisciplinary process followed a classic generic model of problem definition, division of tasks, and evaluation and integration. The quality criteria were: consistency with disciplinary antecedents, balance in weaving together perspectives and effectiveness in advancing understanding.

The potential for sustainable localisation and recycling in rural food systems around the Baltic Sea was demonstrated. Localisation and recycling can enhance sustainability providing that firm economy is improved. Localisation and recycling decrease emissions and use of energy and enhance local economy, equity and trust. Recycling is important for ecological sustainability, and localisation is contributory. Localisation is key for benefits to local economy and social sustainability. A sustainable way of localisation and recycling would be to recycle locally between farms and from the demand chain. Most of the food chain, including inputs, would be local. Demand would be higher and the markets both regional and local. The keys to sustainable localisation and recycling, from viewpoint of all three dimensions of sustainability, are partnership of actors, internalising of externalities in price, and learning citizen-consumers. Interdisciplinary research requires an interdisciplinary plan and project organisation, communication across the disciplines being the learning challenge.

Introduction

Helena Kahiluoto

Sustainable development of food systems is a major challenge for all regions of the world. This report presents the interdisciplinary synthesis of the multidisciplinary BERAS project investigating the sustainable development of rural food systems in countries surrounding the Baltic Sea.

The introductory chapter describes the challenge and notes the complex of rural problem, associated with food systems, with focus on those in countries bordering the Baltic Sea. It concludes with the general hypothesis that food systems that are more local and recycling would be more sustainable than current ones. The common, interdisciplinary research questions of the BERAS project are presented.

Current food systems are not sustainable

The world food system faces the challenge of more than 850 million people suffering from chronic undernourishment mainly due to poor access to food and to resources required for food production, which follow directly from poverty and lack of voice. While most of the hungry live in the Third World, some 9 million live in industrialised countries, and most of the poverty ravishes rural areas (FAO, 2004). Over the years, food systems have developed from people relying on ecosystem services and other local resources towards industrial systems in which regulation by the carrying capacity of the ecosystem has been lost. The depletion of economically exploitable fossil energy and phosphorus (P) resources is accelerated, while environmental pollution and climate change intensify. Biodiversity and ecosystem services are in sharp decline (MA, 2005). Increasingly, the available resources are harnessed to serve the food needs of the industrialised world (Leckie, 1999; Johansson, 2005). A drastic inequity prevails in food systems: between industrialised and developing countries, between urban and rural regions, and even between generations. This situation concerns the Baltic Sea countries also, even if there are differences between the countries in timing, form and degree of industrialisation of the food system. The devastation of the Baltic Sea ecosystem is a clearly visible consequence.

Rural regions lose value added and voice

Liberalisation of international trade, mobility of capital and people, new technologies (Galizzi and Pieri, 1998) and an infrastructure increasingly dominated by multinational corporations are driving to the horizontal and vertical integration of food systems towards global, linear and centralised structures with regional differentiation (McFetridge, 1994; Royer, 1998; Cook and Chaddad, 2000; Reardon and Barrett, 2000; Hendrickson et al., 2001; Harwood, 2001). Rural regions have increasingly specialised in producing and exporting natural resource-based raw materials for, e.g., food industry (Siegel et al., 1995), while at the same time satisfying local demand with food imported from outside the region. The value added in production of inputs, food processing and food distribution has been transferred to urban areas and, increasingly, beyond national borders. Besides liberalisation of agricultural trade, the European Union's (EU) agricultural policy and the associated technological change have forced a rapid reduction in the number of farms. Because food production has always played a central role in rural vitality, and will do for a long time to come (OECD, 1996), this development has led to unemployment, out-migration and disintegration of social structures in the rural regions of all industrialised countries in Europe. This also impedes sustainable development of urban areas. In addition, current directions in the development of food systems have fundamentally changed the character of food chains and their internal interaction, disempowering local rural actors - not only farmers, but also retailers and small-scale processors.

Linear, distanced food chains destroy the environment and pollute the Baltic Sea

Increased geographical distance between stages of food chains, together with the regional specialisation of agriculture offers a wider selection of apparently cheap food, but at the cost of longer transports with the attendant consequences of greater energy use and deleterious effect on global climate. Distancing and regional specialisation has also complicated recycling of nutrients and carbon within food systems from animal husbandry back to crop production and from demand chains back to agriculture. The latter has been further aggravated by the current urban waste management systems, which pollute the wastewaters. The manufacturing industry of fertilizers, that is imported to rural regions to replace recycling, also require non-renewable energy. The linear flow of nutrients from the atmosphere and from non-renewable edaphic pools in fertilizers is increasing nutrient emissions to waters. Following this, also the Baltic Sea is rapidly being devastated.

The countries around the Baltic Sea have agreed on applying Best Environmental Practice to prevent and reduce pollution of the sea, and the EU will not allow surface waters to differ in 2015 from the natural state of the ecosystem and water quality. With the load from point sources already reduced to between 10 and 20% of the total load, agriculture, which now contributes half of the eutrophying discharges to the sea, has the greatest potential for reduction (HELCOM, 2003). In contrast to the improvements in the marine bays dominated by cities, where the natural state was lost in the middle of the nineteenth century, marine bays dominated by agriculture and forestry show no return towards the original state of the nineteen forties, despite the agri-environmental scheme. If, however, the loads from agriculture were to decrease, rapid improvement could be expected, because in those bays there is less accumulation in bottom layers and thus less internal loading (Weckström, 2005). Alternatively, if the production regimes of the new member states of EU were to move towards industrialised agriculture like that of

Denmark, for example, the eutrophying nitrogen (N) emissions would increase by 50-75% (BERNET, 2001).

Organic food systems are a local, recycling alternative in principle but not in practice

Organic agriculture takes sustainability as the development priority. The explicit principles of organic agriculture require reliance on local resources and recycling, adaptation to local conditions and connecting of farmers and consumers (Nordic IFOAM, 1989; IFOAM, 2005). Despite this, even in organic agriculture the current European regulations and subsidies have not motivated a development of local food systems, nor recycling of organic matter between plant and animal production or between consumption and production. Thus, an organic production that is less local and less recycling has emerged. In the Action Plan for Organic Food and Farming launched by the EU Commission in 2004, organic principles have, however, been reemphasized as the basis for sound development of organic standards. There is also a rapidly growing interest and activity in Europe around food produced locally, based on local resources.

Towards sustainable food systems

Contemporary food chains are not totally disembedded, i.e. torn from their local and regional contexts. The processes of disembedding are struggling with processes of reembedding in local socio-ecological conditions as "nature" and "quality" assume more importance in value considerations, especially for food (Buttel et al., 1994; Murdoch and Miele, 1999; Murdoch et al., 2000; for critics see Winter, 2003). The growing interest in and increasing number of initiatives in local food are not only based on the appreciation of fresh food of known origin, but also represent an effort towards a fairer global food system with improved food security. These interests and initiatives imply belief in the hypotheses that more local food systems would be more sustainable through enhanced recycling and, thus, reduced nutrient loads to waters, decrease in the consumption of fossil energy and in the related emissions, more vital local economies and communities with more voice. This study was designed to test these general hypotheses in a case study approach. On the basis of the results, solutions for sustainable localisation and recycling were sought in an interaction with actors.

Multidimensional sustainability was adopted as the evaluation criterion and goal for the development of food systems. This set a requirement for a multidisciplinary approach. However, to serve the development of food systems in all the dimensions of sustainability simultaneously (Figure 1), multidisciplinarity was considered insufficient in itself. The different disciplines representing ecological, economic and social sciences, and their perspectives, had to participate in an interactive process. It was necessary to have common questions, interdisciplinary interpretation of the results and, finally, common answers. In this report, the interdisciplinary synthesis of the research work is presented in the form of common answers to the main research questions of the study. The research questions were the following:

- Do localisation and recycling (that is a greater share of local organic food based on local resources, especially on increased recycling) in rural food systems enhance sustainability, and what are the prerequisites?
- What are the main obstacles to enhancing sustainable localisation and recycling in rural food systems, and what are the solutions for enhancing this?
- Thus, what would sustainable localisation and recycling look like in Baltic rural food systems?

In addition to these main questions of the study, there was a methodological interest in developing interdisciplinary approaches for research on food systems.

Organisation of the report

The following chapters describe, in detail, the interdisciplinary conceptual framework raised by the research questions and approach above. Material and Methods describes the case food systems and research methods, while Results and Discussion presents a synthesis on the potential of sustainable localisation and recycling considering the multiple dimensions, as well as the interdisciplinary solutions for identified obstacles. Finally, conclusions are drawn. The various disciplinary approaches and results are reported in detail separately in the work package reports(see *List of work package reports of the BERAS project* at the end of the report).

The sustainability concept

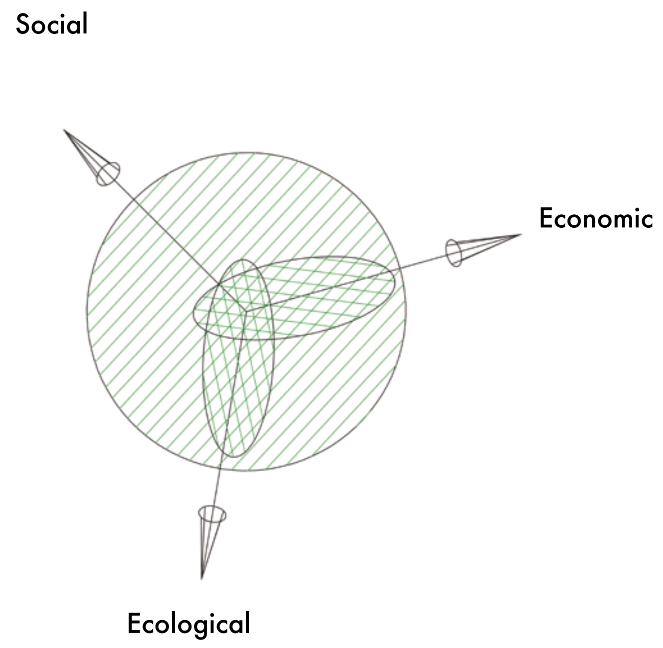


Figure 1. *Systemic view of sustainability in the interdisciplinary work of the BERAS project. Development of a food system in which sustainability is enhanced in all three dimensions simultaneously (the circle with largest area of sustainability) was sought rather than trade-off relations between the dimensions (the alternative ellipses).*

Conceptual framework

Helena Kahiluoto

This chapter introduces the concepts of the interdisciplinary work of the BERAS study - food system, sustainability, localisation, recycling, interdisciplinarity and case study approach - and shows how they relate to one another.

Food system

The term *food system* is increasingly used to describe the complex interactions among processes and actors in the provision and consumption of food in human society. A food system embraces not only the different stages of *food chains* (the flow of products in the food system) but also the production of inputs and waste management involved in each stage. In addition, the support, control and value systems associated with food are included with their respective actors (Dahlberg, 1993; Tansey and Worsley, 1995; Johansson et al., 2000). Several proposals for relevant subsystems have been presented to illustrate the different dimensions of a food system, e.g., the natural, social and technological (Dahlberg, 1993), the socio-economic, learning and biophysical (Helenius et al., 2005), and food (including the food chain and recycling) and actors (including values, attitudes and perspectives) connected by decisions and actions (Vittersø et al., 2004). The food systems approach has also been criticised for being based on a narrow, productionist paradigm, which reduces our relationship with land and food to the production and consumption of commodities (Campbell, 1998).

In this interdisciplinary part of the BERAS study, food system is used as the conceptual framework integrating production of inputs, agriculture, food processing, transportation, trade and marketing, consumption and waste management, including all actors within the chain and in interaction with it (Figure 2). It includes the ecological (biophysical), economic, socio-cultural and value dimensions linked to food.

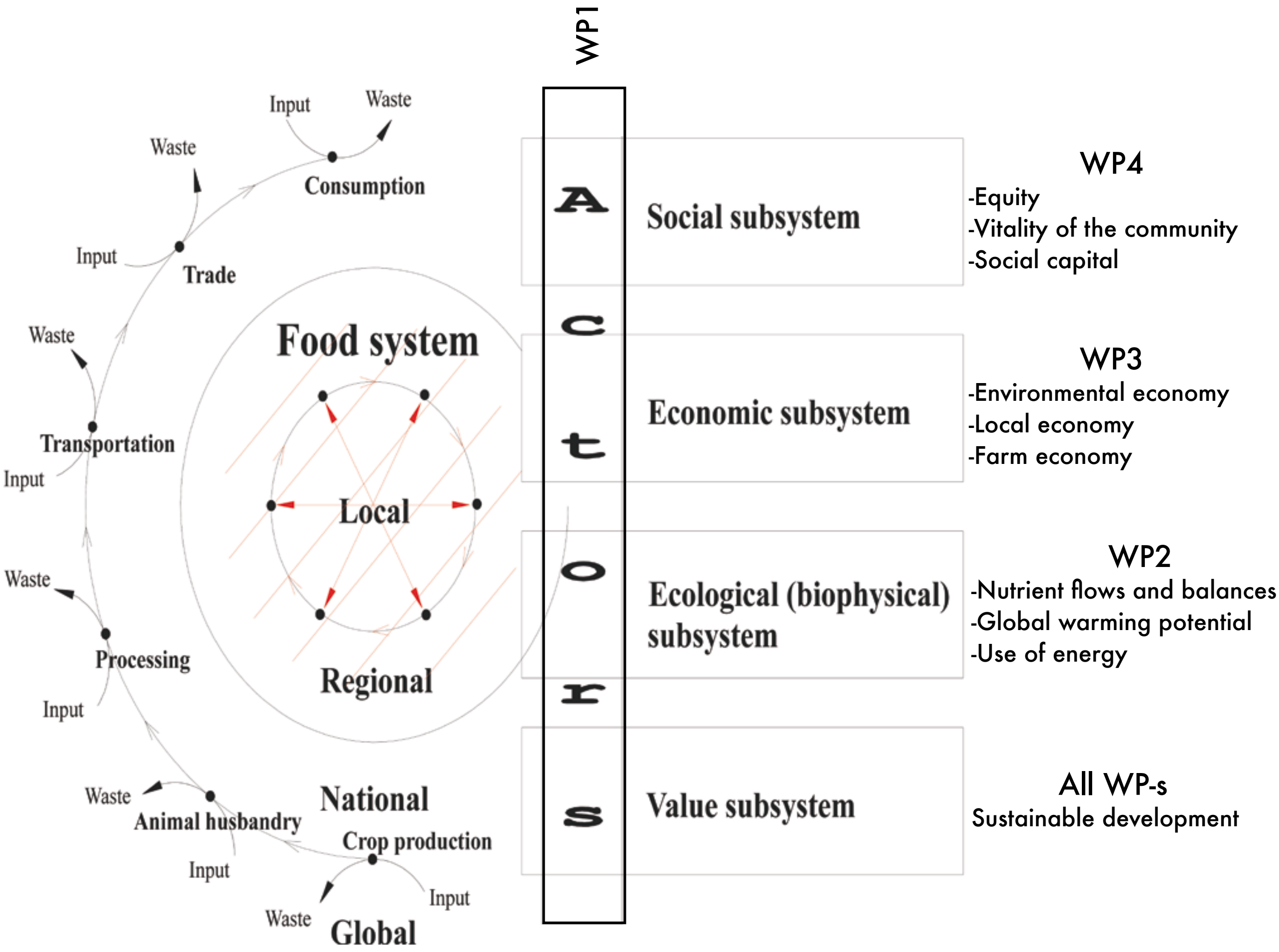
Within the rapidly expanding research on food systems, mainly characterised by theoretical, political economic and consumer-oriented approaches, this study represents a rare and ambitious effort to empirically identify the impact of and obstacles to changes in some characteristics of the systems - here *locality* and *recycling* (i.e., increased share of local, organic food in food systems). The study utilises a case study approach, common in development-oriented food systems research.

Sustainability

The concept of *sustainable development*, first introduced to the common awareness by the Brundtland Committee in 1987 (WCED), has been interpreted in numerous ways. *Sustainability* embraces both a normative vision of desirable characteristics of a target system to be sustained, and the requirement that it can be sustained. The former aspect is the primary one (Thompson, 1992). Disagreements tend not to be about the broad concept but about the desirable characteristics (Clark, 2005). An interpretation of sustainable development as a learning process with repeated feedback has been increasingly emphasised (O'Riordan and Voisey, 1997). It follows that the concept is continuously being redefined and interpreted either with more eco- or human-centred approaches. An example of the latter ones relevant to this study is the Habitat Agenda (1996), which includes physical, psychological, economic, social, organisational and cultural aspects emphasising lifestyles and personal choices.

Sustainable agriculture and *food systems* have been approached from different perspectives, (1) food sufficiency, (2) conservation of resources and (3) in addition to the first two, encouragement of certain virtues and vitality of local communities (Douglass, 1984). The difference in the first two perspectives is in means not ends, while the third perspective extends the concept beyond ecological and economic sustainability to include goals such as democracy, community and care. In other words, social and cultural aspects are included (Burkhardt, 1989). The third

Food system in BERAS



Figur 2. *Food system was the conceptual framework for the interdisciplinary work of the BERAS project. The impact of localisation and enhanced recycling on sustainability was investigated.*

perspective thus sets constraints on the means employed for the goals of the first and second perspective, preferring means that are governed by the local community and thus empower it. The three perspectives further imply different views on the relationship between man and nature, and lead to different management strategies (Figure 3). In the third, man is part of nature, adapting the human economy to be an integrated part of the ecosystem by conserving and relying on ecosystem services (Daily, 1997). In accordance with this, Thompson (1997) emphasises the need for *functional integrity*, i.e. the interaction of agricultural practices with processes of renewal, avoidance of vulnerability and conservation of capacity for *resilience*, all including both ecological and social dimensions. This approach is in coincidence with the *ecosystem approach* adopted for diversity conservation in Johannesburg (Plan of Implementation of the World Summit on Sustainable Development, 2002). And it is in accordance with the view of sustainability implicit in the principles of organic agriculture (Burkhardt, 1989; Thompson, 1997; Alrø and Kristensen; 1998; IFOAM, 2005) and in the alternative food chain and local food movements. The third perspective also provides the framework for the discussion of sustainability in this study.

Sustainability strategies

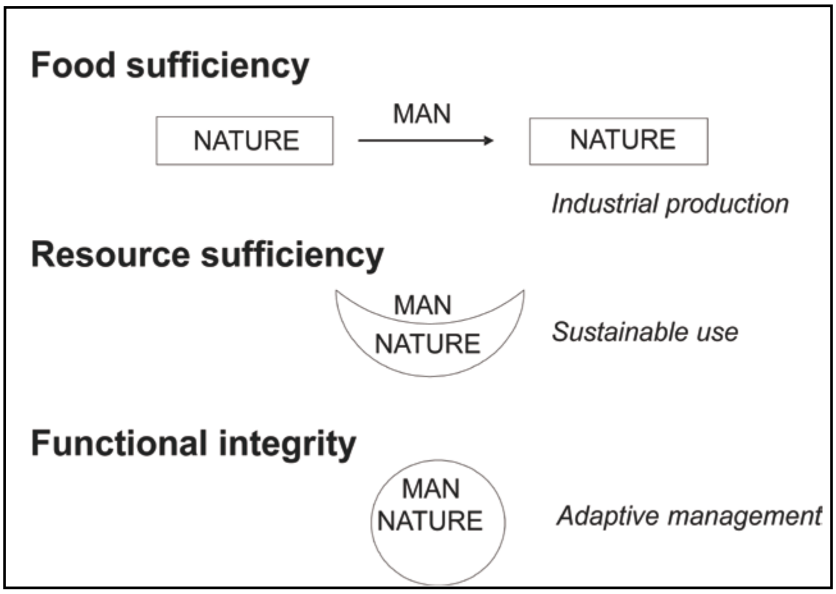


Figure 3. *Alternative perspectives of sustainable agriculture and food systems, views on the relationship between man and nature behind them, and the consequent management strategies. The interdisciplinary work of the BERAS project relied on the perspective of functional integrity.*

Sustainability, according to the third perspective above, is taken as the main objective for food system development in this study. In its three dimensions of ecological, economic and social sustainability, it provides the conceptual framework integrating the various indicators of performance of a food system and agriculture as well as the disciplines evaluating the indicators. The aim with this systemic view of sustainability is to promote the development of food systems in all three dimensions of sustainability simultaneously. Thus, instead of accepting simple trade-off relations it seeks for synergisms (win-win relations) between the different dimensions (Figure 1) in this study through different ways to promote localisation and recycling. Hence, while social sustainability for example, is important as such, it is also a precondition for ecological and economic sustainability (Castella et al., 1999; Nordström Källström and Ljung, 2005).

The indicators used for ecological sustainability were nutrient balances, nitrogen (N) and phosphorus (P) load to waters, gaseous emissions and use of non-renewable energy. The economic sustainability was studied on the basis of environmental economy at a societal level, local economy and farm economy. Social sustainability was investigated as viability of the local communities, as quality of interactions contributing to social capital and as equity (or fairness) among the actors. Equity was studied from the perspective of distribution of power and control and distribution of benefits. Within the vast and diverse research tradition around sustainability issues, the aim of this study is not in studying, problematising or developing the concept, but rather in using an explicit sustainability discourse for setting the goal for sustainability, and choosing indicators for the performance of the studied system and the impacts on the performance.

Localisation

Local food as a concept addresses the spatial dimension of the food chain and food system, yet stressing the proximity (Kloppenburg et al., 1996), space-based communication (Winter, 2003) and personalisation (Hendrickson and Heffernan, 2002) rather than a certain size of the area. *Localisation* (i.e., increased degree of locality) is a supplementing and counteracting force to the globalisation of food systems (e.g., Dahlberg, 1999; Pretty, 2000; Helenius et al., 2005). The concepts of local food and short supply chain are related, but the concept of local food system is broader than the concept of food chain (see *Food system* above). The discourse on localisation of food systems is rooted in approaches like *bioregionalism* (Donald, 1990), *food shed* (Getz, 1991; Kloppenburg et al., 1996), *community food security* (CFS, e.g., Allen, 1999; Biehler et al., 1999), *community-supported agriculture* (CSA, e.g., Feenstra, 1997; DeLind and Ferguson, 1999; Staggl, 2002) and *urban agriculture* (e.g., Rosset, 1996; Jolly, 1999), all with their socio-cultural and ecological dimensions.

Local food is an issue raised by the effort to achieve functional integrity (Thompson, 1997) – the sustainability perspective of this interdisciplinary study (see *Sustainability* above). It emphasises linkages between the local ecosystem and the local community and tight social bonds within the local community – in a word, *local embeddedness* (for a critical discussion and review, see Krippner, 2001; Goodman, 2003). Some critics have warned against simplifying the *quality consumerism* and reducing it to embeddedness, and also see *defensive localism* as a dangerous motivation in the argument for local food (Allen, 1999; Holloway and Kneafsey, 2000; Winter, 2003). Locality is one of the central principles of organic agriculture in the sense of relying on local resources, adapting to local conditions and promoting interaction between producers and consumers (DARCOF, 2000; IFOAM, 2005). Unfortunately, the EU has included only a few requirements for locality in its regulation for organic production (EC Regulation 2091/91, 1804/99), the replacement of commercial N fertilizers by biological N fixation in situ in plant production or by recycling within agriculture being the most notable example.

Local food has been defined as food produced close to the consumer and based on local resources (Packalen, ed., 2001). This concept of local food was adopted in the interdisciplinary work of the BERAS study. The geographic dimension of locality is seen as relative, varying from national or county level to municipal or even village level. Localisation is understood as an increased share of the rural local demand being met by local production based on local resources. The starting point of the BERAS study was the rural development with focus on rural food systems. Since urbanised society is taken for granted the rural food systems necessarily are exporters of food to urban food systems. Thus, localisation is not interpreted as decreased export of food from the system. This is in accordance with the conclusions of Hamm and Baron (1999) that 1) an exclusively local food supply would be isolating, necessitate cultural denial and be potentially unsustainable and 2) sustainable food systems will develop within the current general framework of our society.

Behind the present study is the general hypothesis that localisation will promote sustainability of rural food systems, as assessed by the sustainability indicators mentioned above (see *Sustainability*). This general hypothesis is tested through asking and answering specific research questions. Research on local food systems has mostly been theoretical, with localisation considered as a counteraction to globalisation, vertical and horizontal integration and standardization, with tendency to focus on urban food systems and food security. As interpreted by DuPuis and Goodman (2005), the US academic literature on food systems echoes alternative social norms, where "local" becomes the context in which these norms can be realized. In contrast, again according to Dupuis and Goodman (2005), in the European literature dealing with alternative food networks, localism is seen as a way to maintain rural livelihood. The BERAS study mostly belongs to this latter tradition. Most of the growing body of applied research on local food focuses on consumer perceptions and on the various tools for realising local food systems, especially marketing channels such as CSA, farmers' markets and food box delivery schemes. Empirical efforts to identify the impacts of localisation of food systems such as in the present study are rare, however.

Recycling

Recycling of organic matter and nutrients is an intrinsic function of all natural ecosystems. In sustainable agriculture and food systems characterised by functional integrity (see *Sustainability* above), there is an attempt to simulate this natural function (Figure 4). Recycling processes are examples of ecosystem services and represent the feedback function of all self-organized systems. Along with locality, recycling is one of the principles of organic farming (DARCOF 2000, IFOAM 2005). Most attention has been addressed to recycling within a single farm, which in effect means mixed farms carrying out both crop and animal production.

Recycling of organic matter and nutrients

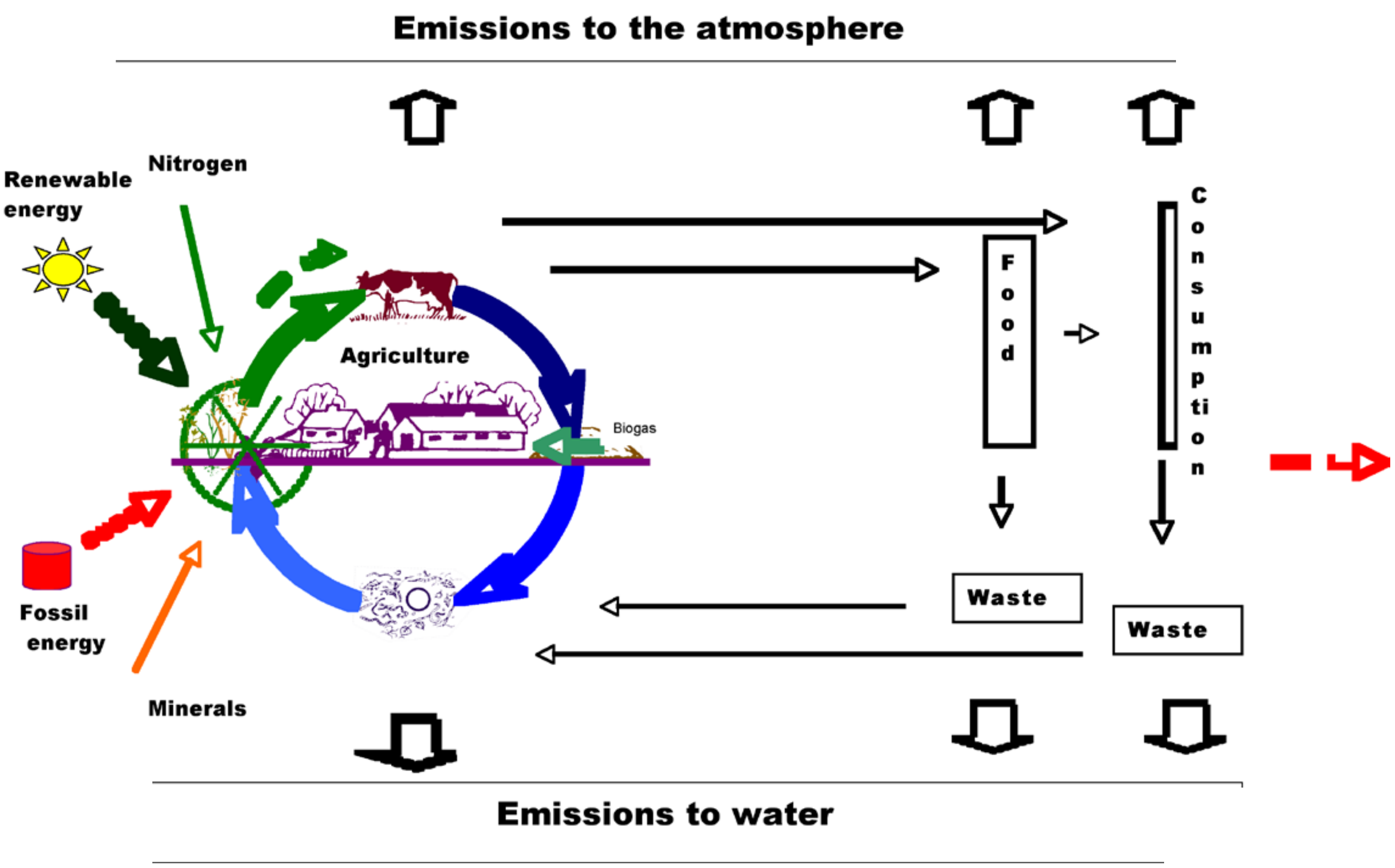


Figure 4. *Recycling of organic matter and nutrients within agriculture and food systems represents reliance on ecosystem services rather than external inputs, thus reducing nutrient surplus and use of energy. (Picture from Granstedt, 1992.)*

Recycling from the demand chain back to agriculture has received less consideration since the quantitative significance is much less and because, in the form of the present waste management system, it carries with it serious health and environmental risks. Recycling organized among nearby farms instead of within a farm has not received significant attention in traditional organic farming. In fact, the organic mode of production regulated by EU (EC Regulation 2091/91, 1804/99) makes few, if any demands on recycling. Thus, the concepts ecological recycling, ecological recycling agriculture (ERA) and ecological recycling agriculture and society (ERAS), as used in the BERAS study, refer to a farming and food system based on organic agriculture, and, in addition, honouring the organic principle of recycling. Note that, in this report, we follow international practice and use the term "organic" rather than "ecological" which has sometimes been preferred by Swedish and Norwegian researchers.

This study began with the general hypothesis that enhanced recycling would promote sustainability of food systems, and this was tested with specific research questions. Recycling of organic matter from the demand chain back to agriculture and from animal husbandry back to crop production is here seen as a mean of localising inputs. Recycling is also a natural consequence of localisation of food systems because the diversified local production, implied in a local food system facilitates recycling between animal husbandry and crop production. A local food system will also make recycling within the food system more effective through the shorter distances for transportation of organic matter and, especially in rural areas, through the reduced environmental and health risks. Helenius (2000) has also used recycling as a metaphor for a local food system with tight inherent ecological, economic and social interaction.

Research on recycling of nutrients and organic matter in food systems and agriculture has mostly dealt with issues of the usability of urban wastes in agriculture, and of the usefulness, handling and application of manure. Contrary to that, the BERAS study belongs to the slowly increasing body of research with a systems approach that attempts to analyse the flows and efficiencies of nutrients and identify options to improve the management system.

Case study approach

In a case study, one or more cases are studied with the purpose of defining, analysing and developing the cases. The case can be individual, a group, a programme, a process, or a phenomenon, and defining the case may be carried out either before or after the collection of data. The starting point for any case study is the research question, which may either be derived from previous theory or emerge from the data (Eriksson and Koistinen, 2005).

The case study approach may involve different science philosophical starting points, theoretical and methodological views, and procedural choices, according to the field of research and discipline. Triangulation is inherent in case study methodology. Triangulation is a means to combine 1) different data sources, 2) the observations of several investigators, 3) several theoretical frameworks, 4) several methods (even qualitative and quantitative approaches and data) in research on the same phenomenon in the same study (Denzin, 1989; Olsen, 2004). In this study, triangulation was used 1) to overcome the inherent weaknesses of using a single approach to validate results obtained with one approach and method, and thereby achieve less biased results, 2) to gain fuller perspective and broader understanding of the issue and 3) to achieve innovation of conceptual frameworks. Case studies are mostly used in the social sciences, but quantitative field experiments in agricultural research in some sense are case studies as well.

Case studies have been classified in several ways, on the basis of target and character. *Intrinsic case studies* seek for understanding of a single case, while *instrumental* and *collective case studies* use cases as tools for understanding beyond the case, the latter through coordination of several cases. *Illustrative case studies* illustrate existing practices, explanatory ones are interested in causal relations and mechanisms, and exploratory case studies produce new theoretical ideas and hypotheses. In an *intensive case study*, the objective is to provide a thick description, interpretation and understanding of a unique, theoretically interesting case (Dyer and Wilkins, 1991; Stake, 1995). An extensive case study rather endeavours to find common characteristics, common models and new theoretical ideas and concepts by comparing several cases (Eisenhardt, 1989). An *extensive case study* uses cases as a mean of researching different phenomena.

Case studies produce detailed information about the topic, but theoretical generalisation from one case to another may also be possible (Stake, 1995). Case studies that develop theory are usually based on several cases and their systematic comparison, i.e. replication. Testing the produced theoretical concepts or models in the explanation of other cases, especially in similar contexts, is called *analytic generalisation*, which may strengthen or weaken the theory (Eisenhardt, 1989; Yin, 2002).

The present interdisciplinary synthesis is based on an instrumental and collective case study approach falling mainly within the extensive case study type and with the emphasis on an explanatory approach. Illustrative case studies were also a part of the BERAS study, but were only sporadically utilised in the interdisciplinary synthesis.

Interdisciplinarity

Interdisciplinarity is methodologically located between *multidisciplinarity* and *transdisciplinarity*. In *multidisciplinary* research a single problem field is analysed simultaneously from the point of view of several disciplines, possibly with no common question, and producing as well as interpreting the results separately. *Interdisciplinary* research integrates knowledge and modes of thinking of several disciplines, utilising their different concepts and methods to address a common question. It involves a systematic process of interaction among and between the separate disciplines and researchers (Klein, 1990). *Transdisciplinarity*, in turn, requires and seeks a common theoretical framework and conceptualisation, which differs from that of any existing discipline (Hukkinen et al., 2005). A transdisciplinary approach may well result in the emergence of a new discipline.

On the basis of an empirical study interviewing experienced researchers at major interdisciplinary research institutes, Mansilla and Gardner (2003) suggested the following fundamental grounds for the assessment of the quality of interdisciplinary research:

1. Consistency with multiple separate disciplinary antecedents, i.e. the way in which the work stands vis á vis what researchers know and find tenable in the disciplines involved.
2. Balance in weaving together perspectives, i.e. the way in which the work stands together as a generative and coherent whole.
3. Effectiveness in advancing understanding, i.e. the way in which the integration of the different disciplines advances the goals that researchers set for their pursuits and the methods they use (compared with a situation in which they work separately).

The interdisciplinary work presented in this report was based on the disciplinary theoretical frameworks (see Material and methods), which were integrated through application of the general conceptual framework presented in this chapter. Within interdisciplinary research, this study represents an effort to intensify the integration of disciplinary work over that of a multidisciplinary approach and to learn about and develop interdisciplinary research processes in the field relevant to sustainable food systems. A full systematic interdisciplinary process was not sought, since the study was not initially planned or organised with a view to interdisciplinary research.

Material and methods

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This chapter introduces the cases and the disciplinary approaches and methods. Details can be found in the work package reports (see *List of work package reports of the BERAS project* at the end of this report, for the scope of each workpackage see Fig. 2). The actor participation and the interdisciplinary process are also described.

The BERAS study had a case study approach, and this report presents the interdisciplinary synthesis of the multidisciplinary study (see *Conceptual Framework* for definitions). Ultimately, the BERAS study attempted to clarify the potential impacts of enhanced localisation and recycling rather than to compare the average status of the present local, organic food systems and organic farms with the dominant food systems and agriculture. Those parts of the BERAS case study work utilised in the interdisciplinary synthesis are itemised below. For the case food systems and case farms utilised, see Table 1.

- Study of the initiatives in local, organic food and the interactions between actors conducted through interviews and workshops, with a historical perspective included
- The situation as perceived by actors in the local, organic food chains was compared with the situation in the dominant conventional food chains represented in the case food systems
- Monitoring of the purchase of local, organic food by consumer groups
- Investigation of present waste management and discussion of the potential for enhanced recycling
- Comparison of the state of the case farms with national statistics
- Drawing up of scenarios on the basis of the case farms for examination of the prerequisites and potential for and the effects of further localisation and enhancement of recycling on the case farms, and for assessment of the impact of converting all agricul ture within the drainage area of the Baltic Sea to recycling, organic agriculture
- Reviews of the literature
- Discussion of the obstacles and alternative solutions identified with the above-mentioned approaches, carried out with stakeholders for purposes of feed-back, revision and verification

Triangulation of data sources (e.g., cases), investigators, theories and methods was carried out. The disciplinary work was done in interaction with an interdisciplinary process to create a synthesis that would provide answers to the common research questions.

Case food systems: location, description and aspects studied

The BERAS study was based on case food systems in the eight partici-

Country	Case scale	Inhabitants/km² country/county/municipality	Age distribution in the municipality (%)		Unemployment rate[1] (%) country/county	Organic production (%) country/county/municipality	Special features
Sweden	Farms, village (country)	20/151/23	0-14 15-24 25-44 45-65 Over 64	20 14 26 25 15	6,5/5,7	7/6/43	Declared as an "Ecological municipality" in 1993. Antroposophy-inspired movement with pioneering biodynamic farming and processing.
Finland	Farms, municipality (country)	17/12/6	0-14 15-24 25-44 45-65 Over 64	15 10 22 31 22	8,8/12,5	7/7,9/16	Declared as an "Ecological county" during 1980's. Pioneering municipality in organic production. Strong local identity.
Denmark	Farms and its customers, county	125/135/67	No data available		6,4/7,3	6/1,9/-	Biodynamic farm and consumer movement, box scheme started 1994.
Germany	Farm and its customers	230/30/15	0-14 15-24 25-44 45-65 Over 64	17 11 33 16 23	10,3/18,4	4/-/-	Village with a formerly state-owned farm in East Germany, now owned by an enthusiastic and active farmer.
Estonia	Village	30/230/27	No data available		9,7/-	4/-/-	Anthroposophy- inspired Camphill community, initiative for adults with special needs.
Lithuania	Municipality, county	52/85/27	0-14 15-64 Over 64	21 56 23	11,4/8,5	0,3/-/1,0	Local marketing through organic producer cooperative
Latvia	County	36/16/16	No data available		10,4/-	2/-/-	90% of farms are very small. Regional organic initiatives with cooperation between farms.
Poland	Municipality, county	124/78/184	0-19 20-29 30-49 50-65 0ver 64	28 15 29 16 12	19,0/17,8	-/-/-	Pioneering in organic and local processing and marketing initiatives.

Table 1. *Demographic and socio-economic features of the eight case food systems.*

[1])Eurostat news release 126/2005 and national statistics for 2004.

[2])Organic farming as percentage of the total utilised agricultural area in 2002. Eurostat, European Environment Agency and national statistics.

pating countries around the Baltic Sea and on 42 case farms, some of them included in the case food systems and some of them outside (Fig. 5, Table 1). The former farms were organic farms typical for the case food system, while the latter were organic farms with advanced recycling. The farms with advanced recycling had at least 85% self-sufficiency in fodder and also produced bread grain or other cash crops for human consumption. The main focus was on one Swedish (Järna) and one Finnish (Juva) rural food system, where initiatives had been taken by actors in local, organic food, the first more than 40 years ago (for the location of the case food systems, see Figure 5).

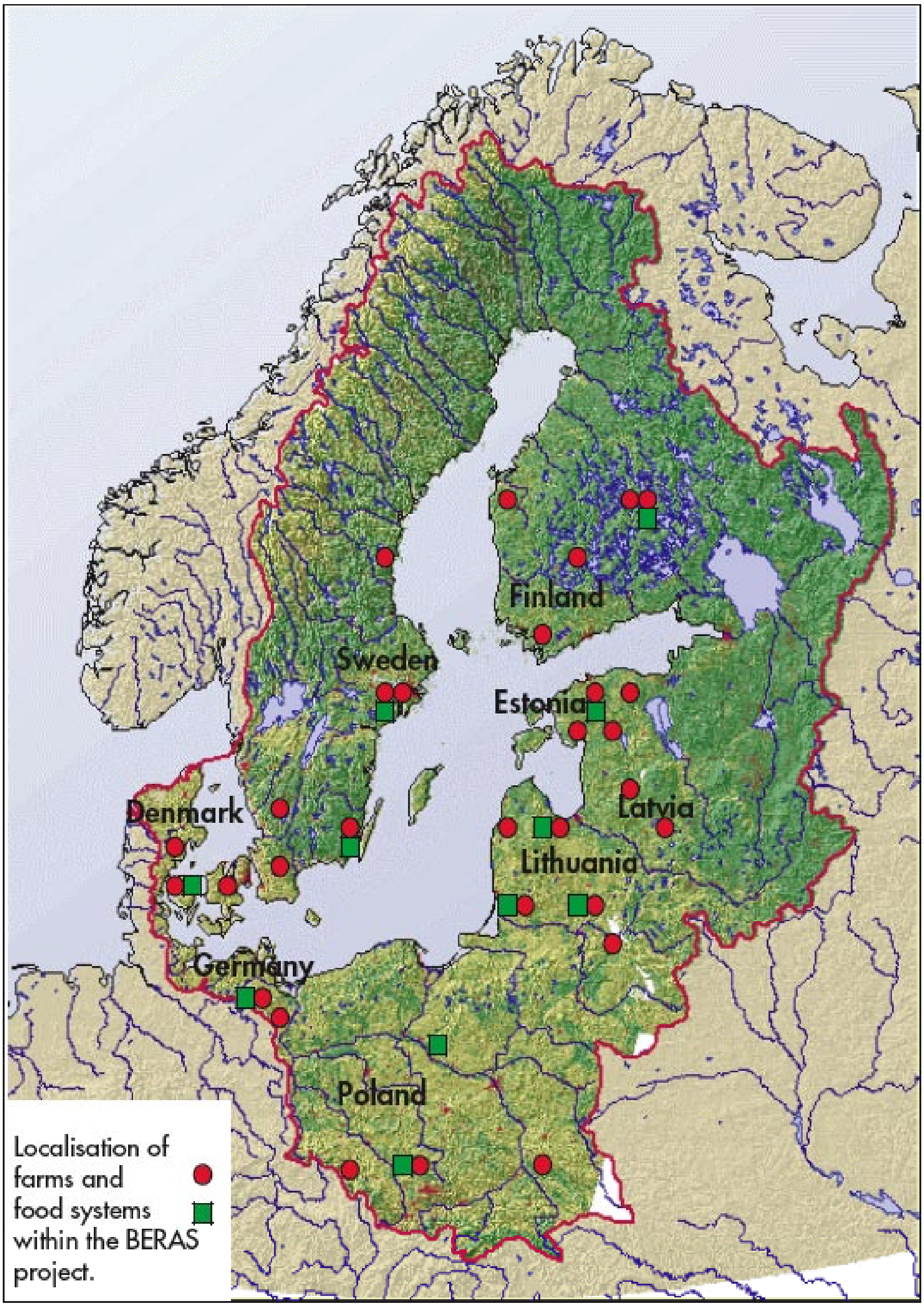

Figure 5. *Location of the case food systems.*

Food systems, especially their demographic, social, cultural, economic and political characters, and the role and structure of agriculture differ markedly in the eight countries (Table 1, Fig. 6). It follows from this that the locality and degree of recycling, as well as the obstacles to the further development of locality and recycling, vary significantly. Sweden, Finland, the former West Germany and Denmark were industrialised early under conditions of market economy, thanks in part to policies aimed at reducing the cost of food, raising farm income and releasing labour for other industries. Their agriculture is intensive and based on external inputs. In the former Soviet countries Estonia, Latvia and Lithuania and in the former German Democratic Republic (GDR), agriculture was industrialised only after the second world war and as part of a planned economy. But some small-scale subsistence farming continued to exist. In these countries, and in Poland, the switch to a market economy occurred as late as 1990, when large, market-oriented farms emerged. In Poland, where most farms were privately owned even before the political upheaval in 1989, agriculture is clearly less industrialised than in EU and other post-communist countries. In 2000, only half of Polish farms produced primarily for the market, and 70% of farms were smaller than 5 ha. With the admission of the Baltic countries and Poland to the EU in 2004, agriculture faced the challenge of integration.

The available field area per capita in the Baltic Sea drainage area varies widely: 0.32 ha in Sweden, 0.38 ha in Poland, 0.40 ha in Denmark, 0.48 ha in Finland, 0.62 ha in Germany, 0.73 ha in Estonia and about 1

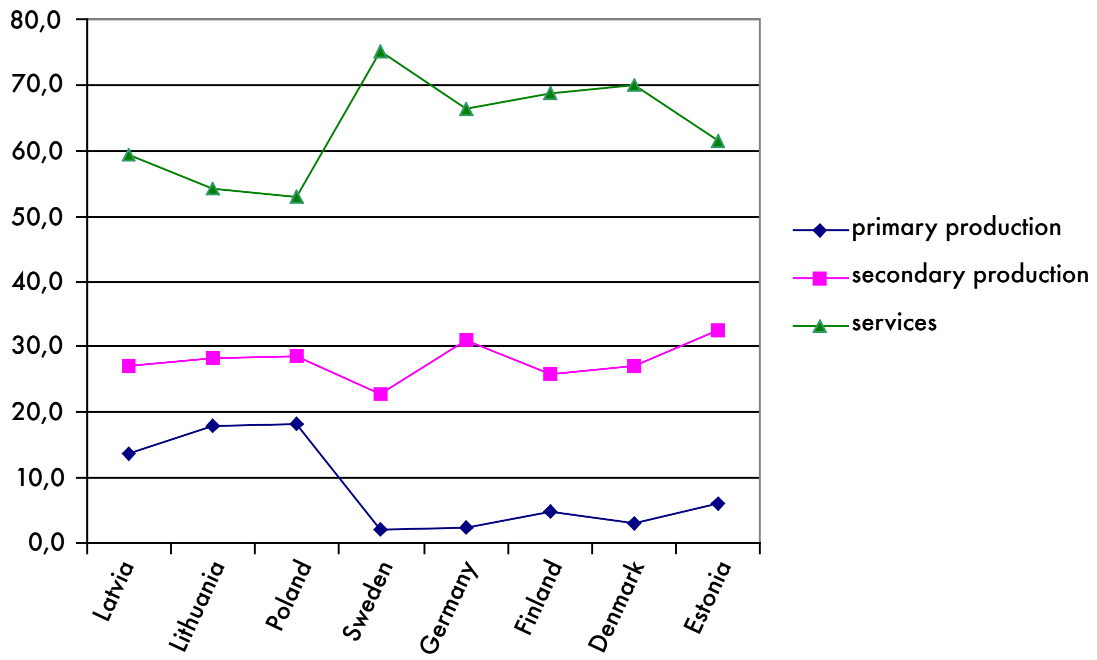

Figure 6. *Employment by industry. Employees in manufacturing and construction are included in secondary production, and employees in trade and transport in services 2005 (http://www.tilastokeskus.fi/tup/maanum/12_tyolliset.xls).*

ha in Latvia and Lithuania according to the HELCOM reports for the year 2000. In Sweden and Finland, there is a strong tendency for crop production and animal husbandry to be regionally separated, while the whole Denmark is devoted to animal production. Two thirds of Danish animal production is exported, and half of the fodder is imported. Most farms in the Baltic countries are mixed farms. Agriculture in the Baltic countries collapsed after 1991 due to the loss of the Soviet market, and all three countries relied on subsidised imports from the EU until they themselves joined to EU. In the Baltic countries and Poland, industrial food systems exist side by side with the local ones, organic farming is in its initial stages, though developing quickly, but the organic market is almost non-existent. In Sweden, Denmark, Germany and Finland, local food systems have a marginal position, though they are gaining ground as a viable option; the organic branch has an established share and is growing at a varied rate. The nutrient surplus on the drainage area and thus the load from agriculture to the Baltic Sea is clearly highest in Denmark, but high also in Sweden and Finland. It is lower in Poland and Germany and very low in the three Baltic countries. The load per capita from Polish agriculture is only a third of that from agriculture in Sweden and Finland.

The representativeness of the cases for each country, and for rural food systems around the Baltic Sea, varies markedly, but together the cases provide a representative picture. For example, Järna in Sweden is located close to the Stockholm market (Figure 5). The region has a high proportion of immigrants. The average farm size is considerably larger than the average in Sweden and proportions of the land in the region in both agriculture and urban use are high. Järna also has some special cultural features (Table 1). Juva in Finland, on the other hand, represents a rural county where economic growth and productivity of work are among the lowest in the country. Agriculture, especially milk production, and forestry are of greater importance than in Finnish rural areas in general. Although food processing is well-developed in Juva, an exceptionally low proportion (5%) of the primary agricultural production of the county is processed in the region. Table 2 shows which aspects of each case food system were studied in BERAS.

Disciplinary approaches

The indicators of sustainability (see *Conceptual framework*, *Sustainability*) were assessed using established methods of environmental, economic and social sciences, described in detail in the respective WP reports and shortly outlined in the following.

Country	Case	Environmental sustainability			Economic sustainability			Social sustainability		Actor networks
		Nutrient surplus	Energy use	Global warming	Environ-ment	Local community	Farm	Social capital	Other	
Sweden	Farms	x	x	x			x			
	Processing	x	x	x						
	Transport	x	x	x						
	Consumers									
	Food system (village)	x						x	x	x
	Country				x[2]					
Finland	Farms	x	x[1]	x[1]			x			
	Transport		x	x,x[1]						
	Processing		x[1]	x[1]						
	Consumers									
	Food system (municipal)	x				x		x	x	x
	County					x[1]				
Denmark	Farm and its customers	x					x			
	County	x								
Germany	Farm and its customers	x				(x)	x		x	x
Estonia	Farms	x								
	Food system (village)								x	
Lithuania	Farms	x								
	Municipality									
	County									
Latvia	Farms	x								
	County									
Poland	Farms	x								
	Food system (municipal)								x	

Table 2. *Use of the case food systems in the assessment of environmental, economic and social sustainability.*

[1]) Results are based on a regional agro-economic (RegAE) model.

[2])Results are based on a literature rewiev.

Assessment of ecological sustainability

For assessment of ecological sustainability, fields, farms, processing and packaging, transportation, and waste management of the food system were investigated. Assessments were made as follows:

- Nutrient loads from fields were obtained by direct measurements.
- N and P balances on farms were calculated.
- Nutrient surpluses of the organic, recycling farms were compared with statistics representative of the present dominant farming system. The comparison was performed on the basis of the primary nutrient efficiency (PNE), which indicates the ratio of harvested nutrients to input nutrients from outside the system (here the farm) to crop production.
- Material, N and P flows in the waste management system were identified.
- A life cycle inventory (LCI) of energy and material use was perfor

med on farms and for different product chains including processing, packaging and transportation. The consumption of primary energy resources and global warming potential (GWP) were then calculated.
- Use of non-renewable energy and GWP in the cases was compared with average figures for the dominant food chains presented in literature.
- Pesticide use and its development were approached through national statistics.

Assessment of economic sustainability

There were six different economic analyses making use of different theoretical frameworks and methods.

- Two studies on farm economics were based on production economics where the data consisted of real farm-level costs. The method was cost calculation and linear programming maximising total gross margin.
- Scenarios were developed to assess the potential gains and income forgone by enhanced localisation and recycling and evaluate the effects of incentives. Sensitivity of farm activities to changes in prices and subsidies were studied indirectly on the basis of validity ranges. Numerous institutional and environmental constraints were analysed.
- A scenario was developed to describe regional economic and environmental impacts through an extended regional input-output model (RegAE).
- A literature review was carried out on the costs at societal level of reducing nutrient emissions to the Baltic Sea and on the willingness-to-pay for this reduction.
- A study on social capital utilising the concepts of trust and resilience and data from in-depth interviews with entrepreneurs.
- A consumer expenditures survey of households committed to environment and health was carried out, on the basis of food purchase diaries, and compared with national average.

Assessment of social sustainability

Since the social reality of any food system is created by actors involved in these systems, and by the relations between the different actors and the wider social context, the alternative food systems (AFS's) were approached through the perspectives and perceptions of the involved actors.

Interviews based on an argumentative attitude approach were conducted with farmers, processors, traders, consumers and politicians in Finland, Sweden, Poland, Estonia and Germany. In all countries, the studies were conducted along the lines of qualitative attitude research using the same questions (statements). The common overarching question was: How do the involved actors evaluate alternative food systems (organic mode of production and local distribution), and especially, how do they evaluate them in terms of social sustainability? Social sustainability was further viewed in terms of

- social capital / trust in the networks (see also Assessment of economic sustainability),
- viability of local community, and
- equity / fairness in the distribution of control and benefits among the actors, especially from the farmers point of view.

Actor participation

Obstacles and alternative solutions were identified on the basis of actor interviews and workshops and the disciplinary studies described above. Semi-structured interviews and meetings were conducted in Sweden and Finland. Key informants were utilised in addition to open participation. In Sweden (Järna), meeting formats were based on Open Space Technology (first meeting addressed to positive considerations and the second to the changes needed to improve the system) and a variation of Appreciative Inquiry. Instead of focusing on problems, the choice was made focus first on the moments of innovation and breakthrough in the development of the local food system at Järna. Through this approach the participants sought to discover what makes the Järna food system a positive example. The meetings were documented.

In Finland (Juva), an open meeting was arranged for all interested actors along the food chain. Key actors were invited personally, but in addition there was an open invitation. Afterwards the discussion was closely analysed. In addition, in both Sweden and Finland, constraints on the use of local, organic food in households were monitored. A meeting of actors was organised at the end of the project to present, obtain feedback on, and discuss the main results and appropriate conclusions, especially the obstacles to and alternative solutions for sustainable localisation and recycling. All the main food system actor groups (farmers, retailers, processors, institutional kitchens, municipality executive board) were represented. Meetings between researchers and individual actors or actor groups were also organised throughout the study.

Interdisciplinary process

BERAS was designed as a multidisciplinary study, and to begin with there were no plans for an interdisciplinary approach. During the first year of the study, however, it became evident that there was a tendency for the different disciplines to formulate their own research questions and hypotheses from their own disciplinary perspectives and scientific interests. It became clear that relevant results that could form a solid basis for decision-making of actors required interaction among the disciplines. Interaction was essential if conclusions were to be drawn about the impact on sustainability with all its three dimensions, which was the implicit evaluation criterion for agriculture and food systems in the study. Interaction was also needed if conclusions were to be drawn about a sustainable way to localise and recycle, taking into consideration the impacts on all the dimensions, and if alternative solutions were to be presented. Klein's (1990) classic generic model for an interdisciplinary research process was therefore applied as far as was possible given that the design, structure and organisation of BERAS were not primarily aimed at interdisciplinary work. Hence the interdisciplinary process was considered the method to obtain the interdisciplinary synthesis, which is presented in this report. The model was as follows:

1. Problem definition
    - a. Defining the problem (question, topic, issue)
    - b. Determining all knowledge needs
    - c. Setting the integrative framework and appropriate questions
2. Division of tasks
    - a. Specifying particular studies to be undertaken
    - b. Role negotiation in teams
    - c. Gathering current knowledge
    - d. Resolving disciplinary conflicts by working towards common vocabulary
    - e. Communicating through integrative techniques
3. Integration and evaluation
    - a. Collating all contributions and evaluating their adequacy, relevance and adaptability
    - b. Integrating the individual pieces to determine a pattern of mutual relatedness and relevance
    - c. Confirming or disconfirming the proposed solution (answer)
    - d. Deciding about future management or disposition of the task project

The main deviation from the generic model was that the interdisciplinary research was started late and performed as a secondary task beside the multidisciplinary research and development, which was the main approach of the study. Thus, specifying particular studies to be undertaken and role negotiation in teams were weak points as these had already been specified in the teams from a disciplinary point of view, and there were few opportunities for complementation. Nevertheless, the process was carried out to completion, with due attention to the definition of interdisciplinarity and quality criteria presented above (*Conceptual framework*, *Interdisciplinarity*).

Results and discussion

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Kari Vesala

In this chapter, the interdisciplinary synthesis of the results of the BERAS project is presented and discussed. First, the effects of localisation and enhanced recycling on the ecological, economic and social dimensions of sustainability based on the case studies are reported,the cases where food systems and farms studied in their present state. Thereafter, the positive additional effects on sustainability obtainable by further promotion of localisation and recycling in the cases are suggested. The impact of a total conversion to recycling organic agriculture is then considered. Obstacles to and solutions for localisation and recycling are identified. And finally, on the basis of these, conclusions about the sustainable way to localise and recycle are presented. The disciplinary results have been published in detail in the disciplinary reports and summarised in the executive summary (see *List of work package reports of the BERAS project*, for the scope of each work package, see fig. 2).

Impacts of localisation and enhanced recycling on sustainability

Results based on cases in their present state

Comparison of the relatively local, recycling case food systems and farms in their present state with the dominant food systems and agriculture indicates the following effects of localisation and recycling on the ecological, economic and social dimensions of sustainability.

In comparison with dominant food systems localisation decreased fossil energy use and global warming potential (GWP) in transportation, except in the meat chain, due to shorter transportation distances. This was despite the smaller quantities in each delivery. In processing, fossil energy use and GWP depended less on the scale (local vs. centralised) and more on the energy source. According to the actors, local marketing increased costs and labour use for producers and institutional kitchens, but profitability was not perceived as a problem. Local marketing also strengthened the market for organic food thus supporting recycling. Localisation of processing invigorated the regional economy through gains in employment and public financing. Locality of the food system, including consumption, increased perceived equity through greater means of influence, and improved the viability of the rural communities. For those effects, locality was more important than recycling (organic mode of production), in line with the conclusions of Trobe and Acott (2000) and Miele (2001) on the importance of combining organic farming with local and regional sourcing to fully address the social and economic problems associated with globalisation of the food system.

Relative to dominant systems, recycling decreased N and P surpluses and loads, P outputs being slightly higher than inputs on the recycling organic farms. It decreased fossil energy use and GWP in agriculture. Recycling within the farm however reduced farm income. Benefits of reduced eutrophication around the Baltic Sea measured by a willingness to pay appeared substantial and higher than societal costs, when both point and diffuse sources were included. The organic (recycling) mode of production increased perceived social sustainability so long as the production was local.

The environmental benefits of recycling were achieved, because recycling substituted for the linear nutrient flows to agriculture in N and P fertilizers, which are also manufactured with non-renewable energy and using limited P resources. Additional decreases in fossil energy use on the case farms were achieved by use of biological N fixation to compensate unavoidable N losses. The decrease in GWP per product unit was reduced by the larger than average emission of methane from animals on the recycling farms. This was due to the higher proportion of ruminants among the animals, lower productivity per animal and higher proportion of roughage in the diet of the ruminants. Income forgone was mainly due to loss of the opportunity to achieve higher productivity through purchase of additional nutrients in the form of fertilizers and feed, and to loss of the opportunity to lower fixed investments through specialisation and trade between farms. The increase in the perceived social sustainability was attributed to safety in regard to environment, working conditions and food, to successful business strategies and to rural vitality. The values linked with the mode of food production appeared to have the potential to form a value base for a cooperation network and to become a key to social sustainability in terms of mutual trust, respect, community and social resilience, so contributing to economic sustainability as well.

Ways to promote localisation and recycling in the cases

Inspection of the case food systems and case farms suggested the following ways to further promote locality and recycling and favourably affect sustainability in the cases:

Further localisation would reduce fossil energy use and GWP and improve local economies through the use of local, renewable energy (e.g., wood, biogas, biofuel) in the whole food chain. To reduce energy use and GWP of transportation, increase in volumes of local, organic food as well as choice of the vehicle appeared to be important. Taking fuller advantage of the benefits of local food to the local economy requires locality of the major stages in the food chain (also agricultural production, inputs to agriculture, inputs to processing), involving local and/or regional cooperation with other industries in the form of inputs, raw material and services. Better social sustainability in local, organic food chains would be achieved 1) through further improvement of equity in influence, especially for farmers, and 2) through including consumers and the local, organic activity of large-scale enterprises in the partnership network.

Our findings on environmental benefits of localisation are parallel with those of another, non-BERAS study (Poikolainen, 2004) on vegetables in the Finnish case food system (Juva), where localisation was found to decrease fossil energy use and the climatic effects of transportation, despite the smaller amounts transported at a time. Further, our transportation findings are in agreement with the conclusions of Jones (2002) on fresh apples and of Blanke and Burdick (2005) on imported vs. domestic, stored apples and of Carlsson-Kanyama (1999) on imports vs. domestic food production generally. Also relevant are the results of Pretty et al. (2005) that the external cost of transportation in local food systems (food basket sourced from within 20 km of retail outlet) would be less than one tenth of the current one in the UK, depending on the transport vehicles, however. Localisation contributes to environmental benefits as well, because it encourages a diverse production structure with easier internal recycling and easier recycling from processing and consumption in the vicinity. Localisation also removes the environmentally harmful effects of concentrating big units of animal production in limited areas, allowing ecosystem's buffer capacity a larger role. Further, localisation and increased reliance on local resources can re-establish feedback relationships that allow adaptive management of the human-nonhuman, thereby promoting ecologically sound land-use and building of vulnerability-reducing redundancy into the global food system (Vergunst, 2002; Sundkvist et al., 2005).

The environmental advantage of local food over regional imports to the food system might, of course, be reversed if too generous a definition of local were allowed and local transport were too inefficient. According to Carlsson-Kanyama et al (2003), with poor logistics such as an absence of coordinated transport and allowing food from up to 200 km away, virtually no environmental benefits would be achieved with a farmer's market relative to similar but non-local products bought at supermarkets. The total effect of localisation also depends on the energy input to production. If production is clearly less energy-intensive when performed outside the region (Cowell and Parkinson, 2003), as it can be for greenhouse vegetables (Poikolainen, 2004) and for cereals with higher yields and lower energy need for drying in warmer regions (Sinkkonen, 2002), the benefits of reduced transportation may be more than offset by the increased energy costs for production.

The benefits of localisation to local economy and the consequent potential of local food to equity among regions is often less appreciated than the overall economic efficiency or firm profitability. Even if globalisation and liberalisation of agricultural trade lead to apparently more efficient production, underutilization of the released resources radically changes the effect. Transfer of the labour to other regions and sectors from declining agriculture is both a social problem causing inequity and an economic problem (Huan-Niemi, 2004). Thus, the counter-effect of local demand addressed to local and regional production obviously is beneficial not only for the local economy, but reduces also the total short-term costs of the structural change. In addition, as noted by Forsman and Paajanen (2002), using local products provided by local actors may result in both economic and non-economic advantages for catering businesses for example, and many non-economic aspects may turn into economic advantages, at least in the long run. The higher equity in control found in a local, organic food chain as compared with the dominant system, was in line with the results of another study on the same local food system (Kahiluoto et al., 2005).

Enhanced recycling of nutrients in fodder and manure would further reduce nutrient loads and energy use. This could be obtained by including more roughage from the recycling system (a farm or a group of cooperating farms) in the animal diet and correspondingly decreasing the cereal-based concentrates imported to the system. If recycling was carried out between nearby farms engaged in animal husbandry and plant production (distances should not be too long for manure transportation) and not within a farm, the loss in farm income associated with recycling would be reduced or nullified. Enhanced recycling from the demand chain would reduce the need for biological N fixation and reduce loads, and at the same time decrease P depletion in soils. Potentially most of the N and P flows to consumption could be recycled back to agriculture. A higher level of societal investment directed to decrease nutrient loads through recycling is well justified by societal gains and by the fact that the greatest reductions in loading today are achievable through agriculture (HELCOM, 2003). The total investment in load reduction could be reduced through cooperation between countries and thus targeting investments to regions where they will have greatest effect.

Our results, that recycling of nutrients in agriculture and food systems notably reduces nutrient surpluses, are similar to those obtained for Sweden by Granstedt (2000). Enhanced recycling and thus lower nutrient load is achieved through lower stocking rates within the recycling system and through more efficient utilization of N inputs into the system (Nielsen and Kristensen, 2005). P depletion in soil occurs in organic, recycling farms because, although the unavoidable N losses are compensated through biological N fixation, no new P is imported to the system except in feed, and there self-sufficiency is sought. Some degree of decrease in plant-available P in soil is even desirable, to consume the P earlier enriched by fertilizers and so increase the conservation of and reliance on ecosystem services (e.g., mycorrhiza) and achieve a decrease in P loads (Kahiluoto, 2000). In the long term, however, compensation of even the decreased losses will be necessary through recycling either from the demand chain and / or from eutrophied watercourses. Integrating a specialised crop farm with an animal farm was by the present study found to be more profitable than recycling within a farm, but an example from Maine, USA, suggests that coupled crop and livestock farms are also more profitable than separate, specialised ones; systems coupled for more than ten years had the most favourable profitability and sustainability measures (Hoshide et al., 2004).

Consideration of all impacts on the different dimensions of sustainability presented above indicates that there is good potential for sustainability through localisation and enhanced recycling. Localisation and enhanced recycling promote sustainability in all its dimensions, providing that firm economy is improved through fair cooperation and / or through interventions and / or price premium. Thus, the weakest loop is firm economy, and the keys to achieving sustainability are cooperation and change of the economic environment. Recycling is essential for and localisation contributory to ecological sustainability. Localisation is key for benefits to local economy and social sustainability.

Further research should consider how localisation of a food system would reduce the total transportation volume in society, including commuting to and from work, and thereby decreasing environmental impacts and costs. It might also reduce the need for expensive high-speed infrastructure.

Impact on sustainability of a total conversion to local, recycling organic agriculture

If all agriculture within the Baltic Sea drainage area were to adopt a similar regime to that on the recycling organic case farms in Sweden, the present N surplus from agriculture could be reduced by 47% and a small P deficit would be resulted. Similarly, if all agriculture of a Danish county were converted to recycling organic agriculture, a 41% reduction would be achieved in N loads to the Baltic Sea from agriculture of that county. The P deficit was estimated to be 6 kg / ha, with only 0 to 25% reduction in P load, since the P load is mainly influenced by particle bound P which, it was assumed, would stay constant within a time frame of 30 years. In addition, the pesticide emissions would be reduced to zero. Because the present conventional and organic forms of agriculture in Poland and the Baltic countries are extensive, conversion of those countries to a recycling organic agriculture regime on the Swedish model would not result in a decrease in agricultural production relative to the present situation in the Baltic Sea drainage area. Scenarios based on the Swedish case showed, however, that if the portion of meat in the diet were to decrease, a higher level of (and even more than) self-sufficiency could be achieved, as well as further reduction in environmental emissions per capita (less decrease per ha). It should be noted, however, that the recycling case farms represent a more recycling agricultural system than present organic farming on average, and that these results are based on case farms in Swedish conditions, which are not fully representative of the ecological conditions in other Baltic Sea countries.

The enhancement of recycling should also be beneficial for societal economy since the societal gains from reduced eutrophication appear to exceed the costs and, given the presently highest potential to reduce emissions from agriculture, the motivation for increased allocation of resources to reduce agricultural loads is strong. Indeed, from the perspective of farm economy, carrying through a conversion to recycling agriculture would require economic incentives. The performance of farm economy contributes to the local economy, too. For local and regional economies, as well as for social sustainability, localisation is more important than enhanced recycling. In other words, the effects on sustainability of conversion to recycling agriculture critically depend on, whether and how this change would affect locality of production and consumption. Therefore, benefits of recycling organic agriculture to local economy and social sustainability require that the decrease in productivity and the larger area needed for fodder production in recycling organic agriculture, do not lead to decrease in local or regional supply. It is important, however, to take the production of inputs also into account. The present food production regimes also include hidden hectares, for Sweden approximately one million hectares (Johansson, 2005). This is the field area outside the country that is used, especially for production of fodder, as an input for food consumed within the country (Deutsch, 2004; Kratochvil et al., 2004; Johansson, 2005). With no change in diet, the national self-sufficiency in Sweden could not be reached, and in Finland it would require a decrease in food exports and the use of field for industrial purposes.

In an earlier Danish scenario, the socio-economic consequences of 100% conversion of Denmark to organic farming was seen as extremely difficult to predict because the change would be dramatic (BICHEL, 2001). The effects would depend on the size of the total production, product prices and the environmental benefits. The modelling efforts were concentrated on estimating the effect of reducing primary production and consequently employment in the food chain of the export-oriented country. It was estimated that with unchanged consumer preferences, the gross national product (GNP) would be reduced by 1-3% and private consumption by 2-5%. If the preferences of foreign consumers were to change with the imposition of price premium of 10% on milk and 20% on pork, the impact on the GNP would be clearly less and the decrease in private consumption only 10-30% of the value noted above. In any event, stated by the report, according to current economic theory, a market-driven change is synonymous both with a more effective resource allocation in society and from the viewpoint of consumers. Therefore, as long as there is a market prepared to pay a premium for organic (and local) products, the conversion will increase the welfare of the society. According to the Danish study, since a switch to organic farming would be accompanied by environmental (and other public) benefits, it would not need to be driven by market forces alone, but could also be encouraged by government regulation. This conclusion was supported by the results of Huhtala and Marklund (2005a).

According to our findings, if rural food systems around the Baltic Sea were appreciably localised, this would facilitate recycling and invigorate regional and local economies in terms of public finance and employment. These changes would promote rural vitality. Further, increased embracement of local actor networks and local food chains would clearly improve equity in control and benefits through greater opportunity to influence, and would increase social capital in terms of trust and resilience of rural communities.

Enhancing sustainable localisation and recycling: Obstacles and solutions

The obstacles to enhancing locality and recycling to maximise sustainability were identified by research (documented impact analyses, interviews, workshops) and confirmed through a participatory process in cooperation with actors. Means to promote sustainable localisation and recycling, though based on the findings, were mostly identified in an interdisciplinary and participatory interpretation process and discussion. The proposed three solutions are characteristically inter- or transdisciplinary and represent win-win solutions, not trade-offs, for the different dimensions of sustainability. In the text below, the solutions are linked to the identified obstacles. That is, in the discussion of solutions, the numbers in parentheses refer to the corresponding obstacles.

Obstacles to localisation

1. Field area (e.g. in Sweden) may be insufficient to satisfy national food demand if production is based on recycling.
2. Present organic standards, in contrast to organic principles, do not require locality. Also, products where processing is local, but most stages of the food chain are not, can be referred to and sold as local. This leads to reduced positive impact.
3. The match between demand and supply of local food (in both volume and quality) is poor; processing and centralised retailing are bottlenecks; and share of consumption is low, which means small volumes, energy-extensive transportation and low benefits of locality.
4. Labour requirements are high, and logistics of local marketing are weak due to small scale.
5. There is a lack of equity in influence, especially for farmers. There is also insufficient embracing of consumers and the local organic activity of large-scale enterprises within the partnership network.
6. Risk for social division exists, due to envy incited by exclusion from the local chain, and by disagreement on price of organic products.

Disagreements can occur between farmers and producers on the one hand and strong centralised retailers on the other.

Obstacles to recycling

7. Recycling between crop and animal husbandry farms is complicated by regional specialisation.
8. Recycling between farms may result in income forgone due to loss of the opportunity to achieve higher productivity through purchase of additional nutrients in the form of fertilizers and feed.

9. Recycling of sewage sludge from the demand chain holds risks due to heavy metals, human and animal pathogens, drug residues etc.
10. According to actors in Finland and Sweden, strict regulations (though not requiring recycling) and bureaucracy in organic farming negatively impact the supply of organic, local food. ("Organic" is the only present label for recycling).
11. Demand for organic products is weak due to higher price (though there is no correlation between the portion of local, organic food purchased and family income) and due to insufficient availability and lack of information.
12. The divided attitude to organic farming creates a risk for social di vision.

Partnership a key solution

Cooperation with equity in influence, i.e. partnership, between farmers and local food system actors (including consumers), between different industries locally and within the region and even between countries was identified as key to achieve enhanced locality and recycling in food systems and win-win relations among the ecological, economic and social dimensions of sustainability.

In addition to the higher price conjoined with lack of commitment, the major constraint on consumers to purchase local organic food was poor availability. Better congruency of demand and supply and thus fuller exploitation of the local market would be achieved in a sustainable manner through tight and fair cooperation within the chain among farmers, processors, retailers and consumers (e.g., through communication, detailed contracts for production, product development and marketing). This kind of cooperation creates solutions for several of the possible obstacles to both localisation and recycling (3, 4, 11). Such cooperation would also enhance the opportunity of actors to influence and accelerate the reactions of producers to market changes, and thus improve availability, firm economy and social sustainability within the local, organic food sector (3). Enhanced local processing and local or regional marketing (e.g., by a farmers' and/or consumers' cooperative) would assist the development of local markets. As an example, processing of vegetables and berries is the prerequisite of supply to institutional kitchens (3, 4, 5, 11). Diversified local distribution channels would reduce the dependence on consolidated retailers, and improve equity in control for both farmers and consumers (5, 6) and, crucially, the availability of products (11). Food baskets, consumer groups, farmers' markets and electronic ordering systems with a middleman for groups like institutional kitchens are some examples of incorporating consumers in partnership networks (5).

Localisation can be initiated by any actor in the food system, e.g., almost all of the initiatives in the case food systems were started by a single individual. Thus, localisation can be demand driven (householder, processor or retailer asks for local products) or supply driven (farmer or processor introduces a local product to the nearby market). Partnership of local actors also create a peer group to develop ideas and initiatives. Some form of common values appeared to facilitate for cooperation within the local food system, and could be a means to promote the involvement of consumers (5, 6). According to Carlsson-Kanyama et al. (2003), the building of trust between farmers / producers and consumers was the most important contribution of a farmer's market to sustainable development. Strengthening of local identity could provide a general opportunity for sharing the process of food production with engaged citizens within the food system. In the case of (recycling) organic agriculture, values linked with the mode of production offer another opportunity for sharing, as organic farmers and purchasers of organic food have common concerns (also Torjusen et al., 2001). Specific options for the common values could be identified and utilised in each case.

The main problems identified for local organic food chains in the present study have earlier been reported for organic supply chains generally. These are imbalance between supply and demand; high operating costs; lack of cooperation and incompatibility of values and goals of actors, not least due to the different strategic roles of organic food for companies; poor information flow; and poor supply reliability (Baecke et al., 2002; Hamm et al., 2002; Wycherley, 2002; Finfood, 2003; Franks, 2003). Kottila et al. (2005) have, in accordance with the present study, identified two important things: closer collaboration and exchange of information within the chain and involvement of actors outside the chain in, for example, management and delivering of information on values of organic food. Likewise, cooperation and deeper understanding of the customer value creation process have been found to play a crucial role in the development of local food supply chains (Forsman and Paajanen, 2002). In the case studies of Vergunst (2003), the reinforcement of the local stock of social capital was perceived ultimately to facilitate and reinforce the local economy. Local partnership in food systems require new structures for communication and collaboration (Guptill and Wilkins, 2002), but has greater potential and feasibility than partnership within national and global food chains and more potential for feedback from ecosystems to actors for the change (Vergunst, 2002; Sundkvist et al., 2005). Further, conscious efforts to find common features of a value base promoting commitment to the partnership network might have more potential in local than in larger systems.

Global and local food systems have even been regarded as dual economies, where the global food system is characterised by general-purpose money, while local food systems employ personalised special-purpose money that is based on trust, and that cannot be exchanged between localities (Douglas and Isherwood, 1978; Hornborg, 1999; Vergunst, 2002). The two forms co-exist, they can give inspiration to alternate ways of being in the food system (Hendrickson and Heffernan, 2002) and they can even benefit from each other (de Haan, 2000; Forsman and

Paananen, 2002). However, opportunities to influence and profit from local development processes are not the same for all (Vergunst, 2002). Moreover, as pointed out by Hinrichs (2000, 2003), Winter (2003) and DuPuis and Goodman (2005), in the development of local food systems attention should be paid to open, continuous, reflexive and democratic processes that also allow a respectful, productive disagreement. In interaction between actors, broad involvement (also Haden, 2002) and equity in influence are especially important for social justice and sustainability. Farmers have also previously found to be the actor group perceiving an impoverished social situation due to lack of control and recognition in the food chain, with a potential improvement through collaboration among actors (Nordström-Källström and Ljung, 2005).

Cooperation between adjacent regions, even across national borders, can ensure reasonably local food to regions with insufficient field area to satisfy demand on the basis of sustainable recycling. Reduction in meat consumption and a higher share of ruminant meat would reduce the requirement for field area, increase the potential for food localisation (1), reduce environmental loads and press down the price of organic, local diet (3, 11). Exporting products in processed form would keep the value added in rural and less-developed regions, reducing the economic and social food print (Johansson, 2005) of the importer (1). The *appropriate scale of locality* would depend on the population density and business strategies. Entrepreneurial skills and modes of action would need to be generated for full exploitation of the local market as well as for extending the market scale (4). That may, however, demand more social and economic resources than individual farms or small firms usually possess.

The strategy of enlargement of the firm scale through fuller coverage of the local market by few, diversified enterprises would introduce competition with serious threats to social sustainability. It would also decrease the coverage of community members by the local network, limiting the social benefits of locality and increasing the risk for social division. Cooperation, and increase in market scale beyond the local rural community, at least to the regional level, while still maintaining a local image would decrease labour and scale problems, stabilise demand, improve firm economy and increase the supply of food to urban communities and regions with high population density (1, 4). Therefore, a strategy of encouraging wide participation in the local market and enlargement of product markets beyond local scale through local partnership, would appear capable of producing benefits in all three dimensions of sustainability.

Ways to get consumers to participate in the partnership network require further study. The same applies to large-scale enterprises that only in a minor way work with local organic food, and towards small local food suppliers so that they become more customer-oriented and willing to cooperate (see also Forsman and Paajanen, 2002). Finding ways to initiate and maintain processes of open communication and equal influence of actors and community members, is another challenge (Pelletier et al., 2003).

For recycling of nutrients in the form of fodder and manure, cooperation between farmers decreases costs, increases ecological sustainability with no economic costs, and promotes social sustainability (4, 6, 8, 11, 12). Cooperation also improves diversification and crop rotation, acquisition and use of machinery, land use, work division, production planning and trade. The improvement, found also by Hoshide et al. (2004) and Anderson et al. (2005) is in both biological and technical factors. As quantified by Lötjönen et al. (2004), savings of as much as 40% were achieved for animal sheds and machinery through different forms of cooperation. A biogas plant compensates costs of recycling within the farm by supplying local, renewable energy and reducing energy costs (7, 8).

Partnerships within the food system and organisational changes are required to improve safe recycling of nutrients and organic matter from the demand chain and watercourses back to agriculture. Recycling from the demand chain and watercourses is of special importance for P management, for which no mechanism corresponding to biological N fixation is available to compensate the unavoidable losses of P within agriculture. Even in rural food systems with small-scale industry, recycling of sewage sludge to bio energy fields would appear, at least in some cases, to create risks for heavy metal contamination and soil deterioration in the long term. These risks could be considerably reduced, and the main part of the N and P flows from agriculture could be returned to crop production through separate collection of urine on the one hand and bio waste from households and processing including slaughterhouse waste, on the other. Of all nutrients in house hold waste waters 80% of N and 60% of P was found in urine in the present study. According to Jönsson (2002), urine represents 70% of N and 50% of P and K of all household waste and waste water fractions. Although risks cannot be totally removed, the hygiene could be much improved through storage of urine (Höglund, 2001), composting, and energy production in biogas plants (9). Cooperation between the countries of the Baltic Sea drainage area would reduce the total cost of environmental investments promoting recycling (8).

Internalising externalities a second key solution

Economic incentives for localisation and recycling would appear to be crucial for sustainable development of food systems since, in the present economic environment local, recycling organic agriculture is much less attractive from the firm economy than the societal point of view. The interdisciplinary interpretation suggests that including the environmental and social benefits and costs in prices (i.e., internalising of externalities) by half of government imposed regulations, subsidies and taxes would be the best form of economic incentive for localisation and recycling (3, 4,7, 8, 11). Price premium (4,7) could contribute to such development, but there are also problems in relying on a voluntary support by individual consumers.

Price premiums require the prior development of organic and local standards (see below) (2,7, 10). According to the interviews, along with availability, price is the main obstacle to consumers increasing their consumption of local organic food. This finding was supported by estimates of price elasticity and is in agreement with previous studies (e.g., Shepherd et al., 2005). Thus, reliance on price premiums to improve the firm economy could work against the conversion to more sustainable food systems. Interviews with consumers and other actors nevertheless suggested that the willingness to pay might be somewhat increased if there was more information about the impacts of choosing local organic food (3, 11). This was indicated also by the fact that even though high price was mentioned as the main constraint against purchase, there was no correlation between family income and share of local organic food. Engagement of consumers in the local network of trust and common values would contribute to willingness to pay (5, 11).

Price premiums could be justified on the grounds that they cover the additional costs incurred by organic farmers to avoid damage to the environment. At present, the difference between farm externalities for an organic compared with the conventional food basket is much smaller than the premium charged to consumers (Pretty et al., 2005). In the Bichel report on conversion of the Danish agriculture to organic farming it was estimated a maximum of 10-25% price premium allowing a continuous growth in the market share, while the present level varies between 5 to 90% to the farmers (BICHEL, 2001). Harwood (2001) notes the need for corrective forces since there are areas crucial for sustainability which market forces are unlikely to adequately address (production ecology, resource protection, technology for "regional " staples, appropriate local food systems, and strong civil sector action). Noteworthy is also, that demand cannot direct development until there is a sufficient selection of products available and accessible to consumers.

Price premium based on a willingness to pay is, in any case, less promotive of equity in control and benefits for consumers than societal intervention would be (Lang, 1999). Given the societal benefits and the willingness to pay for ecological benefits demonstrated by interviews but for several reasons not on the market, public sector intervention would appear to be justified: Consumers often find themselves "locked in" to unsustainable consumption patterns, due to the architecture of incentive structures, institutional barriers, inequalities in access, and restricted choice (Jackson, 2005). On the other hand, as concluded in the report concerning organic farming (BICHEL, 2001), with the current EU rules it is hardly possible to implement a compulsory conversion to local organic food, because importation of food and feed cannot be prohibited. Voluntary change based on societal intervention seems to be the most realistic option. Thus, "internalisation of externalities" turns out to be the best economic solution for sustainability in its different dimensions (3, 4, 5, 6, 7, 11), helping market forces to work towards the social optimum. Alternative and complementary instruments for discouraging negative externalities and encouraging positive ones include penalties (Jackson, 2005), environmental taxes, subsidies and incentives, institutional and participatory mechanisms (Pretty et al., 2001).

Legislation and regulation, e.g., restrictions on livestock density and on fertilizer inputs to the system, could contribute to the break down of regional specialisation and thus to the development of more local, recycling systems (7). Subsidies for recycling could be allocated on the basis of for example animal density within the recycling system, P content in manure, or balances of P and / or N in the system (the system possibly including several farms and recycling from the demand chain). Use of the primary nutrient efficiency (PNE) as a measure (see *Material and methods, Disciplinary approaches*), rather than other common nutrient balances, has the advantage of making crop and animal production commensurable.

The current crisis in agriculture, with its economic, political, social and ecological dimensions, is often seen to have arisen because of the narrow pursuit of a productivity technology and policy model (e.g., Ogaji, 2005). Thus a logical remedy would be a multifunctionality of agriculture and food systems and a move away from the economics of scale and towards the economics of scope (e.g., MacRae, 1999). In the report to the European Commission Creating an innovative Europe, public procurement and taxation are mentioned as useful catalysts for environmental innovation. The report, published in January 2006, considers energy technologies and conservation, recycling and waste and emissions control among the environmental innovations, mentioning agriculture as a main sector to focus on. Not only the subsidies and taxes directly addressed to agri-food systems are of significance, but all the regulations, taxes and subsidies affecting the price relations of factors of production.

According to Pretty et al. (2005), only £219 million of the annual UK government subsidy of £3102 millions to agriculture (not including the additional subsidies for foot and mouth disease) was used to create positive externalities. If this proportion can be considered valid elsewhere, internalising the environmental and social benefits and costs would not necessarily imply increase of subsidy but rather a reallocation. Bahrs (2005) mentions the need to reduce the windfall profits associated with simple land-based subsidies for organic farming, though without making a reduction in the incentive effect since successful businesses should be rewarded. He proposes a change to profit-based tax systems as an effective way to provide selective subsidies for supporting and co-financing incentives. The linking of subsidies to performance and the low transaction costs are the advantages. Miele's (2000) case study comparing different European countries indicated the need to apply EU policy in support of organic farming according to the context, since the same policy can bring about divergent effects in different contexts.

Some current incentives are even directly addressed to promote localisation (e.g., funds reserved for public purchase of local food in some European countries). Tools already exist for promoting recycling in the environmental scheme as an additional voluntary measure. An example is the subsidy for receiving manure for fertilizing crops. The existing regulations on the maximum N and P supply per field area become incentives for localisation and recycling at very high levels of nutrient surpluses. Thus, there is no incentive for the deliverer within a sustainable range. In Maine in the United States, economic performance was better for the specialised integrated crop and animal farms than for separate specialised ones. Coupling was concluded to require close proximity of farms and adequate working relationships of farmers (Hoshide et al., 2004). Nutrient balances are included in the proposal for the new Finnish agri-environmental scheme. In the case of the tax on commercial fertilizer, the problems are implementation (avoidance of smuggling etc.) and legitimacy due to low prices of products.

Research is needed to determine the justified degree (e.g., Huhtala and Marklund, 2005a,b) and the most effective tools to internalise the externalities. The new incentives should directly address the key benefits or costs, instead of being technology-bound. This would ensure not only that a particular existing technology would be supported but also the development of existing technologies, and of food and farming systems, towards sustainability. In addition, the effects of incentives on all the interrelated dimensions of sustainability (e.g., ecosystem goods and services, local economies, and equity and social interactions) should be taken into account.

Information a key tool for citizen consumers

With the increasing transfer of control and responsibility from political decision-makers to the market adequate, accessible information on the market is essential. Information is a prerequisite for the localisation and enhancement of recycling, whether this is achieved through internalisation of externalities and/or price premium (3, 5, 11). Information on impacts and appropriate standards add to social sustainability by enlarging the means of influence of those with little control of the market (e.g., individual farmers and consumers) (5). Consumers and other actors in the market have diverse values, and to accomplish their citizenship they should be able to make informed choices on the basis of their own value judgements (5). In this vein, the Bichel report concluded that a growing organic market depends on consumers' own values being the basis for choices (BICHEL, 2001). Information about the impact of local food choices, especially the impact on the local economy, would increase the market and improve the opportunity for price premium on local food. This impact was, namely, considered important by the actors in the present study (3). Similarly, information about the health and environmental aspects of organic food appeared to play a role in persuading consumer decisions (11). Lack of commitment to consumer-citizenship was seen as a contributor to ignorance. Actors mentioned schools as an important forum of education for the accomplishment of citizenship through food choices (5). In a similar way, Winne (2005) and Lacy and Lockeretz (1997) argue that education of "food competent citizens" is central to the promotion of a more sustainable food system, or as Kloppenburg at al. (2000) put it, "becoming activated as citizen-eaters".

Appropriate standards are a prerequisite to conscious choice (2, 3, 10, 11) and also form the basis for market information and potential price premiums that will promote the supply of local, recycling (organic) food. Less detailed and more principle-oriented standards for organic farming, as also noted in the European Action Plan for Organic Food and Farming (EC, 2004), would decrease the main restraint on increased organic production, i.e., too detailed and inappropriate regulations and bureaucracy (10). The recent reformulation of the IFOAM Standards (IFOAM, 2005) offers a good basis for this. Allowing adaptation to local conditions, and setting requirements for recycling and locality, would enhance the availability of local organic food. A label for local, organic food has been proposed by Forsman and Paajanen (2002), and environmental and social labelling, to complement the direct communication in the chain, by Sundkvist et al. (2005). To take full advantage of the benefits of localisation to the local economy, it was found by the present study to be crucial, that local labels give information on locality of several stages of the food chain including production of raw material and other inputs, for example feed and energy.

Changing consumption behaviour is often proposed as the tool to increase sustainability of food systems (e.g., Heller and Keoleian, 2000). Previous studies too have shown origin / locality to be a more important aspect than the production mode for consumers (e.g., Isoniemi et al., 2006). In addition, local food arose more negative images among consumers in the capital region of Finland than in other parts of the country, suggesting the greater potential for local food in rural food systems. Besides the perceived problems of high price, poor availability and inappropriate quality, local food was also poorly recognised (Isoniemi et al., 2006). Mere consumer information seems not to be sufficient for sustainable consumption, however. Other information may catch a person's main attention and affect behavioural choice (Biel et al., 2005; Shepherd et al., 2005). In addition to the institutional and economic barriers (see Internalising externalities a second key solution), consumer lock-in is created by social and psychological ones such as habits, routins, social norms, expectations and dominant cultural values (Stern, 2000; Bagozzi et al., 2002; Jackson, 2005). Yet, little attention is given to information directed toward changing habitual behaviours.

Change of existing behaviour usually requires that the behaviour is raised from the level of practical consciousness to discursive consciousness, or become an object of conscious analysis and questioning. Behaviour can, however, also change preceding the attitudinal change. For example, an imposed change in services like in municipal waste collection may lead to a slight change in self-perceivance even "spilling over" into other behaviours (Jackson, 2005). In fact, other ways of learning than through information campaigns (e.g., through trial and error or by model) are known to often be more effective. Because consumer behaviour is created in social and institutional contexts rather than being the result of independent individual choices, behavioural changes may be more achievable at the collective, social level.

This underlines the need for policy intervention in the social and institutional context, including market structures, business practices, helping communities to help themselves and the environmental and social performance of governments (Jackson, 2005). This need was expressed by the actors of the alternative food chains in the case food systems of the present study also.

More research is required about, what kind of information is needed by consumers and other actors interested in conscious food choices based on their value considerations, and to generate that information. Better understanding of the effective means to learn about informed choices, would be of great value. In addition, a good understanding is required of the institutional and social constraints and means to remove them in the interests of sustainable eating.

Comparative analysis of the case food systems

The regional imbalance between crop and animal production is a significant obstacle to localisation and recycling in Denmark, Finland and Sweden. Recycling within farms and local food supply face more problems than in Poland and the Baltic countries, where mixed farming is more dominant. Added to this, the present extensiveness of agriculture in Poland and the Baltic countries means that effective recycling would result in marked increase in productivity at no extra cost. While cooperation between farms in recycling is not so crucial in these countries, it might give rapid profits in the sharing of machinery, for example.

In the industrialised Baltic Sea countries, the demand for organic food based on recycling is faced with problems such as strict and ineffective regulations, lack of standards for local food, lack of information appropriate to the perceived value priorities of the actors, and inadequate education of citizen-consumers. In the less industrialised countries, exemplified in eastern and southern Poland, food chains tend to be more local; there the main problems are poor purchasing power and lack of basic product information, and therefore lack of supply and market for organic products in particular. Thus, a change in price relations through internalising the externalities and supplying basic information on the impact of local organic food and production would be the solutions best able to facilitate localisation and recycling in Poland and the Baltic countries. Development of local and regional processing and cooperation among the local actors of the food chain would be important in all rural areas around the Baltic Sea.

In the Swedish case (Järna), a higher rate of consumers and other actors stressed the importance of local organic food than in the Finnish case food system (Juva). Especially the environmental and social performance of recycling organic production and its impact on local economy and vitality was perceived by actors more positively. The difference is evidently due to the values of the anthroposophic movement in Järna, and the longer history of the local organic initiative dating back to the early 1960'ies. The change in values and attitudes is a long-term process: according to the actors, a clear increase in the demand was perceived as late as in 1999 and 2000.

The differences in importance of the obstacles and solutions in countries of the Baltic Sea drainage area primarily reflect differences in the stage of industrialisation rather than geographical, ecological, demographic or cultural features. Thus, though viable solutions may vary in the short term, in the long term the same guidelines for development will apply over the whole area. However, the practical solutions and issues (type of products, method of delivery, pricing) will likely need to be tailored separately for each community (Stephenson & Lev, 2004).

Sustainable localisation and recycling

Investigation of the impacts of localisation and recycling and consideration of the obstacles and solutions for enhanced localisation and recycling, as reported above, suggest the following synthesis in regard to achieving sustainable rural food systems around the Baltic Sea.

A sustainable way of localising and recycling in Baltic rural food systems would be recycling of local organic fodder and manure between farms in close vicinity through a tight cooperation or local markets, complemented by recycling from the demand chain in form of bio waste and urine. The food system, including processing, would rely heavily on local, renewable energy. Sufficient shares of local organic food, together with choice of low-energy vehicles, would ensure good energy efficiency in transportation. All stages of the food chain and inputs to it would be local. Depending on the population density, markets might be extended outside the local rural community to allow sufficient scale from the firm economy point of view and to ensure supply to urban communities and regions with insufficient local production.

The solutions that were identified to generate benefits for all the dimensions of sustainability (win-win solutions) are 1) partnership, i.e., cooperation, with equity in influence, among food system actors locally, within the region and between countries; 2) internalising of externalities, i.e., increasing price according to ecological and social costs and reducing price according to the ecological and social benefits; 3) information in the form of standards for local organic recycling production and labels that inform about locality of most of the stages of the food chain.

Interdisciplinarity

As well as the primary, instrumental objective of answering the common research questions of the mainly multidisciplinary BERAS project, the interdisciplinary work had the epistemological objective to learn from failures and successes and to develop the interdisciplinary approach in research on food systems. In pursuit of the latter goal a critique of the interdisciplinary process is presented below in terms of the success of the process, quality of the research and suggestions for the future.

Success of the process (for the generic model that was followed see *Material and Methods*, *Interdisciplinarity*).
The classic model of the interdisciplinary process (Klein, 1990; see Material and Methods) could not be applied in its entirety since the interdisciplinarity came late in the project and, related to this, there were shortcomings in commitment, understanding and experience. For the most part, it was necessary to rely on the ongoing studies, without the ability to direct the work to prespecified common questions. The short presentations and discussions, formal decisions, group work and workshops were not sufficient to convince everyone of the usefulness and feasibility of the interdisciplinary approach, nor of the suitability for scientific publication. Thus, the interdisciplinary process was weakened by the only partial commitment of the researchers, the insufficient time invested in the process and learning and the inexperience in communicating and making oneself understood across disciplines.

The disciplinary organisation of the work packages and working groups was a disadvantage, as was the imbalance in resources and timing between the disciplines. The latter resulted in insufficient opportunities for interaction between the disciplines in the course of the work, even at the interpretation and publishing stages. The international character and large size of the group made the process still more challenging. Because of the perceived secondary importance of the interdisciplinary process, the possibility to exchange views by e-mail was not fully exploited. Also, conflicts in roles arose as a result of the delayed adoption of the effort, varying devotion and the subsequent separate coordination of the interdisciplinary work. A coordination group formed of the work package leaders for coordination together with the coordinator of the interdisciplinary work, could have been helpful. Despite all this, the process was completed, increased the congruity of the disciplinary work and thus the synergy attainable and resulted in interdisciplinary conclusions. Not least, the process was a useful learning experience.

Quality of the research (for the three quality criteria applied see *Conceptual Framework*, *Interdisciplinarity*).
(1) Consistency with the separate disciplinary antecedents was not the foremost challenge in the study since the main approach of the BERAS project was multidisciplinary, and most of the work was performed within separate environmental, economic and social teams. However, if discipline is defined in the narrow, traditional way, there were researchers from several disciplinary backgrounds in each team. And the economic team, in particular, adopted the approaches of several

disciplines. Thus, in many cases the mediation of the disciplinary tradition depended on one or a few people only, but these individuals had compensating connections to their disciplinary institutions with their scientific communities.

(2) Achieving balance in weaving together perspectives was a problem of the original multidisciplinary study, in the interdisciplinary work. A major reason for this was the project plan and resources which were biased toward certain disciplines and toward the ecological dimension of sustainability. In the end, a fair balance was achieved, thanks to the hard and successful efforts of the teams with least resources. And, in the end, it was not difficult to construct a coherent whole based on the common, interdisciplinary research questions.

(3) Effectiveness of the integration of the different disciplines for advancing understanding, as compared with the situation in which the disciplines work separately, is the ultimate quality criterion of interdisciplinarity. Only effectiveness justifies the effort. The study was successful in this respect. A view of sustainable localisation and recycling in rural food systems was formulated, including obstacles to and means to achieving this, taking into consideration the different dimensions of sustainability. A merely multidisciplinary study would have resulted in contradictory conclusions on the impacts of localisation and recycling on sustainability (especially from the firm economy perspective vs. the ecological and social perspectives) not allowing the further step. Also, different ideas about the sustainable way to localise and recycle would have been raised in different teams. Means to promoting sustainability in all three dimensions simultaneously were identified. The most important of these were partnership and internalisation of externalities. Their priority over alternative solutions, and their key importance and forms, could not have been resolved without interaction between the dimensions of sustainability and thus between the disciplines and researchers representing them.

Ways to improve interdisciplinarity

The disciplinary tradition in science embracing education, conventions, evaluation by financers, publishing channels and the merit system, is so strong that disciplinary work will always be prioritised if included in a plan. For interdisciplinarity to be really fruitful, disciplinary work must be consciously discouraged at all stages of a project. Ideally, the project should be planned in interdisciplinary interaction and be primarily interdisciplinary in objectives and content, organisation and publishing. A shared understanding of interdisciplinarity and its requirements and a full commitment to the interdisciplinary approach should be sought among the contributors at the outset of the planning process. There should be balance in perspectives of the involved disciplines and correspondingly, of the researchers involved in formulating of the goal or problem and research questions or hypotheses, as well as in choosing the material and methods. A well-balanced distribution of resources among the disciplines is preferable unless the character of the substudies dictates otherwise. An interdisciplinary organisation of a study involving only interdisciplinary work packages or tasks organised around interdisciplinary research subquestions or subhypotheses and multidisciplinary teams would create the best starting point for interdisciplinary work. Special communication tools like collaborative development of conceptual models were useful not only to relieve formulating questions, clarifying system boundaries and identifying gaps in data, but also revealing the thoughts and assumptions of fellow scientists across the disciplines (Heemskerk et al., 2003). Similarly, it would be best if only interdisciplinary reports and papers were included in the plan.

It has been proposed that agroecology could be developed and defined as an embracing discipline for studies on the entire agrofood system in all its dimensions (e.g., Francis et al., 2003). A transdisciplinary approach or new, common theory and methodology for an emerging discipline, was not found necessary in the present study. Rather, the results and conclusions have benefited from the accumulated knowledge, methodologies and traditions of the contributing disciplines. The greatest value of any emergent, integrating discipline in the present study would have been in establishing a common language and concepts for the participating researchers. A good alternative to this is gaining proficiency in interdisciplinarity through deepened understanding of the philosophy and theory of alternative approaches and methodologies in science, through development and adoption of procedures and tools for communicating, and through practicing interdisciplinarity as part of researcher education. In accordance with Heemskerk et al. (2003), the present study points to that in many cases, interdisciplinarity would supply a broader and more flexible selection of the expertise and methods required for a sound result than would reliance on the continuous creation of new disciplinary approaches. This is true especially given the time frame of one study and the continuously evolving research needs and objectives.

Conclusions

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The interdisciplinary conclusions of the BERAS project on enhancing sustainable development of rural food systems through localisation and recycling, are as follows:

- There is *good potential for sustainable localisation and recycling* in rural food systems around the Baltic Sea, through 1) integration of nutrient cycles between crop and animal husbandry and between agriculture and the demand chain, 2) increased reliance on biological N fixation and local renewable energy, 3) reduced transportation, 4) increased local employment and public financing and 5) greater equity in influence and trust in interactions between local actors.

- *Localisation and recycling enhance sustainability in its ecological, econo mic and social dimensions* if firm economy is improved 1) through fair cooperation and/or through 2) public economic interventions or 3) price premium, or all three. From the viewpoint of social sustainability, cooperation and interventions are more beneficial means than price premium. Localisation and recycling decrease nutrient load, global warming and use of fossil energy, and enhance local economy as well as equity, social capital and resilience of the community. Local recycling is essential for ecological sustainability, and localisation contributes to this. Localisation is a key for benefits to the local economy and social sustainability.

- *A sustainable way of localisation and recycling* would be local recyc ling between farms and from the demand chain. Most stages of the food chain, including inputs, would be local. There would be greater shares of local, organic food, for which the markets would extend also beyond the local rural community. Essential to ac hieving benefits in all three dimensions of sustainability is 1) establishment of "local partnership" of actors, 2) "internalis ing of externalities" through taxation, reallocation of subsidies and regulation, and 3) promotion of "learning citizen-consumers" through appropriate distribution of information combined with po licy intervention to remove the social and institutional constraints on informed choices.

- For sound conclusions, it is crucial to consider *interactions among the various dimensions of sustainability*, irrespective of, whether the study focuses on one or several dimensions. For the interdiscipli nary process to be successful, to get most use of interdisciplinarity, 1) the project has to be planned in an interdisciplinary manner, 2) all contributors must be committed to the process, 3) research must be organised around interdisciplinary research questions or hypotheses within an integrative framework, and 4) to interdisciplinary work packages and working groups and to be reported in interdisciplinary publications. Close attention should be paid to interdisciplinary communication.

- *Research needs exist* in regard to 1) the creation of collaborative, re flexive, democratic processes to develop sustainable local food sys tems, 2) the development of effective means to internalise the exter nalities of food and 3) the understanding of aspects of most inte rest to food system actors, and the development of tools, enabling conscious choices. In addition, 4) advanced procedures and tools need to be developed for interdisciplinary communication in re search aimed at promoting sustainable food systems.

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