Environmental information in the food supply system

Fuentes, Christian; Carlsson-Kanyama, Annika

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Fuentes C. & Carlsson-Kanyama A. (Eds.)
Biel A., Bergström K., Carlsson-Kanyama A.,
Fuentes C., Grankvist G., Lagerberg.,
Fogelberg C., Shanahan H., and Solér C.

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School of Business
Economics and Law
GÖTEBORG UNIVERSITY

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Fuentes C. & Carlsson-Kanyama A. (Eds.)	Lagerberg- Fogelberg Charlotte	Annika Carlsson-Kanyama
Biel Anders	Shanahan Helena.	**Approved by**
Bergström Kerstin	Solér Cecilia	E Anders Eriksson
Carlsson-Kanyama Annika	Grankvist Gunne	**Sponsoring agency**
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Environmental information in the food supply system

Abstract

Large amounts of food products are handled in food service institutions and during all stages in the food supply chain natural resources are used with resulting pollution. By consciously choosing foods that are efficiently produced, the environmental impacts from the food system could diminish. Information that can inform purchasers about how the environmental impacts of various foods vary is an important tool. We have investigated if and how purchasers use such information today, how they could react if it became more available and what such information would show for different food products. Results are that environmental information play a minor role for purchasers decisions today, price is much more important. Even if environmental information based on calculations of resource use and emissions during products lifecycles became available, it would not influence decisions to any significant extent. The way in which such information is presented is however of some importance. Estimates of the environmental impacts from some food products of various origins and degree of processing were carried out and they show that is difficult to devise single strategies for purchase decisions. To re-localise production is not always optimal as the negative aspects of long-transportation distances may be outweighed by efficient production practices during the agricultural phase. The future for environmental information about food is explored in three scenarios. Results are that the structure and scale of the food system as well as the environmental concern in society influence the likelihood that such information will be of importance in the future.

Keywords

Food system, environmental information, food service institutions, life-cycle assessment, purchasing, scenarios

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Biel Anders	Shanahan Helena	**Godkänd av**
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Miljöinformation i storhushåll och hos grossister

Sammanfattning

Inom storhushålls- och grossistledet hanteras stora mängder livsmedel. Under alla steg i produktionskedjan för dessa varor används naturresurser som orsakar utsläpp av föroreningar. Genom medvetna val av livsmedel som producerats resurseffektivt kan livsmedelssystemets miljöbelastning minska. Information som kan upplysa inköpare om hur miljöbelastningen för olika livsmedel varierar är ett viktigt verktyg. Vi har undersökt om och hur inköpare använder sådan information idag, hur de skulle kunna tänkas reagera om sådan information blev tillgänglig samt vad sådan information skulle kunna visa för olika livsmedel. Resultaten är att miljöinformation spelar liten roll för inköpsbesluten idag, det är framförallt priset som styr dessa. Även om miljöinformation som bygger på beräkningar av resursutgång och utsläpp under hela livscykeln fanns att tillgå skulle den inte påverka besluten i någon nämnsvärd omfattning. Hur informationen presenteras har dock viss betydelse. Skattningar av miljöpåverkan för några olika livsmedel av olika ursprung och beredningsgrad visar att det är svårt att ange enkla strategier för en minskad miljöpåverkan. Att re-lokalisera produktion är t ex inte alltid optimalt eftersom nackdelarna med långa transporter kan uppvägas av fördelarna med effektiva produktionssystem. Framtiden för miljöinformation om lisvmedel utforskas i tre scenarier. Resultat är att både struktur och skala på livsmedelssystemet samt prioriteringar av miljöfrågor i stort påverkar sannolikheten för att sådan information kan få ökad betydelse i framtiden.

Nyckelord

Livsmedelssytem, miljöinformation, storhushåll, livscykelanalys, inköp, scenarier

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Summary

The purpose of the project presented in this report was to gain knowledge about how environmental information is perceived and used in food service institutions, with the aim of exploring how such information could be produced and used in a more optimal way in the future. The ultimate aim of the project was to contribute important knowledge enabling a more environmentally responsible food system to be developed.

The needs and practices of suppliers, producers and corporate customers in relation to environmental information about food were investigated through interviews and experiments. Questions were asked about which environmental issues are perceived as relevant today and why. We also studied how different types of environmental information interact with each other and with norms and directives within the organisations studied. Here, the focus was on the role of quantitative information presented for instance in environmental product declarations (EPDs). Quantitative analyses with a life cycle perspective were used to study how levels of pollution and resource use over the life cycle of various food products in the global food supply system vary depending on product origins and degree of processing. All the case studies formed the basis for exploring how environmental information should, or could, be designed in possible future food systems. Potential challenges to implementing an environmental information system based on environmental product declarations in the food system were identified.

Results from the interviews show that the issue of environmental information in the food system is to a great extent a question of inter-organisation communication. Different purchasers construct and uphold different frameworks of interpretation, which in turn govern the perspective applied to environmental information. The result is a fragmented communication system where the meaning of environmental information is constantly being re-translated by different actors. Although purchasers are aware of numerous environmental problems, they seldom consider food-related environmental issues in their everyday business. When they do consider such issues, it is because they tend to be concerned for the environment on a personal level. However, the interpretive frameworks that dominate in organisations do not allow privately-held environmental values to be incorporated into decisions made by purchasers in their professional roles. Environmental information based on quantitative data that cover product life cycles, such as EPDs, are not available to food purchasers today. Instead other and more incomplete aspects are taken into account when environmental considerations come into play.

Results from the investigations show that even if EPD type information were available, it would be of marginal importance. When purchasers were confronted

with quantitative environmental EPD type information for various products in addition to product price, price had a larger impact on product preference than any of the three major environment-related factors tested in the study (energy use, greenhouse gas emissions, use of pesticides). The results paint a rather bleak picture of the price versus environmental protection struggle. In a conflict situation, product price seems to be the constant winner. On the positive side, how environmental consequences are presented has some significance for how influential environmental information is on product preference. In an organisation in which economic factors are strongly emphasised, more detailed environmental information combined with a symbol system can make environmental aspects more influential.

Several products of various origins and degrees of processing were investigated for variations in environmental impacts during their life cycles. The products were chosen based on the current supply structure in Sweden. The results highlight the need for a transparent information system based on producer-specific data and producer responsibility in the current complex and globally-orientated food system. Due to the complexity of the food system, the competitive advantages of products in terms of pollution reduction potential need to be monitored and communicated to purchasers on a continuous basis. The system is too complex to predict whether simplified strategies such as localisation will be optimal.

Three scenarios were developed for discussing the role of environmental information in future and plausible food systems. They were based on different assumptions about the scale and complexity of the food system on one hand and the extent to which society values environmental issues on the other. The role of EPD type information is marginal if current trends with a strong emphasis on economic issues continue. However, with increased environmental concern and an increasingly global supply system, such information could become more useful. If the spatial scale of the system decreases substantially, expert-based systems such as EPDs would probably become obsolete. The challenges to building an information system are substantial even if environmental issues are given priority. The sheer complexity of a global system makes it difficult to overview. As a result, environmental information is produced and interpreted by a number of different actors with diverse perspectives, making communication within the system more difficult and therefore less sensitive to demands.

In conclusion, the role of environmental information in reducing environmental impacts in the food system is marginal today and without substantial efforts from all relevant stakeholders, it may not increase in the future.

Preface

This report is the outcome of a three-year research project entitled Designing and Evaluating the Impact of Environmental Information in Food Service Institutions and the Food Wholesale Sector e-info. The long-term aim of this project was to contribute to knowledge crucial for establishing patterns of food production and consumption with substantially lower resource use and emissions levels than today. The specific aims were related to the use of environmental information in the food service institutions and the food wholesale sector, with the hypothesis that well-designed environmental information will significantly improve the environmental performance and that this, in turn, may lead to significantly less resource use and pollution from the whole food system. The wholesale and food service sectors control food delivered to large numbers of consumers. Therefore they have a great impact on the overall environmental effects of food consumption patterns. Consequently, it is imperative to understand the potential of environmental information in respect to these sectors.

The main funding for the e-info project was provided by Mistra, the Foundation for Strategic Environmental Research, under the Idea Support Grants. Mistra supports strategic environmental research with a long-term perspective, aiming to solve major environmental problems. Idea Support Grants are intended to help realise innovative research projects with considerable potential to bring about a better environment. The research can have a focus on discovery, innovative thinking or reappraisal. A project funded under the scheme must involve significant elements of boldness, originality and creativity. Support can also be given to research that expressly challenges or questions established ways of thinking. In addition the project received some funds from the Centre for Sustainable Agriculture of the Swedish University of Agricultural Sciences (CUL).

The project was carried out by a constellation of researchers representing disciplines such as natural resource management, psychology, home economics, business administration and agricultural sciences (a list of the researchers involved in the project and their contact addresses is provided in Appendix A). In addition, Ingela Brandén at the Jämtland County Energy Agency and E Anders Eriksson at the Swedish Defence Research Agency gave value contributions. While this report summarises the overall outcome of the project, various papers presenting the results and methods more in depth are available from the individual participants.

Annika Carlsson-Kanyama, ***Co-ordinating grant holder***
December 2005

Introduction, aim and a readers guide

Anders Biel, Annika Carlsson-Kanyama and Christian Fuentes

While many of the needs and wants of modern society are negotiable, the need for food is not. However, the changing patterns of food production and consumption are the subject of debate. The scale and complexity of the food system are increasing, resulting in an enhanced dependency on ecosystem support areas distant from the consumer (Johansson, 2005; Deutsch, 2004; Shanahan et al., 2003). This system, encompassing all processes involved in keeping us fed, is being increasingly questioned for its ability to deliver environmentally sound and safe food. It plays a decisive role in the alteration of ecosystems and their capacity to generate ecosystems services, particularly during the agricultural phases (Björklund et al., 1999; Deutsch, 2004). The intensified production systems during that phase have well-known ecological impacts such as soil erosion, salinisation, groundwater pollution and depletion and loss of biodiversity (Matson et al., 1997, World Resource Institute, 2000). The whole food system commonly uses one fifth of the energy used in developed countries (Uhlin, 1997) and contributes to emissions of carbon dioxide, the most important greenhouse gas, as well as several important non-energy related greenhouse gases such as methane and nitrous oxides.

Solutions to these problems can partly be found in more efficient management and more efficient production technology at the farm and processing levels. These technological fixes have been rather well investigated and substantial research efforts have been, and continue to be, made in this regard. Another part solution to the problems could perhaps be found in changing consumption patterns among end consumers. A prerequisite for such a change is that consumers incorporate environmental concerns into their decision-making processes. As an example, consumers would choose an organic food product rather than the 'conventional' alternative. To date, although consumers report positive attitudes toward organic products, purchase frequency is commonly low (e.g. Shephard et al., 2005). One should also bear in mind that although end consumers may start choosing organic alternatives, the set of products to choose from is to a large extent

determined by decisions in the wholesale sector. Hence, the role of the wholesale sector in enabling consumers to make environmentally informed decisions about food choices is substantial.

Another factor that contributes to the importance of looking beyond the choices of end consumers in supermarkets is the changing purchase patterns. Preparing food from scratch at home is increasingly being exchanged for industrially prepared food, i.e. 'home meal replacement'. About half of all meals in Sweden are consumed outside the home (Shanahan & Ekström, 2001). During 1999, 1.438 million meals were served by restaurants in Sweden and this figure has steadily increased (Delfi Marknadspartner, 2000). On average, every Swede had 162 meals outside the home in 1999 and the anticipation is that, with an increasingly hurried life pattern and less cooking skills, this number is going to increase (Carlsson-Kanyama & Lindén, 2001). Thus, purchasing managers as well as purchasers in the wholesale sector are expected to play a major strategic role in the environmental performance of food consumption patterns in the future.

In this setting it becomes relevant to shift research attention from technological fixes and the end consumer and focus on the other actors in the food system. It becomes imperative to know the needs and practices of suppliers, producers and corporate customers in relation to environmental information about food. Which environmental issues are perceived as relevant today and why, and what issues may become more relevant in the future? How do different types of environmental information interact with each and with norms and directives to affect food purchasing decisions now and in the future? To what extent would an increased transparency regarding environmental information affect decision-making among purchasers? What differences in levels of pollution and resource use may one expect between the wide ranges of products available in an increasingly globalised food supply system?

These are some of the focal questions that this research project addressed by studying professional food purchasers in the Swedish food system and a number of food products supplied to these purchasers. The purpose was thus to increase knowledge of how environmental information is perceived and used, as well as to explore how it could be used and produced in order to promote a more environmentally responsible food system. The long-term objective of the project was to contribute to patterns of food production and consumption with substantially lower resource use and emissions levels than today.

Chapter 1 presents a background of the Swedish food system and international food trends. The term food system is used to describe the complex set of activities and series of transformations involved in providing food for sustenance and nutrients for maintaining health. The food system includes all processes involved in keeping users fed: growing, harvesting, processing, packaging, transporting, marketing, consuming and disposing of food waste (Johansson, 2005). The term food

system, rather than food chain, implies that it is a system with interconnections and feedback. It is a complex system with many interdependent parts (Tansey & Worsley, 1995, cit. Johansson, 2005). A brief review of the impact of eco-labels on product choice among end consumers, where research has been done, also serves as an introduction.

Chapter 2 presents the results from three empirical studies that focus on the perceptions and use of environmental information in the Swedish food system. In a first interview study, a perspective analysis was used to explore how purchasers in different positions in the food system perceived and used environmental information as part of their everyday work. The focus here was on frameworks of interpretation and how they affected environmental communication in the food system. This was followed by an experimental study in which purchasers were asked to choose between products that varied with regard to information about price and environmental characteristics. Information about environmental characteristics came from life-cycle assessments of food products in the current food supply system. In addition, the information varied in wealth of detail. Lastly, the perceptions of current environmental issues among purchasers were further explored. In this second interview study, greater emphasis was placed on the construction of professional roles and their impact on the use of environmental information. Furthermore, differences between personal values concerning environmental issues and their impact on professional roles were explored.

Chapter 3 addresses some environmental impacts during the life cycles of selected food items. Calculations of energy, land and water use and emissions of greenhouse gases were carried out for a number of products with different origins and degrees of processing. The use of pesticides during farming was evaluated based on a red-flag system, while the products were chosen based on current supply and how this is distributed with respect to product origin. The calculations were carried out in order to portray the variations in results from environmental impact assessments that one may find in the current global food supply system. Understanding this variation is important for knowing the potential of a more transparent and accessible information system than today.

In ***chapter 4***, some possible future states of the food system are explored by means of scenarios. The scenarios were constructed based on different assumptions about the scale of the food system (local or global) and the degree of environmental concern among the key actors (high or low). Three plausible scenarios are described and the role of environmental information and the potentials for lowering environmental impacts are discussed for each one of them. The chapter ends with concluding remarks about the potential future role of different types of environmental information systems.

In ***chapter 5***, the main conclusions emanating from this research project are presented. This chapter offers an insight into how environmental information is

used in the Swedish food system, as well as tentative proposals for how it could be used and produced in the future. It also spells out future research needs and identifies key areas that need to be addressed by society in order for purchasers and other similar actors to make more efficient use of environmental information than today.

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Chapter 1

The supply chain in the food system and the role of the purchaser

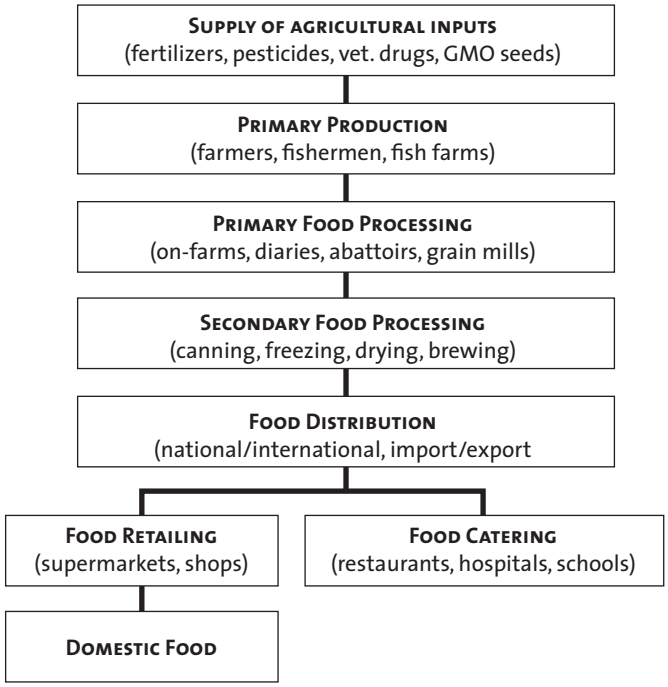
Anders Biel, Kerstin Bergström and Helena Shanahan

Food markets have become global and ingredients in most meals can be traced from all parts of the world (Murphy, 2001; Schlosser, 2002; Shanahan et al., 2003; Gardner et al., 2004). As a result, food consumers in affluent parts of the world are increasingly becoming disconnected from their local resource base. Through the global trade system, they can consume resources unhindered by geography and are thus to a lesser degree constrained by the biological conditions of their near ecosystems. The complex global production and distribution system makes the impact on the natural environment difficult to trace for consumers (Klein, 2000; Talwar, 2002; Lang & Heasman, 2004). It has been argued that today's food supply system leads to undesirable consequences in terms of loss of local varieties and employment opportunities (Lyson & Green, 1999). Furthermore, today's food supply chain is far from transparent from a consumer perspective. Hence, consumers have difficulties in communicating their claims directly to producers. Professional purchasers in the food system, particularly at the wholesale level, are key agents in supplying the market with more environmentally friendly products. Foods and environmental information flow from agriculture through food processing to food consumption in catering and domestic use, as illustrated by Figure 1.0 In other words, the ability of consumers to change their food habits towards a more environmentally benign supply depends greatly on food purchasing decisions.

Central to both public and commercial organisations are the customers, individuals as well as organisations, and meeting their demands is considered to be of the utmost importance. Individual customers can consume food as diners at restaurant and canteens but also as household members. Individual customers are often referred to by food producers and wholesalers as end-consumers. Organisational customers are procurement departments at local government agencies and county councils. Organisational customers are often termed relevant authorities.

Other stakeholders in the catering industry include business owners, share-

Figure 1.0 The supply chain in the food system.
Source: WHO[1] cit. Lang & Heasman, 2004



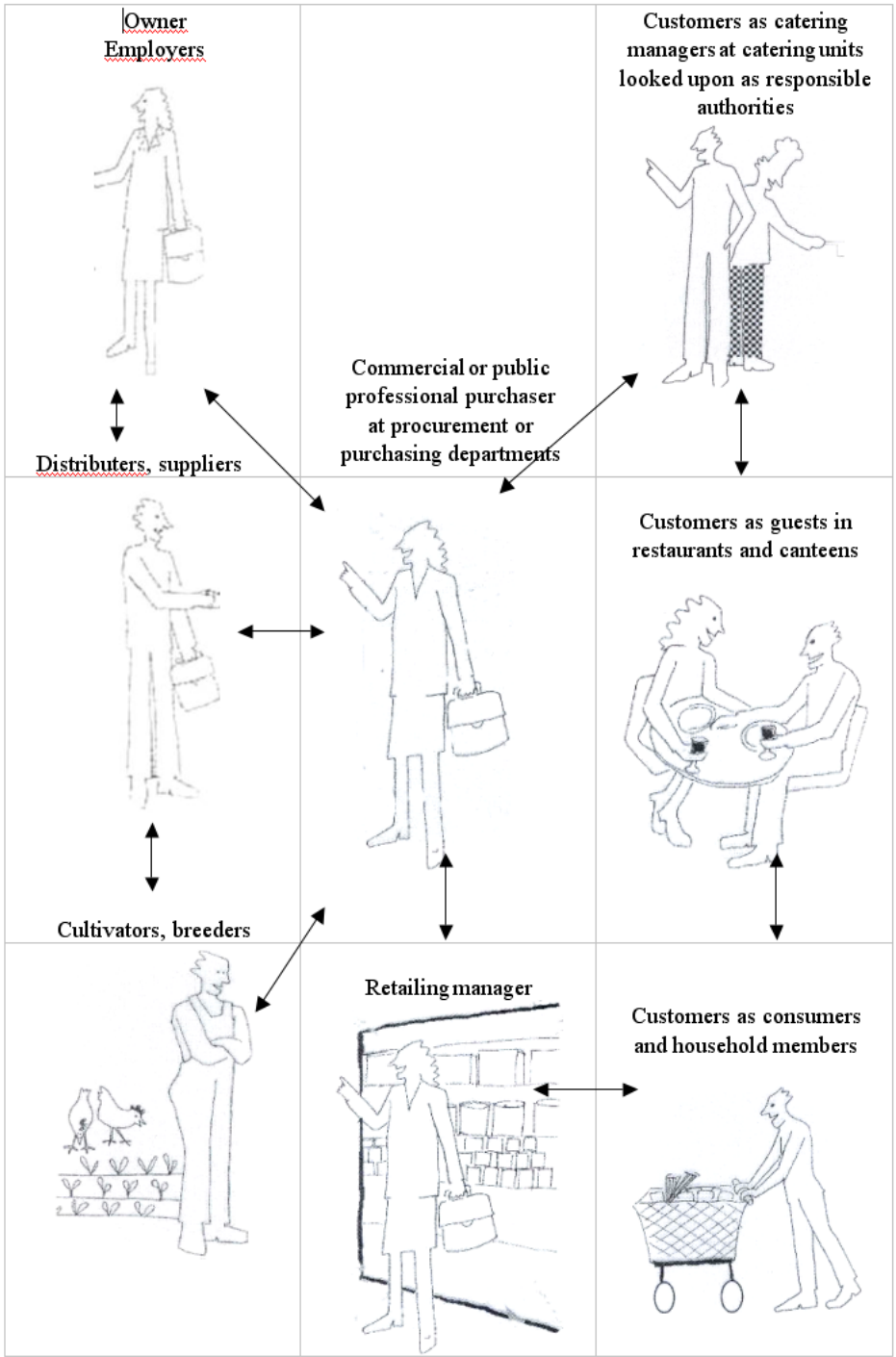
holders and relevant public authorities. In Sweden, politicians and the Swedish public at large are stakeholders in the food service industry, as well as legislators, the consumer ombudsman and others. Stakeholders who were investigated in the project were cultivators, breeders, distributors, suppliers and wholesalers of food, company employees, public catering employees and employees in catering chains. Relationships between these stakeholders are depicted in Figure 1.1.

The food service industry and food retail in Sweden – local characteristics and global trends

Eating out in Sweden has increased over the last ten years. Every day, 5.6 million meals are served outside the home, more or less equally divided between public and commercial food service (Delfi, 2004). Meals are served without charge in schools and in day-care centres. Moreover, subsidised meals are served in municipal

1. WHO is the World Health Organisation, a department in the United Nations.

Figure 1.1. Customers and stakeholders in the food supply chain.



centres for elderly people and in hospitals in the public sector. In the commercial food sector, meals are served in staff canteens and in restaurants such as pizzerias, hamburger restaurants etc., many as lunches, but also a sharply increasing number of other types of meals. This trend has resulted in the expansion of the food production and catering industry with its related wholesale sector.

In the other Nordic countries, the habit of eating out differs from Sweden. Finland is the most comparable country, but offers more commercial than public meals. The trend in Finland is an increasing amount of meals in restaurants serving alcohol. In Denmark and Norway, public catering is much less common than in Finland and Sweden. This is mainly due to the lack of hot meals at lunchtime. Pupils and workers often bring sandwiches for lunch (Delfi, 2004; Kjaernes, 2002). In the rest of Europe, eating out, daytime as well as in the evenings, implies commercial meals. The Food and Drink manufacturing industry in UK is the single largest manufacturing sector, with 6,752 Food and Drink enterprises (Food and Drink Federation, 2005). In the USA, one of every five meals consumed is prepared in a commercial setting. On average, only 14 meals per week are privately prepared (Hall, 2005). An indication of the fast food trend is the expansion of McDonald's. In 1968 they managed 1000 units globally. In 2002 this figure had increased to 30,000 units. In the USA, McDonald's is the largest purchaser of beef, pork and potatoes and the second largest purchaser of chicken (Schlosser, 2002).

Retailing in Sweden is organised into different groups. The market is dominated by three main chains, where ICA has 35%, Axfood 20% and the Co-op chain 25% of the market. These chains, together with smaller retailers, produce a turnover of 167 billion SEK, approximately 17.6 billion Euros per year. The added cost for retailing varies with products. Retailing costs are 10-15% of the final price for milk, flour and sugar, while for beer, meat, fresh fruit and vegetables they can be as much as 30-50%, reflecting the costs of storage and transportation (Livsmedelssverige, 2005). In the year 2003, retailing in Sweden comprised more than 6000 shops organised as supermarkets and stores, as well as small after-hours shops and discount stores.

Between 1980 and 2001, each of the five largest global supermarket chains, all based in Europe or the United States, increased the number of countries in which they operate by at least 270%. The largest increase has been in Asia and Latin-America (FAO, 2004). The 30 largest supermarket chains now account for about one third of food sales worldwide (FAO, 2004).

Actors in the supply chain

The food supply chain in Sweden is highly complex in terms of number of actors at different levels and types and sizes of organisations. In the present project, sec-

ondary food processing and food distribution, subdivided into food retailing and food catering, were investigated. Figure 1.2 presents a typology of participating departments in the food supply chain where environmental information is used.

Figure 1.2: Purchasing departments in parts of the Supply Chain of Food in Sweden. Source: Bergström et al., 2005.

Producers	*Wholesalers*	*Authorities*	*Catering chains*	*Retail chains*
Purchasing departments at **food producers** that are also suppliers of food	Purchasing departments at **food wholesalers** that are also suppliers of food	Purchasing departments at **local and regional authorities** responsible for contracting in-house public catering	Purchasing departments at **global catering chains** responsible for contract catering	Purchasing departments at **retail chains** responsible for purchasing to retailers

Producers of processed food

Producing companies supply food processed in-house and food processed by other food producers. These companies buy unprocessed material and some ready-made products for their own production. Food is supplied directly to public and commercial caterers and retailers. In Sweden secondary producers, as well as importers and brokers, comprise approximately 500 units, mainly canning and freezing companies.

Food wholesalers

Food is delivered to wholesalers either from farms or from the food industry. Food sourced from farms is collected or distributed unprocessed, directly from harvest or slaughter, in order to be stored and then transported to the supplier's customers. When sourced from food industries, the products are processed, e.g. washed, rinsed or peeled. Products can also be blanched, deep-fried or cooked. Ready-made meals are also delivered. Wholesalers supply food, produced nationally and internationally, to public and commercial catering. Food wholesalers in Sweden include national co-operative producers (in all 25 units, e.g. Arla, Scan), wholesalers (e.g. Servera, Menyföretagen, 85 units) and fresh food wholesalers/importers and brokers (e.g. Fresh Fish, Fresh Vegetables, Fresh Meat, 115 units) (Delfi, 2004).

Local and regional authorities

Local government agencies and county council departments are responsible for food purchasing, which is carried out in accordance with agreements and contracts developed in a procurement process with suppliers. Framework agreements

are drawn up to include several other local government agencies under public management. The public catering comprises approximately 12,800 units, serving 2.9 million meals per day (Delfi, 2004). They are organised in-house by 290 local authorities and 20 county councils (www.svekom.se).

Global catering chains

Global catering chain purchasers make agreements locally and regionally, as well as nationally and internationally. The role of global catering chains operating in Sweden is to purchase and procure for their own commercial catering units, which are contracted to cater for different companies. The consumers include diners in the public food service sector and in commercial companies. Commercial catering is organised in the form of commercial restaurants run by private owners or catering chains. Around 19,500 units serve almost 2.7 million meals per day.

Retail chains

In retail purchasing management, food is delivered directly from farms, small and medium-sized food companies and large national and international food companies. The retailers sell food directly to the public through a variety of market channels. Segmentation strategies are employed, leading to different ranges of products for different customer segments. There are approximately 6,000 retail units operating in Sweden.

Purchasing and procurement

In the commercial food service sector in Sweden, catering is managed by entrepreneurs known as contract managers while in the public food service sector catering is managed by local and regional authorities, referred to as in-house catering. The purchasing of food for both public and commercial catering is subject to very restrictive and highly regulated procedures. Most catering authorities have specific departments working with purchasing and procurement. The task of purchasers is to find companies willing to sell food to the catering units. In order to make good deals, procurement contracting (see NOU, 2004) is used. This is a time-consuming process that starts a year before the actual buying occurs. The purchaser in a catering department sends out inquiries to many food producers and distributors who then respond to written descriptions of products to be bought. The procurement process usually results in 2-year supply contracts. The purchasers' work ends here and at this stage each catering manager can start to buy the food provided for in the agreements.

The Food Act in Sweden (1971) regulates food content, food additives and foreign substances. The aim is to safeguard citizens from harmful food. The Act prescribes how to handle the food, how to label it and how to offer sales. It also presents regulations for personnel hygiene, food premises and supervision. It is

harmonised with the European Food Regulations authorised by the European Community and since 1995 has included regulations related to organic production and the protection of designations for foodstuffs.

The food is labelled as it is distributed along the supply chain. The Swedish Food Act (SLV, 2004a, 2004b) regulates how the product contents, including additives, the producer's name and the origin of the product are to be displayed on the label. The expiry date for best use and storage instructions for the food must be specified. Nutrients must also be reported, normally voluntarily, but mandatory in the case of baby food. The only piece of information related to environmental issues is the place of origin of a product. As the purpose of the Swedish Food Act is to prevent damage to human health, there are no provisions within this legislation for regulating labelling concerning environmental information, nor is there any regulation within the Environmental Code concerning environmental information about food. This means that purchasers cannot rely on regulation to provide them with environmental information about purchased food products. Instead, they have to seek other sources of information, such as voluntary systems, to obtain environmental information.

Based on empirical data obtained in the project, the food purchasing process can be summarised as follows. It starts with the signing of contracts with cultivators and breeders. Contracts are related to volumes. When signing agreements, purchasers make sure they can order food at fixed prices. Fresh food such as meat can, on the contrary, be bought at current prices. In order to get the most advantageous prices, large volumes are bought. In the project we identified four themes that seem to guide the purchasing process: i) profit, the primary goal of these companies; ii) co-operation within the food system; iii); product availability at from distributors; and iv) customer demands. The buying of food takes place continuously and seasonally. Many contacts exist both nationally and internationally, mirroring demands from the market. The food purchasing process in public and commercial catering starts with procurement, which results in framework agreements. These are based on specific demands made by reference groups of food managers in public catering units. The amount of food to be bought is based on the quantity of food bought the year before. In retailing, the purchasing process is different. Purchasing managers do not work with procurement, but search for, and are themselves sought by, suppliers to identify the best products to suit special markets. Quality and environmentally labelled products are factors that retailing purchasers point to as important for sales.

The role of standardised environmental market information for product choice

Many factors have to be considered when purchasers make their decisions about which products to buy, the environment being only one. To emphasise the importance of the environment in the decision-making process, eco-labels are used to inform customers about the environmental impacts from producing or using products.

At present, there are three types of standardised communication formats for conveying environmental information (Baumann & Tillman, 2004). Type I refers to labels where criteria are set by independent labelling bodies and monitored through a certification process. The White Swan, the Blue Angel, the EU-flower and, in Sweden, Bra Miljöval are but some examples. Type II labels refer to labels developed by producers or retailers. There are no pre-defined criteria and no verification by independent bodies. As for environmental impacts, Type II labels are the least informative and are not discussed further below. Finally, the Type III environmental product declarations (EPD) provide quantitative environmental product information about the product's environmental impact through its life cycle and are based on Life Cycle Assessment (LCA). This information is set and verified by the industrial sector or independent bodies.

To receive a Type I label, a product has to meet certain standards. Whether the product meets these standards or not depends on its environmental impact according to several criteria, e.g. the extent to which it is air polluting, water polluting, etc. The problem here is how to integrate this information into a final verdict. It is up to the independent body to weigh up different criteria, and it is not always easy to determine how much worse in the long run it is to pollute the air as compared to water. For consumers, Type I labels are convenient since they provide a verdict on the environmental performance of the products. Hence, products can be easily compared and sorted into two categories, those with and those without an eco-label. Type III labels provide quantitative information based on life cycle impacts about several criteria, such as energy used, hazardous waste produced and emissions of greenhouse gases. However, there is no weighting of criteria and no comparison with other products. These tasks are left to the purchaser. Since the average consumer probably has little time and knowledge to judge such information, it has been claimed that EPDs would probably be more relevant for business-to-business communication.

Life Cycle Assessment (LCA), which is the method used for creating EPDs, is a tool for quantifying, evaluating, comparing and improving goods and services in terms of their environmental impacts. Environmental impacts include emissions into the environment and consumption of resources, as well as other interventions (e.g. land use) associated with providing products that occur when producing materials, manufacturing the products, during consumption/use, and at the end-of-life of the products. These emissions and consumptions contrib-

ute to a wide range of impacts belonging to broad groups such as human health, the natural environment (resources and life support functions-climate regulation, soil fertility) and man-made environments (such as cultural artefacts and natural forests) The methodological framework of LCA is spelled out in the ISO 14 000 series including ISO 14040 on principles and framework, ISO 14041 on goal and scope definition and inventory analysis, ISO 14042 on impact assessment and ISO 14043 on interpretation. A number of articles and other publications provide more details as to the methodological approaches (for an overview, see Pennington et al., 2004; Rebitzer et al., 2004).

The strength of LCA, it is argued, is that it provides a framework for systematic analysis, thus 'avoiding dogmatic objectives which can be, while intuitive, incorrect even in their general tangent" (Rebitzer et al., 2004, pp. 717-718). LCA has found a use among multinational corporations, especially among automotive and electronics manufacture. Governments such as those in Japan and the United States have actively promoted the use of LCA by supporting methodological development and facilitating information exchange. In the European Union, the adoption of the Integrated Product Policy (IPP) implies that stakeholders are made more responsible for environmental impacts during a product's life cycle. At present, only Type I labels are used for food products. Hence, knowledge about the effects of labelling systems has mainly been gathered for Type I labels. Some of the findings of these studies are reviewed below. Although Type III declarations do exist on other kinds of products, no studies of their effects on product choice seem to exist (Leire et al., 2004). However, interview studies targeting Environmental Product Declaration provide some insights into how Type III declarations are perceived (Fallenius et al., 1997; Jönsson, 2000; Solér, 2001). Considering these together with findings from the studies of Type I labels, some implications for business-to-business, the emphasis in the present report, are drawn below.

Effectiveness of eco-labels on food choice - Awareness, knowledge and trust

As pointed out by Thøgersen (2000), knowing that an eco-label exists is a prerequisite for using it as an aid in decision-making. A survey study of Nordic consumer knowledge, attitudes and trust in relation to the Swan label can be used to illustrate this point (Palm & Jarlbro, 1999). Somewhere between 60 and 75% of random subjects in Norway, Sweden, and Finland were able to spontaneously mention the Swan label unaided when asked about eco-labels that could be found in their respective countries. In Denmark, the figure was substantially lower, 18%. However, early in 2001, this figure had increased to 56% (Miljøstyrelsen, 2001). One should bear in mind that whereas the Swan label was introduced in the other

Nordic countries in 1989, Denmark did not join the labelling scheme until 1998. Hence, once the label was promoted in campaigns and seen in the shops, awareness and knowledge increased. Other studies also report high figures for knowledge about eco-labels (e.g. Konsumentverket, 1995/96).

Besides knowledge, consumers should also trust the message that the label conveys. The aforementioned study by Palm and Jarlsbro (1999) indicates that knowledge and trust go hand in hand. However, this is not always the case. In particular, consumers are less ready to trust Type II labels where information is provided by producers or retailers (e.g. Tufte & Lavik, 1997). This negative effect of type II labels can also spill over onto third-party labels and reduce trust in them (ibid.).

Attitudes toward eco-labels

Given that consumers have knowledge about eco-labels and trust in them, one would expect that they also have a positive attitude towards such labels. This indeed seems to be the case. A large percentage (65-90%) of the subjects interviewed in the Nordic countries agreed that eco-labels are needed (Palm & Jarlsbro, 1999). More recent data on Swedish consumers bear direct evidence in that the majority of consumers hold a positive attitude towards buying organic food products (Shepherd et al., 2005). This positive attitude signals that consumers expect that the choice of eco-labelled alternatives can help them in attaining valued goals. However, their positive attitude did not result in an intention to purchase such products or in actual purchase behaviour (Shepherd et al., 2005). Only 4-10% stated that they were very likely to choose a labelled alternative the next time they purchased one of the targeted products and only 8-16% declared that they regularly bought one of the labelled alternatives. Why this apparent discrepancy between attitudes and intentions and behaviour? Here, two kinds of purchase should be distinguished: deliberated and habitual.

A deliberated purchase implies that the consumer considers information about products and makes some kind of trade-off between how alternatives measure on important purchase criteria. Hence, the positive attitude associated with benign environmental consequences may be over-ridden by considerations about e.g. price or taste. Indeed, a study by Magnusson et al. (2001) showed that although consumers associate organic food with positive environmental consequences and a more healthy product, they also believe that organic alternatives are more expensive and do not taste better. The positive attitude towards organic food is superseded by a more positive attitude towards alternative products, mainly because of a lower price.

A habitual purchase on the other hand is performed with little mental awareness. A familiar brand label or product look may serve as a cue initiating an automatic response or purchase. Despite a positive attitude towards organic products,

in the well-known environment of a familiar shop, such habitual behaviour is not easily overcome. It is also the case that the average time consumers spend on purchasing everyday goods and foods is very short, around 7 seconds per product (Hoyer, 1984). This indicates that there is a minimum of reflection in the choice process between products. Rather, consumers rely on established habits and may not even notice that a product is eco-labelled.

Nevertheless, some consumers may be more attentive to eco-labels than others. A survey conducted in Norway reported that those who purchased organic foods were more attuned to ethical, environmental and health issues (Torjusen et al., 2001). Such customers were more attentive to reflective traits, while other consumers were more affected by observational traits. The former category includes how food is produced, processed and handled, and how these circumstances affect people, animals and nature. Observational traits refer to traditional food quality aspects such as appearance, freshness and taste. One can assume that eco-labels serve as a more salient cue to the reflective than the ordinary consumer.

The difference between observational and reflective traits partly mirrors a distinction between self-enhancement and self-transcendent values. Self-enhancement values emphasise concern for consequences of actions for the self, while self-transcendent values relate to concern for the welfare of all people and for nature. Price is an indicator of a self-enhancement value, personal wealth, while nature and the environment represent self-transcendent values. Since information about the latter is not evident from the look of the product, or regularly displayed on the shelf as is price, there is a need to convey such information to the consumer through the use of eco-labels.

To the extent that consumers give priority to environmental values and focus on environmental outcomes, they favour eco-labelled alternatives despite their higher price. Those are consumers for which environmental values are central in their lives, a part of their self-conception. It is only for this smaller group that a moral duty, to buy eco-labelled products, guides their purchasing decision (Biel et al., 2005). To them, the eco-label serves as a potential cue to habitual behaviour.

Business to business

Little is known about the effectiveness of Type III information in a context of business-to- business relations. However, a Swedish study using focus group interviews in Denmark, Norway and Sweden paired with follow-up personal interviews in Sweden investigated user requirements of certified Environmental Product Declarations (EPD), an ISO Type III declaration (Fallenius et al., 1997; Solér, 2001). Interviewees in the focus groups were all working in companies producing EPD information, while interviewees in the follow-up study were either in companies producing EPD information or consumers of products labelled with such information.

Two main results emerged. The attitude towards EPD information was positive among those who produced it, for whom it provided verified and quantitative information. Hence, it was regarded trustworthy. Customers, on the other hand, found it complex and less useful than Type I information when it came to choosing among products. Similar results were reported in a study by Jönsson (2000) on the use of environmental product declaration in business-to- business communication in the building, energy and automotive sectors. While producers, the suppliers of Type III information, found it useful, customers perceived the information as too complex and not easily communicated to private customers.

Two main conclusions could be drawn. In order for EPD information to guide product choice, customers need to learn what EPD information conveys. Furthermore, there is a need to simplify EPD information, perhaps in the form of threshold values, to fulfil the function of a guiding device.

To meet these demands, LCA methods are under development. Challenges ahead include: how to best simplify the rather extensive analysis needed for a full-scale LCA, how to provide high quality and transparent data with low or no costs and how to better interpret and disseminate the results (Pennington et al., 2004; Rebitzer et al., 2004).

As for Type I labels, knowledge and trust are important factors in order for Type III labels to be useful as an aid in decision-making. At present, knowledge about Type III labels does not seem to be widespread. As a consequence, trust in the labels has not been established. Furthermore, the information that is currently provided through Type III labels seems to be too complicated to guide the decision-making process. A combination of Type I and Type III labels might be an optional solution. However, the information must not only be easily understood, it must also be regarded as an important choice criterion. At least some end customers in their role of private citizens give priority to environmental values and choose Type I labelled products. The question is whether customers in a business-to-business relationship also give priority to these values. A recent study indicates that while people as private citizens are prepared to act on their environmental values, these values are less important when they act in their role as private employees (Nilsson & Biel, 2005). In business, self-enhancement values are more accentuated than in the private sphere. As a result, it could be even more difficult for people to act on environmental information in a business context than in private life.

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Chapter 2

Exploring the perceptions and use of environmental information in the food system

Gunne Granqvist, Kerstin Bergström, Christian Fuentes, Helena Shanahan and Cecilia Solér

In this chapter the perceptions and use of environmental information in the food system are explored. Three different but interconnected studies present a complex picture of the use of environmental information. First, an account of the multiple perspectives co-existing in the food system and their impact on the use of environmental information is presented. This analysis is based on in-depth interviews with purchasers in different positions in the system. Second, results from an experimental study in which purchasers were asked to choose between different environmental factors are presented. This included the introduction of a simple label system that expressed whether an outcome was worse or better than average. Finally, results from a second interview study are presented. In this analysis purchasers' construction of their professional roles and the impact that these roles have on the perception and use of environmental information are discussed.

Multiple perspectives on environmental information – communicating in a fragmented food system

The communication of environmental information is rightly often attributed great importance in the effort to encourage and maintain environmentally friendly production and consumption. If environmental initiatives from supply chain actors and other stakeholders are to lead to an improvement in the environmental performance of products and services, we need to understand the communication that takes place within the food system. Strategies such as Environmental Supply Chain Management (ESCM) can only be successful in a context of interorganisational communication (Zsidisin & Siferd, 2001). This problem of interorganisational communication is particularly accentuated within the Swedish food system. As illustrated in the previous chapter, the food system consists of a myriad of actors striving to fulfil their particular objectives. The complexity of this supply

chain in terms of number of actors, types and sizes of organisations makes it an interesting communication challenge.

So how do these different actors perceive and use environmental information? What different ways of seeing environmental information are there and what affects these different perspectives? In this study the purpose was to investigate how actors in the food supply chain perceived and interpreted environmental information in their role as purchasers. The aim was to understand how environmental information is perceived and consequently used by different purchasers in the food system.

With this purpose in mind, in-depth interviews and a phenomenologically[2] inspired perspective analysis was applied to explore purchasers' conception of the use of environmental information. The interviews were carried out in autumn 2002 and focused on decision situations, as well as specific organisational factors that were presumed to affect the use of, and perceived need for, environmental information. Participating companies and departments were selected to represent different stages of the food chain in Sweden. The following categories were represented: commercial producers, commercial wholesalers, public catering in procurement departments, commercial catering in global food service chains and retailing. Fifteen purchasing managers were interviewed. Interviews covered topics such as procurement, purchasing processes, environmentally-friendly food production, type of food information used when making purchasing decisions and what environmental friendly food meant to the respondents . Interviews lasted 60-80 minutes and were tape-recorded and transcribed in full.

Below is a brief presentation of the food system and buying processes in order to place the subsequent discussion within a relevant context. Thereafter the different perspectives on environmental information that emerged in the analysis are presented and discussed.

The actors of the food system in a public and commercial setting

Interviews with purchasing managers revealed a very complex purchasing process in which different actors interact, exchanging both items and information. These production-consumption processes create a flow of food items that travel along the system in different directions, being processed and transformed along the way (see Figure 2.0). In this system actors are both producers and consumers, shifting between these roles as part of the buying-selling processes that create the food supply chain.

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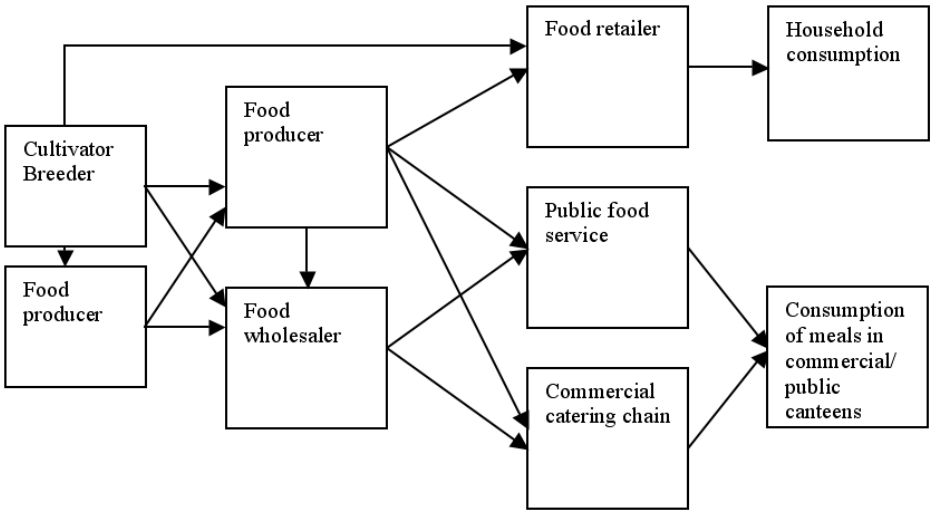
2. The phenomenographical method, related to consumer purchases of environmental friendly products, is taken from Solér et al. (1997).

3. For specific questions about environmental information, please contact Kerstin Bergström, see Appendix A.

Figure 2.0. Flows of information in the food purchasing process.



The figure illustrates the position of the different actors in the food system, from food producers to meal consumption (see Chapter one for a more detailed description of the different actors in the food system). Interaction, although not completely linear, is focused on other actors in direct connection, emphasising positional relationships. For example cultivators focus mainly on food producers and food wholesalers, while commercial catering firms have more interactions with end-consumers.

Another relevant aspect is the public-commercial dimension of the food system. While public food service firms exist mainly within the realm of government control, commercial catering firms are guided by a more market-orientated ethos. As the perspective analysis shows, this duality of guiding purposes adds to the complexity of the food system in unexpected ways.

Four perspectives on the use of environmental information

Four different ways of perceiving the use of environmental information emerged from the analysis. These perspectives held by purchasers in the food system varied according to their position in the food supply chain. As a result, the financial perspective, the regulatory perspective, the demand compliance perspective and the quality control perspective all represent distinct ways of perceiving the use of environmental information. The perspectives are summarised in Figure 2.1 below.

Each of these perspectives is guided by its own logic focusing, excluding and reinterpreting different aspects of the use of environmental information. That is, perceiving environmental information from a certain perspective means that some

issues are accentuated and made central to the notion of environmental information, while others are reinterpreted and thus viewed differently according to perspective. Consequently, each perspective contains an element of reinterpretation of seemingly similar dimensions, producing a situation where an issue such as food safety can mean different things to different actors. The following sections are devoted to a presentation and discussion of these four different perspectives. The presentation concentrates on explaining the focal point of each perspective, while aspects that comprise this perspective are discussed in less detail.

Figure 2.1. Purchasers´ perspectives on environmental information in the food supply chain. Source: Modified from Solér et al. (2005).

P1- The financial perspective **Food producer and wholesaler** **To consider financial facts**	**P2 – The regulatory perspective** **Public food service** **To work according to the law**	**P3 – The demand compliance perspective** **Global catering chains** **To adjust according to demand**	**P4 – The quality control perspective** **Food retailer** **To be in control**
Focus on cost * To subordinate environmental considerations to financial realities.	**Focus on regulation** * To follow rules and guidelines. * To trust the judgement of others.	**Focus on compliance** * To listen to customers and consumers. * To make financial adjustments.	**Focus on documentation** * To document the quality of food. * To focus on food and product safety.
* To listen to the customer. * To focus on food safety. * To make transportation as environmentally friendly as possible. * To trust the judgement of others	* To focus on food safety. * To make packaging and transportation as environmentally harmless as possible.	* To examine suppliers. * To focus on food safety. * To make packaging and transportation as environmentally harmless as possible * To trust the judgement of others	* To examine suppliers. * To make packaging and transportation as environmentally harmless as possible

The financial perspective

The financial perspective was held by purchasers positioned in a food producing company or at a food wholesale outlet. The financial perspective meant that environmental issues were, for the most part, reinterpreted into cost issues. That is, environmental issues were only considered within the market framework of cost and revenue. These actors used environmental information to a limited extent when purchasing food. They argued that using more environmental information would mean disregarding harsh financial facts. In other words, using environmental information when purchasing food to them meant subordinating environmental considerations to financial realities. The interview extract included below shows that from this perspective, environmental information could influence organisational action only on condition that the proposed action was financially advantageous.

> To be honest I sometimes wonder what is the meaning of all this. Because the financial side is linked to this, sometimes environmental demands or ambitions are not priority number one, after all the financial side is the guideline…

– What about the importance of product origin?

> Well yes, it's more and more important, the customer must have a choice, it's an important choice for the customer, we do not value whether the pig comes from Denmark or Sweden or Germany…

– And what about means of transportation?

> ..we have a comprehensive view on logistics, full trucks… its financially and environmentally advantageous…

Following this market logic, special emphasis was put on listening to the customer and meeting their needs (food wholesalers, local authorities, global catering chains etc), thus making environmental information only relevant when required by customers. Moreover, using environmental information was perceived as a food safety issue, thus highly limiting the scope of consideration by focusing on the absence of chemical residues, bacteria or other unwanted contents as specified in the Swedish Food Act. Another aspect accentuated within the financial perspective was to make transportation as environmentally benign as possible. Transportation made it possible to intertwine financial (i.e. transport costs) and environmental considerations, thus making it a relevant issue within a cost-revenue framework. Finally, from this perspective, using environmental information meant to trust the judgement and expertise of others. Purchasers representing the financial perspective depend on environmental information from their suppliers. They trust this information and base their business relations on supplier statements.

The regulatory perspective

The regulatory perspective was found among persons who worked in public purchasing departments run by local authorities or county councils. When using environmental information in the process of purchasing food they focused on regulations. They expressed the view that they would like to use environmental information to a greater extent when purchasing food but that this contravened Swedish public purchasing laws. For them, using environmental information when purchasing food meant following rules and guidelines.

Swedish public purchasing laws prohibit discrimination against products. This regulation is a major impediment to the use of environmental information in the process of public food purchasing.

> there is pressure from the politicians to purchase locally produced products, something which we cannot do according to the Act on public procurement

–What type of environmental information do you use when purchasing food? Do you discuss ways of production?

> No, we are not allowed to according to the law on public purchasing

… do you consider the origin of food products?

> We discuss it but there is a law about public purchasing that does not allow discrimination of any kind

- Does this mean that if a product is considered a good one you purchase it even if it comes from a place far away?

> We have to

This aspect was central for those representing the regulatory perspective. Regulations not only determine the way food is purchased in the public sector, but political guidelines can exert a great influence on the local and regional level.

Within this perspective trusting the judgement and expertise of others was accentuated when dealing with environmental information. Those purchasers representing the regulatory perspective relied on the environmental expertise of others, suppliers or environmental experts. The regulatory perspective emphasised the aspect of food safety understood as the absence of chemical residues, bacteria or other unwanted contents as specified in the Swedish Food Act. Representatives of the regulatory perspective have been involved in active environmental transportation adjustment and as a result they tended to consider making packaging and transportation as environmentally benign as possible an important environmental aspect.

The demand compliance perspective

Interview subjects representing the demand compliance perspective worked in commercial catering chains. When using environmental information in the process of purchasing food they focused on demand compliance. Their use of environmental information reflected demands coming from relevant authorities and consumers. For them, using environmental information when purchasing food means listening to customers and consumers.

From this perspective the financial situation of business is dependent on goodwill towards both guests and responsible authorities, i.e. clients.

– Do consumers have any opinions concerning your products?

> Yes, ….you get comments, it so happened that we served crayfish once…, we shouldn't have done that,… what a mess because people had opinions about this,….. there are a lot of opinions about farmed salmon or cod….
>
> …we try to have a clear environmental profile…, and that's what the University demands that we as subcontractor have…., given the current price level we do not have the possibility to purchase only organic alternatives …., but we try to have an overall environmental profile

– What about BSE?

> Well first, there were demands from the public sector that we had to do something about it, and before that we had demanded that all our authorised meat suppliers signed a certificate to verify that they could account for the origin of every part of the meat and that the meat did not come from countries that had had BSE some time during the last 36 months
>
> the cod discussion started, and we decided not to sell cod…, we tell the consumer that we want to protect the existence of cod, …and it became too expensive to serve…..given the shortage and the rising price level we had a hard time keeping our fish budget…

Within this perspective environmental information is relevant as a way of meeting the demands of customers. That is, it operates within market logic and sees environmental information as a way of meeting demands from customers. This means that environmental information is most relevant to them when it can operate within the framework of customer satisfaction.

Following market logic, environmental information is used to comply with demand within certain financial limits. In other words, it is important to make financial adjustments, linking the use of environmental information to a commercial reality. Another aspect of the use of environmental information within the demand compliance perspective is to examine suppliers in an effort to attain

certain environmental guarantees. From the demand compliance perspective, food safety is perceived not only as legal compliance but as active prevention of dissatisfaction on behalf of diners and relevant authorities. The meaning of environmentally benign packaging and transportation is a reflection of the focus on compliance. Making packaging and transportation as environmentally benign as possible is central from an environmental point of view on the condition that diners/relevant authorities regard these matters as important. Finally, the aspect trusting the judgement and expertise of others means here to rely on the environmental expertise of others, suppliers or environmental experts.

The quality control perspective

Interview subjects representing the quality control perspective worked in national retailing. When using environmental information in the process of purchasing food they focused on documentation. Their use of environmental information reflects their ambition to attract, satisfy and retain customers. As the following interview passage illustrates, for them using environmental information when purchasing food means to document the quality of food.

> nearly 80% of all x products are included in our own X control program…if we sell them in our own bags the quality is guaranteed and we even write on the bag that there are no pesticide residues in this product…, we have a comprehensive programme for defining and choosing what field to sow…, we analyse the soil, we choose the fields, we sow and we harvest, we analyse the products when harvested….we wash them…, we cultivate according to the Euro-gap model….this is what we do and it's a conventionally cultivated product. We buy organic X products…but we do not have a clue what's in the product…because we cannot control the soil…we do not know if the product absorbs Y more than it should have done, there are no limits for Y…, so I'm not sure an organic X product is better for one's health than an conventional one, our X products are guaranteed to be good for your health, but with the organic one we do not know because the KRAV- organisation does not specify…

> according to our opinion there is only one environmental label and it's the KRAV-label…., then we say that all organic products must be Krav-labelled and we even demand that the certification of imported KRAV-products must be done by an accredited certification organisation.

For these purchasers, the documentation of product quality is central to the use of environmental information. This documentation can be undertaken by the organisation or by the KRAV-organisation. Thus in the documentation of quality, the work with third party certification schemes are an important ingredient.

The focus on documentation clearly accentuates certain aspects of using environmental information and makes a focus on food and product safety particularly important. Food safety is perceived not only as law compliance but as

active prevention of dissatisfaction on behalf of consumers. Furthermore, within this perspective the act of examining suppliers and forwarding environmental demands to them is an essential aspect of using environmental information, thus emphasising the relational aspects of their work. The quality control perspective also means that a special emphasis is placed on making packaging and transportation as environmentally benign as possible. Packaging and transportation are central from an environmental point of view on the condition that consumers regard these matters as important.

Perspectives and frameworks of interpretation – Organisational characteristics and the system-actor relationship

As the analysis shows, there are four different perspectives on the use of environmental information held by different actors in the food system. While the financial perspective focuses on cost, the regulatory perspective puts its focus on regulation. Similarly, while the demand compliance perspective is mainly preoccupied with meeting customers' demands as they perceive them, the quality control perspective is focused on documenting the quality of food.

These different perspectives change how environmental information is perceived, creating a fragmented communication system where information is interpreted and reinterpreted between different actors in the food system. This line of thought can be illustrated by comparing one aspect of environmental information – food safety – across perspectives. Purchasers representing the financial and regulatory perspective perceive food safety as an essential quality issue focusing on the absence of chemical residues, bacteria or other unwanted contents specified in the Swedish Food Act. In contrast, purchasers representing the demand compliance and quality control perspective perceive food safety not only as law compliance but also as active prevention of dissatisfaction on behalf of consumers and clients. Consequently, in this latter case, purchasers not only want to prevent dissatisfaction through the elimination of unwanted substances, but they also work to promote customer satisfaction through labels and information. In comparison to the financial and regulatory perspective, food safety is here perceived and handled in a more proactive manner.

What the perspective analysis shows is that the different perspectives are moulded or constructed in relation to both the position of the actor in the food system and the nature of the organisation in which the actor is situated. This two-dimensional influence constructs the framework of interpretation that these actors then use to evaluate environmental information. The example concerning food quality presented above illustrates that the perception of environmental information by one actor in the food system is affected by perceived claims from other actors in the system. Environment-related information is considered to be crucial when it contributes to sustain business relations between food producers/whole-

salers and their clients (public/commercial catering and food retailers) on the one hand, and between food retailers and households on the other. At the same time there is a connection between the different perspectives. The financial perspective and the demand compliance perspective can both be described as part of general market logic. Both the focus on cost/revenue and customer satisfaction can be traced to mainstream economic thought prevailing in society in general and the business community in particular. On the other hand, the regulatory perspective and quality control perspective are both part of a governmental regulatory logic where market arguments, although still valid and incorporated, are not necessarily given primacy. These perspectives aspire to follow regulations and see the necessity of documentation as part of the regulatory system.

The relational position in the food system and the commercial/public dimension intertwine to create a fragmented environmental communication system where different environmental aspects are considered important in different ways. A close connection can be seen between the actor's position in the food system (guiding the relational aspects) and the public/commercial setting (guiding the goals of the organisation).

In the relation between food producer/wholesaler and their clients, practically no environmentally information is communicated. Environmental information is reinterpreted through the financial perspective of not being seen as important for financially advantageous business. This results in an interpretation of environmental issues/information as connected to costs rather than to investment. For purchasers representing the quality control perspective, the situation is completely different. In the relation between food retailer and Swedish households, environment-related information supporting the consumers' sense of safety and well-being is perceived as an investment in loyal consumers and good business. The focus on documentation reflects efforts (financial and other) to provide environment-related information that is in demand by retail consumers. The same pattern can be discerned when analysing the regulatory perspective (represented by public food service) and the demand compliance perspective (represented by global catering chains). Their focus on regulation and compliance reflects the perceived environmental claims made by clients and consumers.

For the purchasers representing the regulatory perspective, the most important criterion for their clients is law compliance. For purchasers representing the demand compliance perspective, environmental claims are perceived to be diverse. This is a consequence of conducting business with both corporate clients and governmental authorities.

Conclusions – explaining fragmentation in the food system

In conclusion, the analysis of purchasers' perspectives on environmental information clearly shows that environmental information is perceived differently de-

pending on where the purchaser is situated in relation to other actors in the food supply chain. Furthermore, these perspectives are influenced by the public or commercial context in which the organisation is situated. These structural forces intertwine and create different frameworks of interpretation in which distinctly different perspectives on the use of environmental information are developed. The different perspectives are thus the result of a combination of the system-actor relationship and organisational characteristic.

Environmental factors and purchasing decisions

A general aim with both these studies was to investigate how different types of environment-related information influenced product preference. One further aim was to test if more detailed environmental information would make environmental aspects more influential as regards product preference. The Elaboration Likelihood Model (ELM) suggests that if people are involved in a topic and willing to invest time and effort in information elaboration, more detailed information will have a greater impact (Petty et al., 1983). Since the degree of involvement in environmental issues and willingness to engage in the questionnaire were unknown, it was an open question whether more detailed information would result in more impact of these environment- related aspects.

Experiments are studies where researchers manipulate one or more independent variables (e.g. type or amount of information) to study if there are any causal effects on the dependent variable or variables (e.g. product preference). In between-subject designs, one control and at least one experimental group are created by use of randomisation. The latter group(s) is treated in exactly the same way as the former, except for the manipulation of the independent variable(s). Since the groups are equal before the manipulation is introduced, any differences in the dependent variable can be attributed to the independent variable (Schweigert, 1998).

In the first experiment, one of the manipulations was the introduction of a simple eco-label system that indicated environmental consequences much better or worse than average. The second experiment included an appeal either to choose environmentally friendly or the cheapest alternative. In both experiments the dependent variable was preference for an alternative of either minced beef or fresh apples.

Three environmental aspects were targeted: (1) Energy, defined as the total amount of energy used; (2) emission of greenhouse gases, defined as emission of gases transformed into carbon dioxide equivalents that contribute to climate changes on earth; and (3) pesticides (and other chemicals), for example biocides, insecticides, pesticides and herbicides. These aspects were chosen since they represent different sorts of influence on the natural environment.

The numerical values to express these values represented the total 'amount of' the measured factor used, or produced, during the product's entire lifetime. For example, the total amount of energy used, or greenhouse gases produced, during the entire lifetime of one kilogram of apples. Life Cycle Analysis (LCA) is the technical term for the analysis of the total environmental impact of a product or service. Finally product price was presented. This referred to the price at the supplier. All values referred to production and consumption of one kilogram of the product in a life cycle perspective.

Participants were informed that a number of pairs of products would be presented and their task would be to indicate their preference within each pair. The three LCA variables, use of energy, emission of greenhouse gases and use of pesticides, were assigned values either 90% above or 90% below each parameter's mean value. These means were obtained from experts in Life Cycle Analyses. Values assigned to the price variable ranged from 7% above to 7% below the mean supplier price.

Two alternatives of each product were presented together with information about values for the four variables presented above; see Figures 2.2-2.5 below. By a systematic variation of these values it was possible to study the relative importance of the four aspects (energy, greenhouse gases, pesticides, and price) on product preference.

Data were collected by use of questionnaires distributed by traditional mail via the Internet. A total of 170 professional purchase managers were contacted and asked to participate. About 50% participated in one or more parts of the study. In the first experiment, the product studied was minced beef (10% fat). In the second survey, fresh apples were examined.

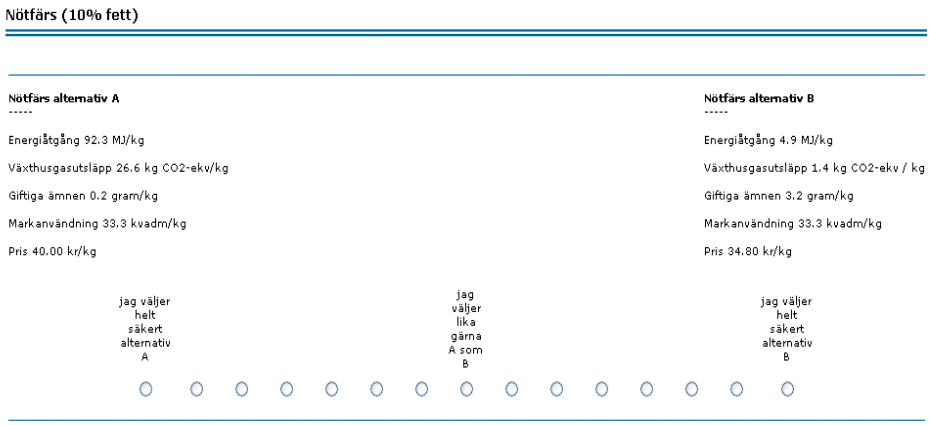
The first experiment – impact of simplifying signs

In the first study, the experimental group was exposed to a simple labelling system. A plus (+) sign indicated an environmental value that better than average, and a minus (-) sign that environmental consequences were worse than average for the factor and product in question. In Figure 2.2 a scenario presented to the respondents in the control group is displayed. As can be seen, only numerical LCA based information was presented. In Figure 2.3, the same scenario is displayed, but now plus and minus signs are added to signify whether a numerical value indicates an outcome better or worse than average.

Respondents were asked to indicate their product preference on a 15-point scale anchored on 'I would definitely choose alternative A' (jag väljer helt klart alternativ A) (1)/ 'I would definitely choose alternative B' (15) (jag väljer helt klart alternativ B). The midpoint of the scale (8) was defined as 'I could just as well choose A as B' (jag väljer lika gärna A som B).

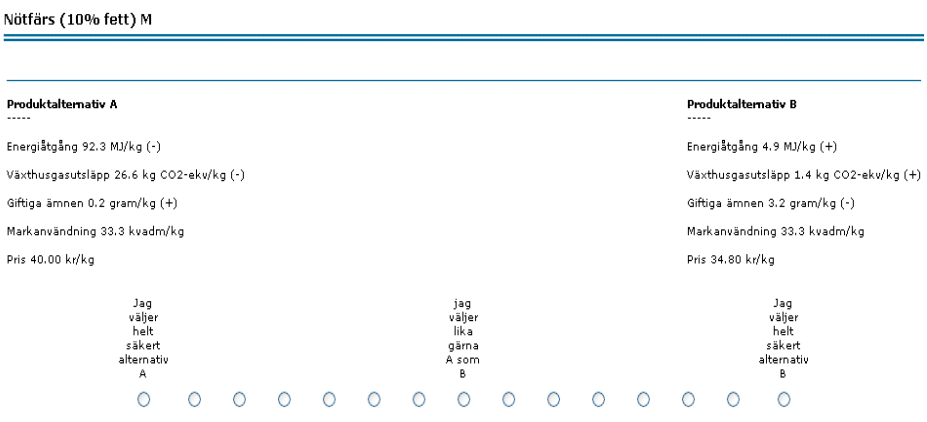
Data showed that price had a larger influence on product preference than

Figure 2.2. One of 16 situations in total presented in the first experimental study. Minced beef (nötfärs) (10% fett). The two alternatives A and B, and LCA-based values for the environment-related parameters. Use of energy (energiåtgång), Emission of greenhouse gases (växthusgasutsläpp), Pesticides (giftiga ämnen), and price (pris).



any of the three environment-related aspects. This was true despite the fact that price only varied +/- 7% around the mean, while the three environmental aspects varied as much as +/- 90% around their corresponding mean values. The use of pesticides had a larger effect on product choice than use of energy or emission of greenhouse gases. The introduction of the simple two-level labelling system re-

Figure 2.3. The same situation as in Figure 2.2 is presented, in this version, however, plus and minus signs have been added.



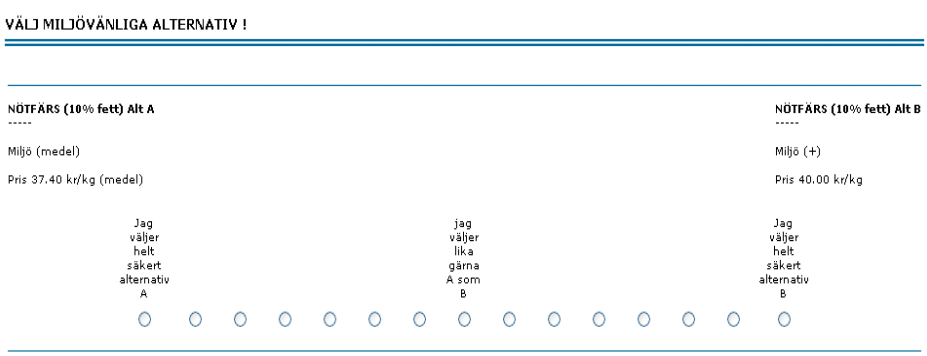
sulted, as hypothesised, in an increase in the effect of environment-related aspects. For minced beef it was use of energy, and for fresh apples emission of greenhouse gases that became more influential on product preference as a consequence of the plus/minus sign label system.

The second experiment – including LCA-based information

In the second study, effects of an appeal to choose environmentally friendly or the cheapest alternative were studied. These appeals should correspond to a company emphasising either environmental or economic concerns. Furthermore, environmental consequences were presented on one (see Figure 2.4) or three dimensions (see Figure 2.5). In the former condition, there was no numerical information, but a plus, minus or mean sign was presented. The plus and minus signs worked as described above, mean indicated environmental consequences that were between better and worse than average. In the latter three dimensional case, numerical LCA-based information, as well as the three level eco-label system with plus, minus and mean, were included for each of the three environmental factors. This resulted in a 2 x 2 (choose environmentally friendly or cheapest x environmental consequences as one or three dimensions) between subject design, with four separate groups.

This experiment showed that if environmental consequences were presented in more detail, in three dimensions instead of one and with explicit numerical LCA-based information, these environment-related consequences became more influential on product preference. This effect of more detailed information is, as mentioned above, in the elaboration likelihood model (Petty et al., 1983) suggested to occur only if the audience or respondents are rather interested and willing to invest time and effort in the subject.

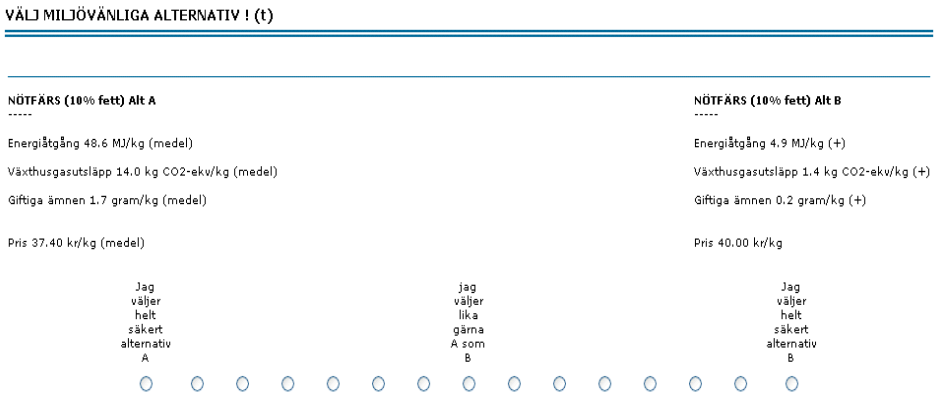
Figure 2.4. A scenario used in the second experiment. Respondents were requested to choose environmentally friendly alternatives. Environmental consequences were presented as one dimension (miljö).



The tendency that more detailed environmental information implied more influence on product preference was stronger in the try to minimise economic cost condition. That is, in a company where low costs are strongly emphasised, more detailed environmental information could be necessary to make environmental aspects more influential.

Furthermore, it was found that information about negative environmental consequences was more influential than information about positive environmental consequences. This result is in line with research on consumer reactions to negative and positive environmental information (Grankvist et al., 2004). It is also in line with the more general result in psychology that negative information is more influential than positive information. For example, bad impressions are quicker to form and more resistant to disconfirmation than good ones (Baumeister et al., 2001). These researchers suggest that in order to survive, attention to possible negative outcomes could have been more important than attention to positive outcomes.

Figure 2.5. The same scenario as was presented in Figure 2.4. Now environmental consequences are presented as three dimensional and LCA-based numerical information is added.



Conclusions – the dominance of price

In line with results from the initial interview study as well as other studies, (e.g. Preuss, 2005), product price was found to have a larger impact on product preference than environment-related factors such as pollution caused by production of the product. These results paint a rather bleak picture of the price versus environmental protection struggle. Environmental considerations could be rated as important, but only as long as the cost is low or not taken into consideration. In a conflict situation, product price seems to be the constant winner.

On the positive side, the way in which environmental consequences are presented makes some difference for how influential environmental information is on product preference. The following combination seems to be the most influential: Environmental consequences are presented as multidimensional, numerical LCA-based information is presented for each of these dimensions and a simple eco-label system is used to indicate if a numerical value implies an outcome worse or better than average.

Constructing purchaser roles – professionalism and the use of environmental information

The purpose of the second interview study was to further explore the purchasers' view of environmental issues and the use of environmental information. This included both general issues and assessment of specific environmental factors. Special emphasis was placed on investigating their personal prioritisation of environmental issues.

Participants in the second interview were professional purchasers in the food system and included wholesalers and retailers from the category 'Food Distribution' as well as public and commercial caterers from the category 'Food Catering'. In this enquiry, interviews focused on purchasers in different positions within the companies and not exclusively purchasers in procurement departments as in the initial interview study. Furthermore, all purchasers in the second interview study had participated in the experiment and some had also participated in the initial interview study. Seventeen interviews were carried out using a structured interview guide. Fifteen of these were conducted by telephone and two at the respondents' work-places. The interviews lasted 40-60 minutes, were tape-recorded and transcribed in full. The interview guide covered different environmental topics and addressed issues such as current environmental concerns, environmental policy and the benefit of using environmental labelling. Furthermore, opinions about the three specific environmental factors included in the experiment were explored. Finally, the respondents were asked to rank the environmental factors preferred to obtain environmental information about. In addition, a certain degree of flexibility was sought in the interviews, allowing respondents to answer either as private persons or as professional purchasers.

Seller and buyer orientated purchasers

When analysing the results, two main categories of purchasers were identified; Seller-orientated purchasers (found among wholesalers and retailers) and buyer-orientated purchasers (found among food managers from public and commercial catering). The two categories represent two distinctively different purchaser roles,

each with a specific focus affecting how they perceive and evaluate environmental information.

In the following sections, an account of these different roles, their focus and aspects related to them, is presented. The aspects discussed are to be seen as qualitative differences when it comes to perception and use of environmental information between the two different categories of purchasers.

The seller-orientated purchasing role

The seller-oriented purchasing role (found among wholesalers and retailers) is primarily constructed within the market framework, granting economic criteria a privileged status. This means that the role of purchaser and the idea of professionalism itself are closely linked to market logic. Consequently, purchasers' opinions of environmental information are shaped by economic criteria, constructing a decision framework guided by economic norms. One expression of this characteristic is the particular emphasis placed on working according to correct business practice as the quote below illustrates:

> *IP 3*: We have a common policy for environment and business assurance ….saying we shall deliver good and service claimed by our customers' expectations…all in a holistic businesslike way…actively working together with customers, owners, employees and suppliers actively environmental and business assurance.

The focus on economic criteria also manifested itself in the reinterpretation of environmental concerns as cost issues. The seller-orientated purchasers understood the environmental factor 'use of energy' primarily as a cost driving factor, thus allowing it to be incorporated into the market logic guiding decisions. Similarly, seller-orientated purchasers argued that environmental labelling must produce added value for the consumers and pointed out that the environmental friendly food assortment is small, and can be offered only to a special group of customers, thus translating environmental labelling into a revenue and customer satisfaction issue.

> *IP 6*: The environmental labelling has to make a value to the consumer, otherwise it is worthless

As the discussion illustrates, the role of a seller-orientated purchaser is constructed drawing on market logic accentuating business practices, cost and customer satisfaction. This produces a specific interpretation of what it means to use environmental information as part of being a purchaser. It creates a market-influenced decision-making framework closely tied to an idea of professionalism, which renders environmental information a secondary consideration. Furthermore, this professional role construction is often at odds with the purchasers' personal values, i.e. when acting out their professional roles they often act in contradiction with

personal environment-related beliefs. This contradiction is seldom experienced as the role of professional purchaser is seen as separate from the private sphere. When actors perceive or are confronted with this contradictory situation, two mainly different practices are employed aiming at resolving it: the incorporation of environmental consideration or the reallocation of environmental responsibility. These strategies are not mutually exclusive and can be combined as the following interview abstract demonstrates.

It is interesting to talk about how individuals act differently?

> *IP 17*: Yes, it is individual, purchasers are a human person.. some are like me (environmentally responsible) and some mostly go for the price,
>
> The difficulties, I believe, are that the purchasers are experts on price, ..and others are experts on environmental issues, and they are seldom the same person…that's why one uses environmental certification systems, ..for example using EurepGap production…so we are working with the quality and the environment ..but not towards the purchasers….we just want to say this is good. EurepGap is a good system, we are only to use EurepGap, and the purchasers need not to worry about any amounts (of residues). Working with the subjects you have brought up here is never done in purchasing.

Here the purchaser demonstrates the incorporation strategy when referring to his own conduct in which he seems to balance price with environmental concern, i.e. he incorporates what he perceives as his own personal environmental concerns into the professional role of a purchaser. As the example above illustrates, this particular purchaser also employs the reallocation strategy. Within this strategy responsibility for environmental issues is reallocated from the role of purchaser to other instances (for example departments) or systems. This latter strategy was also observable in other interviews where purchasers argued that individual possibilities to act pro-environmentally were of importance but that they themselves could not make environmental judgements on the organisational level. They believed that environmental decisions should be made by a specific environmental department within the organisation. As an extension of this strategy, purchasers expressed trust in company environmental policy as well as food legislation and limit control systems on national and international level.

The buyer-orientated purchasing role

While the seller-orientated purchasing role is primarily shaped within a market framework, the buyer-orientated purchasing role, as observed among public and commercial food managers, is constructed within a regulatory framework. This means that the use of environmental information and the idea of professionalism are closely linked to the aim of providing food quality. Purchasers in catering work

within a decision frame mostly influenced by food quality criteria and consequently deal with issues such as food classification, texture, appearance, taste and cooking capacity. The emphasis on food quality means that environmental issues are reinterpreted as food quality issues, thus enabling them to be incorporated into the regulatory framework. For the buyer-orientated purchaser, environmental criteria were often seen in opposition to food quality and the purchasers were of the opinion that the food quality of organic products added no premium value, compared to conventionally produced products. This is illustrated in the interview extract included below:

Talking about environmental criteria, what do you think is important?

> *IP 8*: I think quality is important

So?

> It has to be a fine product…and a fine product is…you can produce much environmental friendly but it looks bad and no-one will buy it, and no-one will eat it, then it does not matter

Do you mean environmental friendliness does not care about food quality?

> Yes

The issue of quality is central to purchasers' role construction. As an example, standing up for food quality was important among the purchasers in catering, although they submitted to legislation and decisions made at higher levels in the company.

What if you hypothetically worked in this procurement group and got information about use of energy (of the product), would it be interesting if you ignored the price?

> *IP 7*: Yes, maybe, it might be, I mean then one could compare the use of energy, but ..we cannot follow the use of energy when making procurement, because we ought to have made that demand from the very beginning, they should firstly be written in the specification of requirements.

Purchasers felt they were obligated to adhere to the company's environmental policy, which was not particularly related to food but generally to business. One purchaser said:

> *IP 15*: We are to reduce the discharge from the whole hospital, so it is about discharge from different things ..like medicines, laughing gas …and other gases…and we try all the time to use less electricity and water and the lot..

So this is what is included in the environmental policy?

Yes

Is there anything about food?

No I don't believe there is

As the discussion illustrates, here the strategies of incorporation of environmental values and reallocation of environmental responsibility are also used to cope with the discrepancies between personal values and the professional purchaser role, although slightly different in this context. In their roles as professionals, buyer-orientated purchasers perceive their actions as regulated by different structural aspects out of their control, such as food legislation and limit control systems. These structures effectively delimit their possibility to incorporate environmental concern into their role as purchasers, simultaneously shifting environmental responsibility to other actors, such as government authorities or other departments in the organisation.

Talking about all these aspects of the environmental friendly food, would you say more about it?

> ***IP 1***: Much can be said when you start thinking…how food is produced, the transportation, how humans treat both animals and crops, and how humans are treated also, ..a lot of alarming reports are coming.. . you should not eat bananas, they are much poisoned and all workers get cancer, yes there are many examples..

Yes…

> And, unfortunately you cannot bring everything to work, there are procurements guiding and probably including some environmental demands, even if they don't notice them, I don't know…and once the procurement documents are signed one is forced to buy from them. One can make a few choices, sort of environmental labelling, …but the choice must not be bad quality and also the money firstly makes the limits, …our saving costs is really guiding.

As this interview extract demonstrates, buyer-orientated purchasers were aware of numerous environmental problems. However in their role as professional purchasers, they were constrained by organisational structures and were unable to incorporate personal environmental values into their purchasing decisions. Instead they expressed trust in food legislation and its limit control systems and argued that their possibilities to make environmentally friendly purchases should be organised by the procurement department.

Conclusions - role construction and the private/professional distinction

The results from this second interview study show the importance not only of organisational culture, but also of role construction among professional purchasers. The results showed that the purchasers seldom considered food-related environmental issues in their everyday business. An in-depth interpretive analysis presents a complicated picture in which both the perception and use of environmental information are shaped by ideas of professionalism. Two separate purchaser roles were identified. The seller-orientated purchasing role, found among wholesalers and retailers, is built mainly by drawing from a market framework, thus making economic criteria central to the interpretation of environmental information and its use. On the other hand, the buyer-orientated purchaser, found among wholesalers and retailers, is constructed by drawing from the regulatory framework, making food quality of central importance to the interpretation of environmental information. Furthermore, purchasers perceived a number of environmental problems and tended to be concerned for the environment on a personal level. However, as a result of the distinction made between the private and professional sphere, these values were seldom allowed to be incorporated into their purchasing behaviour.

From these results, three main conclusions can be drawn. Firstly, as professional purchasing roles are shaped by market and regulatory frameworks, attempts to incorporate environmental information in the purchaser role are muted in these dominant frameworks by means of translation. Secondly, the structural systems in place, most predominantly within the regulatory system, constrain the ability to incorporate environmental concerns. Thirdly, as the private and personal spheres of life are seen as separate and as they rely on different logic, environmental responsibility on a personal level can only with difficulty be incorporated into the professional domain.

Chapter summary

These three studies present a complex picture of the perceptions and use of environmental information in the Swedish food system. Four different ways of perceiving the use of environmental information emerged from the initial qualitative analysis: the financial perspective, the regulatory perspective, the demand-compliance perspective and the quality control perspective. Environmental information is reinterpreted within each of these perspectives to fit the dominant framework. Different positions within the system create contexts in which distinctly different frameworks of interpretation are built and maintained. The different perspectives developed are thus a combination of organisational characteristics and relational position to other actors. The result is a fragmented food system in which environmental information is not easily communicated.

The experiments show that in regard to environmental information, symbols (- and +) are more effective than figures related to environmental aspects. However, symbols in combination with figures (LCA information) seem to have a stronger effect when choosing more environmental friendly products than when used separately. If environmental information is related to economic factors in financially harsh times, different dimensions of such information seem to be considered in decision situations compared to the overall concept of 'environment'.

The second line of interviews demonstrates that the construction of professional purchasing roles has a great impact on how environmental issues are perceived and treated. The seller-orientated purchasing role (found among wholesalers and retailers) is mainly built by drawing from a market framework, while the buyer-orientated purchaser (found among wholesalers and retailers) on the other hand is constructed by drawing from the regulatory framework. These constructions of professionalism guide decisions in different directions and impede to a great extent the incorporation of privately-held environmental values.

From the three studies reported in this chapter, two main conclusions can be drawn. Firstly, product price is much more influential on product preference than environment-related factors such as pollution caused by production and consumption of the product. Economic criteria dominate the reasoning, and environmental information is not seen as important for economically advantageous business. Secondly, different interpretive frameworks constructed drawing on different systems of thought shape perceptions in the food system. These different interpretations of environmental information and the translation of meaning from one actor to another that they imply makes communication in the food system a complex matter.

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Chapter 3

Environmental assessment of foods – an LCA inspired approach

Charlotte Lagerberg Fogelberg and Annika Carlsson-Kanyama

In order to make decisions that lead to decreased environmental impact from foods, it is essential to have access to multifaceted information covering all relevant parts of the food supply chain. The information supplied by this project can be helpful for purchasing managers seeking to take more environmental responsibility, as well as for policymakers aiming to devise strategies for lowering environmental impacts from the food system. The objective of this study was to address differences in the environmental profiles (i.e. differences in environmental impacts) of products of different origins and processing levels. In addition, inclusion of protein sources from both plant and animal origins allowed for further discussions on dietary choices. The products for environmental assessment were thus chosen to represent both animal and vegetable products, fresh and preserved. Broccoli, carrots, onions, tomatoes, legumes of different kinds and chicken were selected for this project[5]. Case studies of some of these products have been performed previously (e.g. Carlsson-Kanyama, 1998, 2002; Lagerberg & Brown, 1999; Mattsson, 1999; Widheden et al., 2001). However, expanding and improving current knowledge on these products was also an important objective addressed by the choice of products.

In this study we used a collection of parameters that highlighted different aspects of potential environmental impacts associated with the products in focus. Thus parameters associated with fuel use, greenhouse gas emissions (resulting from e.g. fuel use and animal rearing), water use, use of chemical agents (resulting in potential toxic effects), land use (for primary production) and transportation work were addressed and included in the environmental assessments.

5. As additional data forming the basis for environmental assessments is still coming in, a selection of results are presented in this report. For final and complete environmental assessments, please see forthcoming publications in scientific journals and reports.

Environmental assessments from different studies are in general not completely comparable due to for instance different time and space boundaries of the systems in focus. The resolution, i.e. the amount of detail, may also be different in that some matters may be included in one study while ignored in another. The results presented in this chapter are not fully comparable, mostly due to differences in system boundaries and differences in functional units. Consequently, while some results are presented per kilogram product delivered to the wholesaler or catering unit, other results are presented per weight delivered to a private household. In the studies of broccoli, chicken and legumes, case-specific data are complemented with literature studies, while the studies of carrots, onions and tomatoes draw more on site-specific data from producer interviews. For this reason this chapter is divided into two main sections, of which one section deals with carrots, onions and tomatoes while the other concerns broccoli, chicken and legumes. It is recommended that these sub-chapters be read as separate entities before considering what comparisons may be made between the different products.

Environmental assessments of carrots, onions and tomatoes

The purpose of this study was to assess whether and how purchasing managers can contribute to a more environmentally benign food system by choosing products of different origin. The improvement potential for the selected food products was also investigated. The food systems analysed encompassed primary agricultural production (farming), production and distribution of raw materials and energy carriers, processing of agricultural products, and delivery to the gate of a food wholesaler. Emissions to air, water and soil occur from all activities in the system and all activities of the system are supported by inputs of resources and fuels. (Figure 3.0)

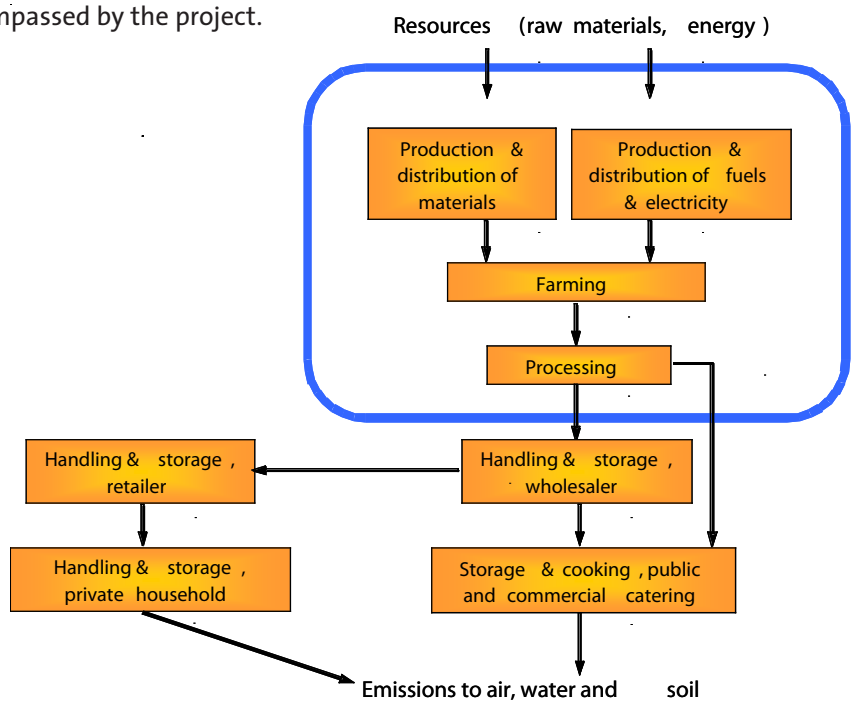
When analysing the systems, a number of delimitations and considerations came into play. Environmental profiles were performed for comparative purposes and therefore some processes which were considered to be identical were excluded from the systems studied.

Transportation between the different stages of the system was incorporated, as was storage until delivery at the wholesaler. In contrast, wholesale storage was not included as similar products were considered to be stored for the same time span, regardless of origin. Handling of waste throughout the system was not included in the studies except for inputs associated with waste handling on the farm and in the processing plant. Direct energy input for operating machinery and vehicles was included but process energy for manufacturing of machinery was disregarded. Economic allocation was generally employed when dividing resource flows be-

tween several products deriving from a single process. For instance, when sorting and discarding of products occurred, the flows of resources and their associated potential environmental impact were assigned in accordance with the economic relationship between the output products. The results were estimated on the basis of 1 kg of food product delivered to the wholesaler. The products were set to be delivered to a wholesaler in Stockholm, Sweden.

This project focused on purchasing managers of a wholesaler or a catering unit and the environmental study was thus designed to support decision making of purchasing managers in the wholesale and food service sector. The studies were then performed on systems which could be affected by the choices of the purchasing managers. The handling of a food product was considered to be the same regardless of origin. Thus transport, storage, cooking and other handling associated with the food product at the wholesaler and at the catering unit were not included. For the same reasons and because the stages downstream from the wholesaler are not affected by the decisions of purchasing managers of the wholesale and catering sector, handling of foods throughout retail and private households was not included in the study. Consequently, excluding the retail and private household from the environmental profiles of foods to be considered by purchasing managers of the wholesale and catering sector protected the decision support material from irrelevant and unreliable data.

Figure 3.0. Generic simplified systems diagram of the food systems encompassed by the project.



Environmental profiles of products, companies, industrial sectors and even entire countries can be assessed according to different formalised approaches and tools. Some tools focus on resource use, while others focus more on environmental impact. Several surveys of environmental assessment tools are available (e.g. Levett, 1997; Dale & English, 1999; Moberg, 1999; Moberg et al., 1999; IVF Industriforskning och utveckling AB, 2000; Ulgiati, 2000; Eriksson et al., 2001; Lagerberg, 2001; 2002). In this present study a collection of parameters that highlighted different aspects of potential environmental impact associated with the products in focus was used. Thus potential greenhouse gas effect, energy use, transportation distance from farm to wholesaler, potential toxic effects from the use of chemical agents, water for farming and processing, and land use for agricultural production were addressed. The potential greenhouse gas effect was measured by the global warming potential (GWP) based on greenhouse gas emissions associated with direct energy use on-farm and in processing, and indirect energy use in transportation, fertiliser production, pesticide production and production of packaging. The fuel supply chains were included when estimating energy use. However electricity was not converted to energy of primary fuels used for generation of electricity, nor were grid losses in distribution of electricity included in the assessments. Actors involved in the food supply chain were interviewed with regard to direct use of resources (such as use of fertilisers and manure) and energy carriers (such as natural gas or diesel). These data were used to estimate the collection of environmental parameters constituting the environmental profiles of the food products studied. These parameters encompass certain aspects of potential environmental impact, which may occur at many levels. For instance, changes in landscape appearance were not included in the environmental profiles.

The present methodological approach may be described as inspired by life cycle assessment (LCA) in the sense that food systems were analysed using a life cycle perspective for e.g. energy use and LCA models were used to estimate the potential global warming resulting from such use. However, we did not use the life cycle perspective for all types of resource use i.e. for all kinds of materials, nor did we address eutrophication according to the ISO standards (International Organization for Standardization, 1997; 1998; 2000a; b; Baumann & Tillman, 2004).

The use of chemicals was addressed using a 'red-flag' system based on properties of the individual chemicals. The red flag indicates that there may be cause to expect greater potential environmental impact from use of that product. Acute toxicity, persistence, ability to cause cancer and ability to disturb reproduction were assessed in accordance with a model proposed by Berntsson (Carlsson-Kanyama, 2005). Other reasons for red-flagging may be that the chemical is prohibited in Swedish agriculture according to the Swedish Pesticides Register (Kemikalieinspektionen, 2005). The criteria for red-flagging in this study were more extensive than those used previously in Cederberg (1998), who used prohi-

bition in Swedish agriculture as an aggregated criterion for red-flagging. General lists of approved chemicals within e.g. the European Union are very similar to each other but provide very little information on the potential risks associated with the actual case product in focus. The red-flagging in this section is based on actual amounts and substances used in the cases studied.

Carrots in Sweden

The Swedish per capita consumption of fresh carrots is 8.3 kg per year (2002; Jordbruksverket & Statistiska centralbyrån, 2004) and the degree of self sufficiency is about 92% (2002; Jordbruksverket, 2005). Fresh carrots of domestic origin can normally be supplied for 11 months of the year, with import peaking during spring and summer. Carrots are imported from European countries and major trading partners include The Netherlands, Italy, Germany and Denmark.

The Swedish climate is very favourable for carrot production. Carrots are sown in the field continuously from late March to mid June and are harvested in early July to late October. Carrots for fresh consumption are stored and packed on demand from the end of July until the end of June the following year. The results presented are based on data from an integrated packing company (which also grows the carrots) and a company processing cut frozen carrots. This data is considered to be of high quality.

Fresh carrots

Results are presented in Table 3.0. The carrots were stored at the packing facility, meaning that inputs associated with the storage are included in the packing stage. In order to protect the identity of the company supplying data the distance from packer to wholesaler was set to 400 km, which is reasonable considering the distribution of packers in the country.

The sorting, washing and packing of carrots dominated the energy use and consequently the potential greenhouse effect measured by the global warming potential. However, transportation represented the same order of magnitude as the agricultural production stage. Almost 40% of the farm global warming potential was contributed by the use of fertiliser. In this region irrigation is hardly ever needed, so the water use was by far dominated by the packing stage.

Frozen carrots

The carrots for processing were grown in Sweden and stored on the farm before delivery to the processing plant. In order to protect the identity of the processing company, the transportation distance from the company processing the frozen carrots to the wholesaler was set to 530 km. Storage of the frozen product is included in the processing stage.

Table 3.0. Environmental profile of carrots for fresh consumption, Sweden. Results are given per kilogram of carrots at the wholesaler

	Farm	Packing	Transportation	Total
Global Warming Potential (kg CO_2 equivalents), 100 years	0.018 26%	0.032 46%	0.019 28%	0.069 100%
Energy use (MJ): Fuels	0.21 11%	1.4 75%	0.26 14%	1.61 100%
Electricity	0.013 2%	0.76 98%	0 0%	0.77 100%
Transportation distance (km)	Not applicable	Not applicable	400	400
Chemicals red-flagged (number and reason)	No	No	Not assessed	100%
Water use (litres)	0.02 3%	0.69 97%	Not assessed	0.71 100%
Land use for agricultural production (m^2)	0.22	Not applicable	Not applicable	0.22

Results show that the processing stage dominated over the farm stage and the transportation as regards all parameters estimated. The energy use and potential global warming of the processing stage was about ten times that of the farm stage. However the global warming potential from transportation exceeded the farm stage by a factor of two. The fertiliser use contributed almost 40% of the farm global warming potential (Table 3.1).

Table 3.1. Environmental profile of frozen cut carrots, Sweden. Results are given per kilogram of frozen carrots at the wholesaler

	Farm	Processing plant	Transportation	Total
Global Warming Potential (kg CO_2 equivalents), 100 years	0.023 9%	0.195 73%	0.049 18%	0.267 100%
Energy use (MJ): Fuels	0.25 6%	3.58 80%	0.67 15%	4.5 100%
Electricity	0.34 11%	2.72 89%	0 0%	3.1 100%
Transportation distance (km)	Not applicable	Not applicable	670	670
Chemicals red-flagged (number and reason)	no	no	Not assessed	100%
Water use (litres)	0.02 0%	21 100%	Not assessed	21 100%
Land use for agricultural production (m^2)	0.26	Not applicable	Not applicable	0.26

For comparison between frozen and fresh products it would have been desirable to include the storage at the wholesaler and catering unit. Alas, the models available were developed for household storage (Sonesson et al., 2003) and, as pointed out by the authors, are not valid for storage in catering units. However, frozen products are expected to be stored very briefly at the wholesaler. The turnover time of frozen foods at the catering unit is also expected to be short. Consequently the additional potential environmental impact of this freezer storage is not expected to greatly affect the results.

Carrots in the Netherlands

The production system of carrots in the Netherlands is very similar to the Swedish one. Sowing take place from mid May and the carrots are harvested until October - November. The farms growing carrots are usually situated close to the packing company. The carrots may be stored either on the farm or at the packer.

Fresh carrots

In this case the carrots were stored at the packing company, which was situated about 15 kilometres from the farm. The potential global warming was dominated by the transportation step, whereas the energy use in the farm and packing stages respectively both exceeded the energy used by the transportation step (Table 3.2). The water used was mainly for irrigation in growing carrots. The fertiliser use contributed about 70% of the farm global warming potential. Pesticides containing linuron and iprodione respectively were red-flagged.

Table 3.2. Environmental profile of carrots for fresh consumption, The Netherlands. Results are given per kilogram of carrots at the wholesaler

	Farm	Packing	Transportation	Total
Global Warming Potential (kg CO_2 equivalents), 100 years	0.040 26%	0.044 28%	0.071 46%	0.155 100%
Energy use (MJ): Fuels	1.2 32%	1.5 41%	0.98 27%	3.6 100%
Electricity	0.016 4%	0.38 96%	0 0%	0.40 100%
Transportation distance (km)	Not applicable	Not applicable	1467	1467
Chemicals red-flagged (number and reason)	2; carcinogenic, disturb reproduction	No	Not assessed	
Water use (litres)	0.94 76%	0.29 24%	Not assessed	1.2 100%
Land use for agricultural production (m^2)	0.18	Not applicable	Not applicable	0.18

Figure 3.1 shows comparisons between the carrot systems investigated.

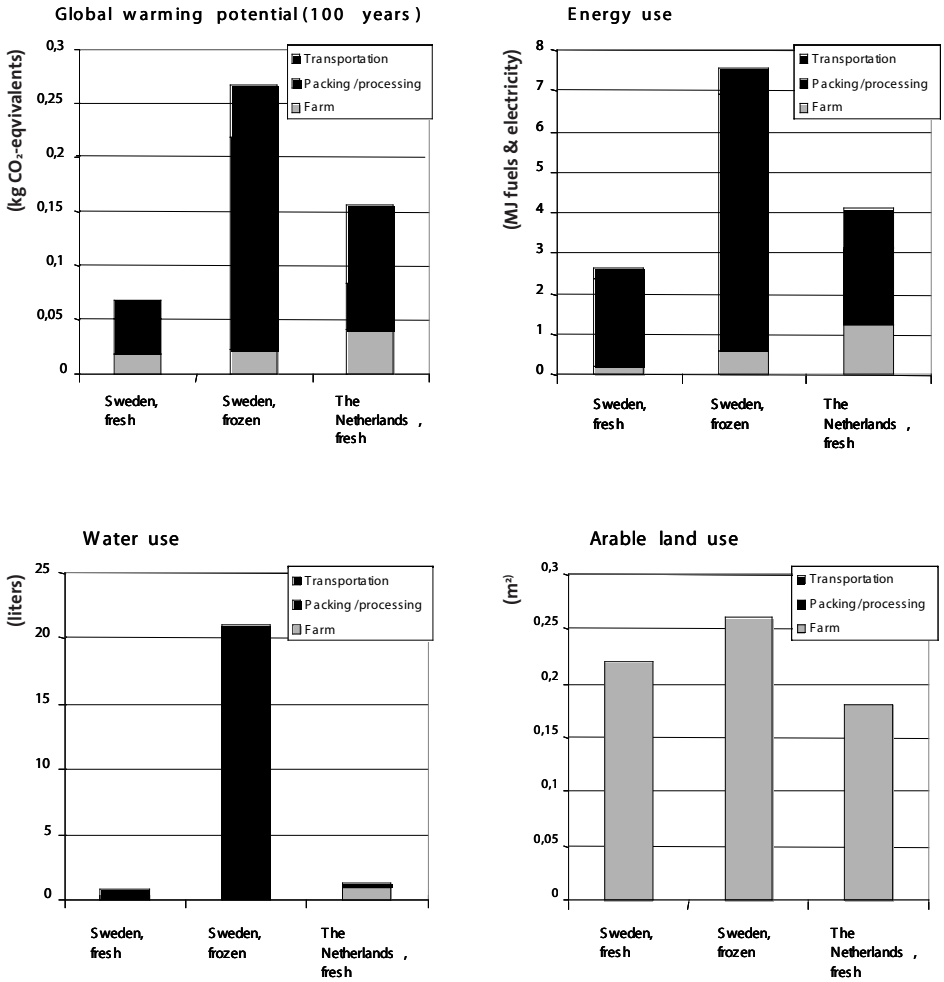


Figure 3.1. Environmental assessment of carrot systems of different origins and processing levels. Results are given per functional unit, i.e. per kg carrots delivered to the gate of the wholesaler.

Onions in Sweden

The Swedish per capita consumption of fresh bulb onions is about 5.6 kg per year (2002; Jordbruksverket & Statistiska centralbyrån, 2004). The degree of self sufficiency is about 49% (2002, Jordbruksverket, 2005). Onions of domestic origin typically run out in May and thus supply depends entirely on imports dur-

ing summer and until harvest of domestic onions starts in September. Onions are imported mainly from European countries such as Denmark and the Netherlands but also from for instance New Zealand.

The farm growing onions in Sweden was integrated in the same company as the packing of onions. Storage takes place in the packing step. Results show that the agricultural production dominated the potential global warming, which reflects the use of fossil fuels and fertilisers, while transportation dominated over the

Table 3.3. Environmental profile of bulb onions for fresh consumption, Sweden. Results are given per kilogram of onions at the wholesaler

	Farm	Packing	Transportation	Total
Global Warming Potential (kg CO_2 equivalents), 100 years	0.039 57%	0.011 16%	0.019 28%	0.069 100%
Energy use (MJ): Fuels	1.1 69%	0.24 15%	0.26 16%	1.6 100%
Electricity	0.031 10%	0.28 90%	0 0%	0.31 100%
Transportation distance (km)	Not applicable	Not applicable	400	400
Chemicals red-flagged (number and reason)	1; potential risk for foetus damage	No	Not assessed	
Water use (litres)	22 100%	0 0%	Not assessed	22 100%
Land use for agricultural production (m^2)	0.19	Not applicable	Not applicable	0.19

packing step. The fertiliser use contributed about 60% of the farm global warming potential. The water use constituted water for irrigation and spraying. One pesticide containing ioxynil octanoate was red-flagged (Table 3.3).

Onions in Denmark

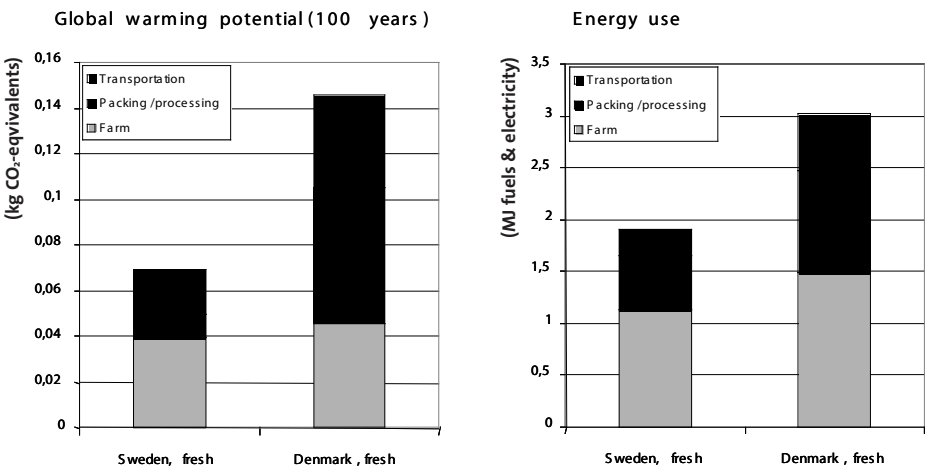
In the Danish case study, storage was included in the packing step. The onions were considered to be transported to trade terminals in Helsingborg and then to Stockholm.

The farm and transportation steps showed similar levels, while the packing step displayed somewhat higher global warming potential. The fertiliser use contributed about 75% of the farm global warming potential. The fossil fuel use was dominated by the agricultural production, while the packing step used more electricity. Water was used for irrigation and spraying. The same pesticide containing ioxynil octanoate as in the Swedish system was red-flagged. (Table 3.4)

Table 3.4. Environmental profile of bulb onions for fresh consumption, Denmark. Results are given per kilogram of onions at the wholesaler

	Farm	Packing	Transportation	Total
Global Warming Potential (kg CO_2 equivalents), 100 years	0.046 31%	0.059 41%	0.040 28%	0.145 100%
Energy use (MJ): Fuels	1.47 52%	0.79 28%	0.55 20%	2.8 100%
Electricity	0.020 10%	0.19 90%	0 0%	0.21 100%
Transportation distance (km)	Not applicable	Not applicable	818	818
Chemicals red-flagged (number and reason)	1; potential risk for foetus damage	No	Not assessed	
Water use (litres)	9 100%	0 0%	Not assessed	9 100%
Land use for agricultural production (m^2)	0.29	Not applicable	Not applicable	

Figure 3.2 shows comparisons between the onion systems investigated.



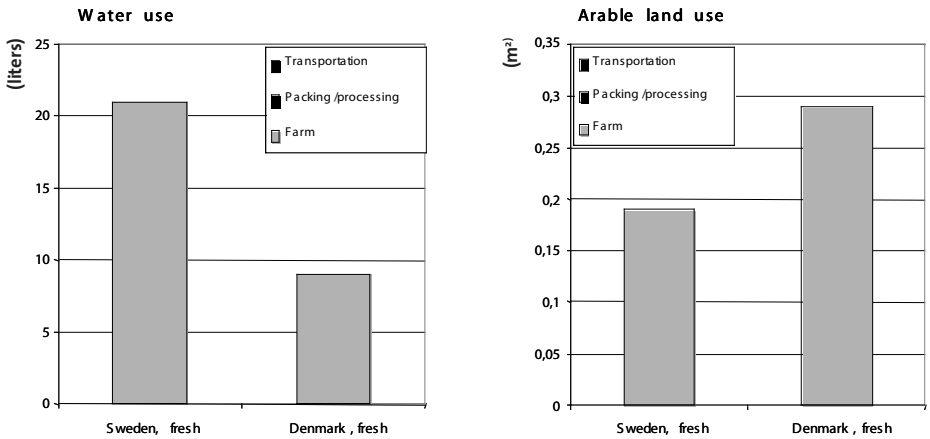


Figure 3.2. Environmental assessment of onion systems of different origins. Results are given per functional unit, i.e. per kg onions delivered to the gate of the wholesaler.

Tomatoes in Sweden

The Swedish per capita consumption of fresh table tomatoes is about 8.7 kg per year (2002; Jordbruksverket & Statistiska centralbyrån, 2004) and the degree of self sufficiency is about 22% (2002, Jordbruksverket, 2005). Domestic tomatoes can be found on the market from early March until late October-beginning of November. During the winter, consumption depends entirely on imports but imported tomatoes can be found all year round. Tomatoes are mainly imported from Denmark, The Netherlands and Spain.

In the case of domestic tomato production, the sorting and packing take place at the greenhouse nursery. Plantlets are produced in the nursery. Since most tomato producers are located in the south of Sweden, the transportation distance was set to include 40 km distance from farm to reloading in Helsingborg and subsequent transportation to Stockholm.

The results show that the energy use and potential global warming were by far dominated by the production of tomatoes (Table 3.5). This energy use is mainly for heating and artificial light. The fertiliser use contributed almost 0.04 kg carbon dioxide equivalents per kg tomatoes, corresponding to 1% of the nursery's global warming potential.

Table 3.5. Environmental profile of table tomatoes for fresh consumption, Sweden. Results are given per kilogram of tomatoes at the wholesaler

	Nursery/packing	Transportation	Total
Global Warming Potential (kg CO_2 equivalents), 100 years	2.694 99%	0.030 1%	2.724 100%
Energy use (MJ): Fuels	49 99%	0.41 1%	49 100%
Electricity	2.0 100%	0 0%	2.0 100%
Transportation distance (km)	Not applicable	627	627
Chemicals red-flagged (number and reason)	No	Not assessed	
Water use (litres)	20 100%	Not assessed	20 100%
Land use for agricultural production (m^2)	0.020	Not applicable	0.020

Tomatoes in the Netherlands

The sorting and packing take place at the greenhouse nursery. Energy for purchased plantlets is included in the nursery stage. The tomatoes were considered to be transported to Helsingborg for reloading and subsequent transportation to Stockholm.

Energy use and potential global warming were by far dominated by the production of tomatoes. This is mainly due to heating and artificial light but almost 0.06 kg CO_2 equivalents originated from the fertilisers, which corresponds to 2% of the nursery's potential contribution to global warming. Three pesticides containing etridiazol, pymetrozine and carbendazim respectively were red-flagged in accordance with the risk assessment used in this study (Table 3.6).

Table 3.6. Environmental profile of table tomatoes for fresh consumption, The Netherlands. Results are given per kilogram of tomatoes at the wholesaler

	Nursery/packing	Transportation	Total
Global Warming Potential (kg CO_2 equivalents), 100 years	2.833 97%	0.074 3%	2.907 100%
Energy use (MJ): Fuels	51 98%	1.1 2%	52 100%
Electricity	1.4 100%	0 0%	1.4 100%
Transportation distance (km)	Not applicable	1551	1551
Chemicals red-flagged (number and reason)	3; carcinogenic, disturb reproduction	Not assessed	

Tomatoes in Denmark

The sorting and packing take place at the greenhouse nursery, while energy for purchased plantlets is included in the nursery stage. The tomatoes were considered to be transported to Helsingborg for reloading and subsequent transportation to Stockholm.

The energy use and potential global warming were by far dominated by the production of tomatoes, caused mainly by the use of fuels for heating and artificial light. The fertiliser use contributed 0.04 kg carbon dioxide equivalents per kg tomatoes, corresponding to about 1% of the nursery's global warming potential. There was no cause for red-flagging since no pesticides are used in this tomato production system. (Table 3.7)

Table 3.7. Environmental profile of table tomato for fresh consumption, Denmark. Results are given per kilogram of tomatoes at the wholesaler

	Nursery/packing	Transportation	Total
Global Warming Potential (kg CO_2 equivalents), 100 years	3.62 99%	0.038 1%	3.65 100%
Energy use (MJ): Fuels	60 99%	0.55 1%	61 100%
Electricity	0.91 100%	0 0%	0.91 100%
Transportation distance (km)	Not applicable	765	765
Chemicals red-flagged (number and reason)	No	Not assessed	
Water use (litres)	22 100%	Not assessed	22 100%
Land use for agricultural production (m^2)	0.020	Not applicable	0.020

Figure 3.3 shows comparisons between the tomato systems investigated.

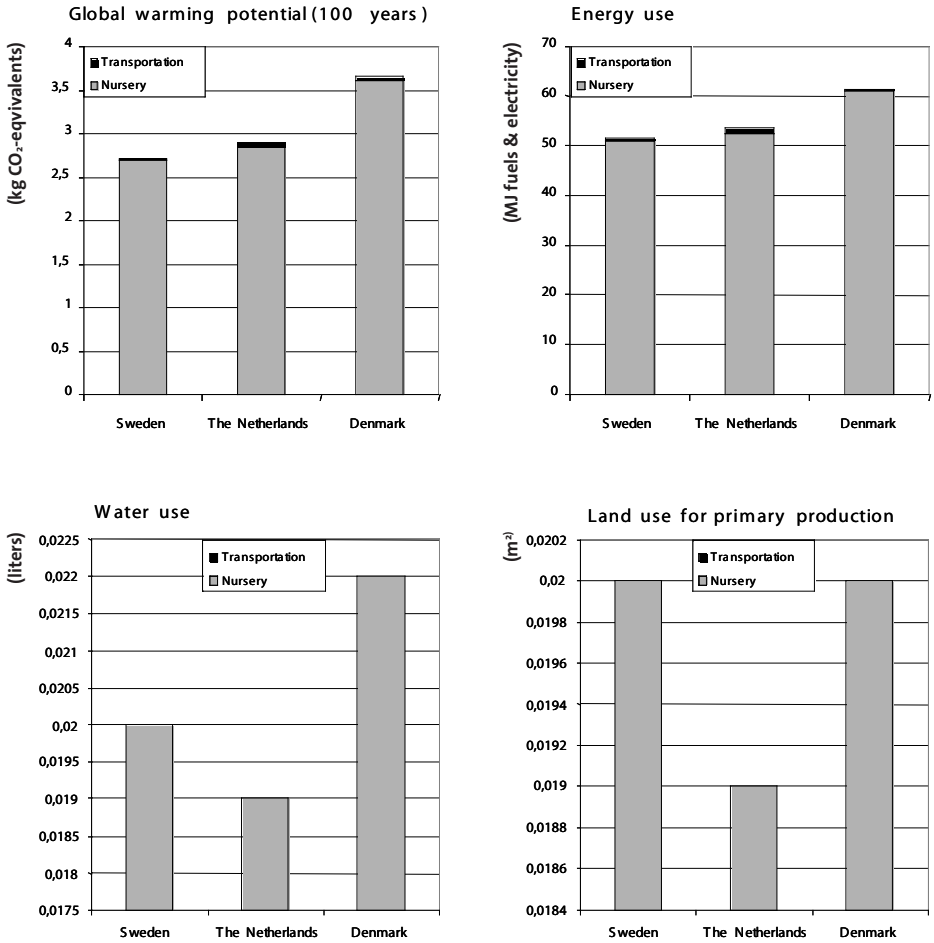


Figure 3.3. Environmental assessment of tomato systems of different origins. Results are given per functional unit, i.e. per kg tomatoes delivered to the gate of the wholesaler.

Discussion and conclusions

Of the systems supplying fresh carrots investigated, the Swedish system seemed more efficient in terms of energy use, potential effect on global climate and water use, while using more land per kg carrots than the Dutch carrots. As discussed by Cederberg (1999), using more arable land per kg product may not always be negative. For instance in regions such as Sweden, where there is the problem of maintaining the aesthetic values associated with open landscape caused by farming,

using more land may even be positive. On the other hand, in the Netherlands there is great competition for land and open landscape is not a problem. In this region, reduction of land use per product or service output must be seen as important. The carrot cases illustrate this very well. The Dutch system uses more inputs while delivering more output per unit area than the Swedish system. However measured per kg carrots, the Swedish carrots are more environmentally efficient except for land use. Thus in the Netherlands the decrease in use of arable land is probably very important, while in Sweden it is more important to reduce other resource use and energy use, which also results in less potential global warming.

For the Swedish carrot case, hot spots for potential improvement include reduction of energy and water use during the packing phase. For the Dutch carrots there seems to be a great potential in reviewing the fertiliser strategy and energy use on the farm, provided that this can be done without increasing the need for pesticides. Another hot spot for improvement of the Dutch system is to replace the two red-flagged pesticides with less harmful ones. During packing, reducing energy use and choosing cleaner fuels should be in focus. For enhanced overall environmental performance of frozen carrots, it is of major importance to reduce energy and water use during processing.

In the case of onions for fresh consumption, the Swedish system seemed more efficient in terms of use of energy and land and potential global warming, while using more water for field irrigation than the Danish system. Reviewing fuel use on the farm and during packing would contribute to enhanced environmental performance. Disregarding the transport step, the results still show significantly greater energy use and potential global warming of fresh Danish onions in comparison with Swedish onions. This is partly caused by lower yield in the Danish system. In the case of onions, the marketable yield depends on which sizes of onions can be sold, i.e. good quality onions may be discarded solely because smaller bulb fractions have not found a market. The discard was about ten times higher in the Danish system than in the Swedish one, which indicates that finding a market for small onions would decrease the potential environmental impact of Danish onions. However this would not explain the entire difference between the products. Hot spots for potential improvement of the Danish onions include reviewing the fertiliser strategy and reduction of energy use during packing. For both the Danish and the Swedish system, it is highly desirable to seek to replace the red-flagged herbicide with a less harmful one.

In the comparison of energy use in tomato producing systems, the Swedish tomato case used less energy, which resulted in lower global warming potential than the Dutch system. The Danish case uses significantly more energy than the other two systems. However, the Danish tomato system uses no pesticides, while the Swedish system uses some pesticides. Moreover, the Dutch system uses 15 times the amount of active ingredients of the Swedish system. Three pesticides

were red-flagged in the Dutch system, but none in the Swedish one. Land use and water use were about the same for the three systems investigated.

The tomato systems investigated clearly demonstrate the general association between resources/energy, time and space, which was also shown by Lagerberg & Brown (1999). Inputs of energy or resources such as fertilisers decrease the need for time and space and vice versa. The tomato production systems were very intensive, requiring a lot more inputs than field production but also produce output levels that are not possible to achieve in field production of tomatoes. Producing the same amount of tomatoes in the field would require about ten years, or about ten times the present acreage. For all tomato systems, reducing energy use without increasing the demand for pesticides and using cleaner energy must be a priority. In the Dutch system another important priority is to replace the red-flagged pesticides with less harmful ones.

Environmental assessments of broccoli, legumes and chicken

Estimates of resource use, greenhouse gas emissions and potential impacts of pesticide use were made with a life cycle perspective for three different products of various origins and with different degrees of processing. The consumers of the products were assumed to live in Stockholm, Sweden, in all cases. The purpose of these investigations was to provide a basis for discussing the potential environmental implications of a food system with global supply chains and many processed products and, based upon that knowledge, the need for environmental information systems. As mentioned in Chapter 1, the environmental implication of a globalised food system is a contentious issue. It is argued that the globalisation of food trade increases emissions from transport and that this development increases the overall pollution of the food system.

The cases presented here are based on data collected from numerous sources: producers in different parts of the world provided information about resource use during production and processing, available default values for transportation resource use were used (The Network for Transport and Environment, NTM, 2005), while handbooks or digital tools were consulted for transportation distances (Reeds Marine Distance Tables, 1992; Universal Auto Atlas; USmap24)), models portraying the energy use of storage and food preparation (Sonesson et al., 2003) and irrigation (Gonzales & Carlsson-Kanyama, 2005) were consulted and some estimates based on weighing of packaging materials were also made. Three products with different degrees of processing were analysed: fresh and frozen broccoli, dried and canned legumes, and frozen chicken fillets. For broccoli, five different countries of origin were considered, for legumes three and for chicken fillets two.

The functional units and system boundaries used are presented for each case (see below). In all cases energy was estimated as primary consumption6. The primary electricity consumption was calculated based on national estimates for the respective countries, as were emissions from electricity use. Estimates of non-energy related emissions of greenhouse gases as a result of manufacture and application of N-fertilisers were included, as were emissions from storage and application of manure and emissions from cultivation of nitrogen-fixing crops. These non-energy related emissions were calculated based on recommendations from the Intergovernmental Panel on Climate Change, IPCC (1996a, 1996b, 2001).

Fresh and frozen broccoli from Europe and South and Central America

Broccoli is marketed for its content of vitamins and it is argued that it may prevent cancer because of its high content of isothiocyanates (National Institute of Environmental Health Sciences, 2000). Frozen broccoli is less nutritious than fresh, on average 10%, so in this study the functional units were selected to portray these differences: the FU (functional unit) for frozen broccoli was 1.1 kg prepared product at the household, while it was 1 kg prepared product for fresh broccoli. The analysis included production of farm inputs, farming, processing or packing, storage and transportation and production of consumer packaging. The consumer phase also included storage, preparation and transportation from the retailer to the household. Waste treatment is not included however. The allocation of resource use was based on the economic value of products and co-products, in this case the florets used for consumption and the stems.

From a general viewpoint, it is possible to argue that there ought to be substantial differences in resource use and pollution levels from broccoli that is either fresh or frozen and/or produced domestically or within the same continent or in another one. One would anticipate that emissions from transportation would differ, as well as resource use for processing, storage and preparation with broccoli produced far away and with a high degree of processing as the most polluting stage. It takes more energy to transport products from far away than from nearby and less energy to store fresh products than frozen ones because of differences in storage temperatures. In Sweden, frozen broccoli today either originates from Southern Europe or from South and Central America. As broccoli is a cool-season crop, Swedish production for the national consumer market is feasible but this crop is only produced on a small scale today and then only sold fresh.

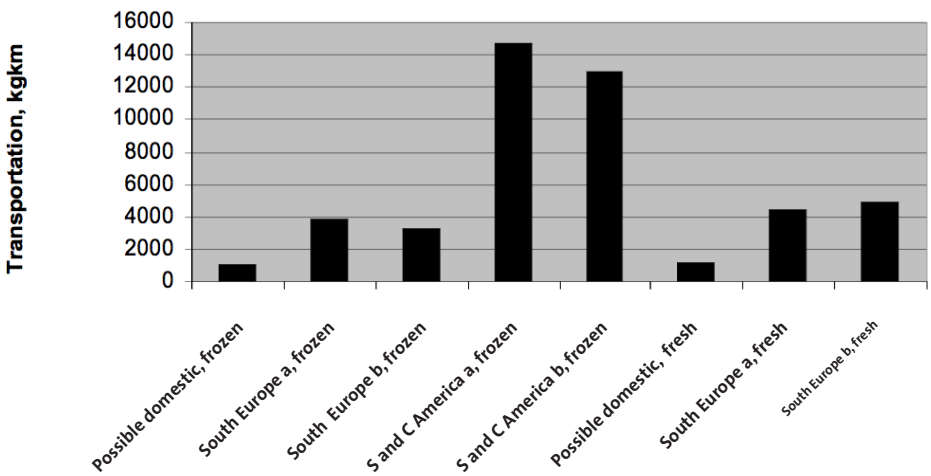
In this study, an estimate was made of how much resources and pollution production of frozen broccoli in Sweden would cause if the processing equipment

6. Primary energy consumption: Primary energy consumption is the amount of site consumption, plus losses that occur in the generation, transmission, and distribution of energy (US Department of Energy, 2005). Energy Glossary at http://www.eia.doe.gov/glossary/glossary_main_page.htm

were similar to that used in other countries but with a Swedish farming system. Estimates of emissions from the production chain of frozen broccoli from southern Europe (two cases) and South and Central America (two cases) were also made, as well as estimates of production of fresh broccoli from Sweden and Southern Europe. Results are expressed as energy use (MJ), emissions of carbon dioxide equivalents in a 100-year time perspective (kg), amount of water use (litres), amount of land used (m^2) and transportation work (kgkm). Pesticides were evaluated based on a red-flagging system proposed in Carlsson-Kanyama (2005).

Results concerning transportation work clearly indicate the extent to which globalisation of the food trade contributes to an increase in transport. The transport for the domestically produced frozen products and those from South and Central America differed by a factor of 15 (Figure 3.4). However, these results also show that more efficient transportation is obtained when the product is processed by industry instead of by the household, on average 35%. The reason for this is that the stems (considered as waste) weigh about 40% of the fresh broccoli sold at the supermarket and when these parts are removed by industry before delivery to the market, a smaller amount of products needs transportation.

Figure 3.4: Transportation work (kgkm) per FU for eight types of broccoli of different origins and different degrees of processing.



Results for energy use and emissions of greenhouse gases show patterns that are both similar and different from the estimates of transportation work (see Figures 3.5 and 3.6). At first sight, fresh broccoli appears more energy-efficient than frozen broccoli, but when uncertainties in the range of 20% are considered, the levels of energy use for producing frozen broccoli in one of the South and Central American countries is similar to or lower to that for fresh broccoli (Figure 3.5).

When emissions of greenhouse gases are compared (Figure 3.6), the differences between products from different continents and with varying degrees of processing are even more blurred. Given uncertainties of 20% in all results, it is in fact not possible to say that there are any substantive differences between the products analysed. This is because the particularities of the different farming systems play a large role in the total assessment when emissions are accounted for rather than energy use. In Sweden, the substantial use of diesel during farming contributes to high emissions of carbon dioxide, while the less mechanised farming systems in parts of South and Central America with low inputs of fossil fuels mean fewer emissions during farming. Even when processing and long transportation differences are considered, the frozen broccoli is thus competitive emission-wise.

The systems for electricity generation also come into play when emissions are compared. In countries such as Sweden and some countries in South and Central America, emissions per MJ electricity generated are low compared to in countries such as Spain. This is because electricity is generated from sources such as nuclear and hydro power, which contribute differently to emissions of carbon dioxide than the use of oil and coal. In Sweden, nuclear energy and hydropower dominate power production, while in Spain a substantial proportion of the electricity is generated from coal and oil.

Figure 3.5: Primary energy use (MJ) per FU for eight types of broccoli of different origins and degrees of processing.

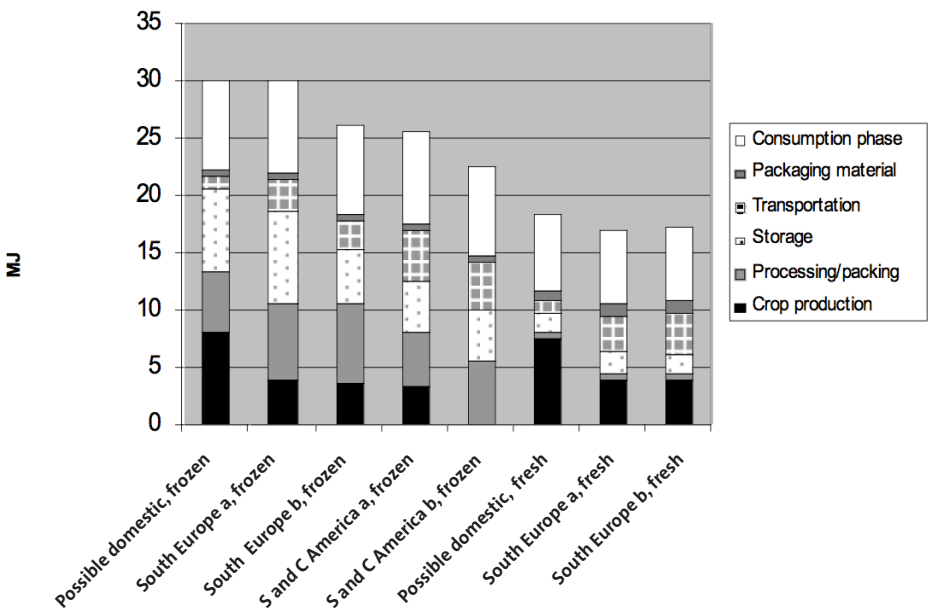
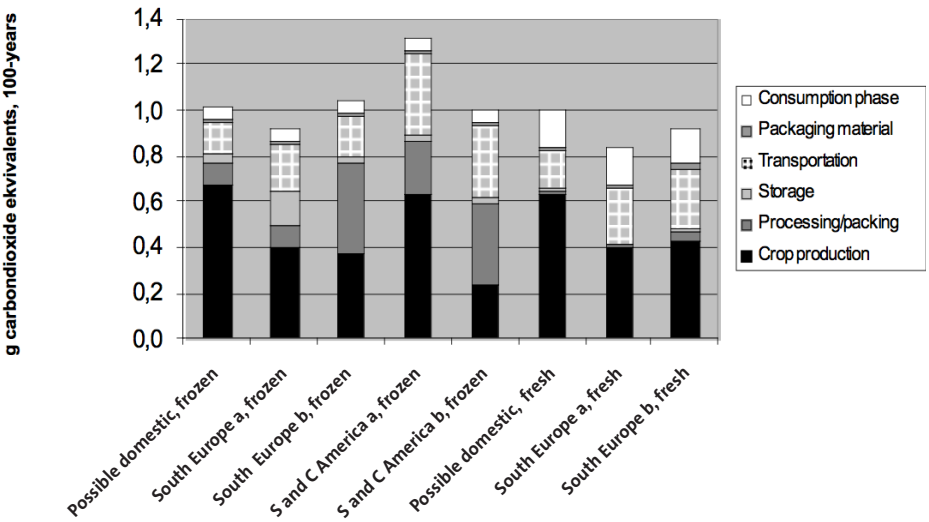


Figure 3.6: Emissions of greenhouse gases per FU (kg carbon dioxide equivalents, 100-year time perspective) for eight types of broccoli of different origins and degrees of processing.



When products of similar degrees of processing but with different origins are compared with one another, results concerning best options available are even less conclusive. Based on the results from this study, it cannot be said that domestic products should be favoured instead of imported ones. Two main reasons for this are that that long transport over seas and by heavy trucks is quite efficient and that, as mentioned before, the degree of mechanisation of farming systems differs greatly and these differences have large impacts on the energy use and emissions of greenhouse gases. In the two South and Central American countries studied, broccoli is reported to be produced entirely by hand or with little mechanisation. This is in stark contrast to the Swedish system, where the use of diesel per ha is reported to be about 500 litres, or to the systems in Southern Europe, where it is reported to be between 200-300 litres. In one of the systems in South and Central America, the use of N-fertilisers is substantial and that contributes to large emissions of nitrous oxides in that system. Options for improvements are different in the different systems. In the domestic production system, the aim should be to lower use of fossil fuel, while in the system in South America it should be to make more efficient use of fertilisers.

Water use in all systems is dominated by irrigation, as water use for irrigation contributes more than 90% of the total water use when processing and food preparation are accounted for. The need for irrigation is lowest in the domestic system, 140 litres per FU, while in South and Central America it is 3-4 times higher. All

broccoli cultivation systems investigated here are located in zones with a need for irrigation. Land use, expressed as m^2 per FU, is similar in all countries as the harvest levels are quite similar. This is a function of the climate in zones where broccoli is cultivated being conducive in all the areas studied. In South America it is cultivated at high altitude, where continuous cropping throughout the year is possible.

The same conducive climate in South America also accentuates the need for insecticides and on the list of substances used there four insecticides with active ingredients classified as being acutely toxic can be found: metomil, diclorvos, endosulfan and carbofuran. In one the systems from Southern Europe a highly toxic insecticide, chlorfenvinphos, is used.

In conclusion, the study of broccoli shows that in the global supply system, energy use and emissions from transportation can sometimes be offset by the low use of fossil fuels in farming systems with a low degree of mechanisation. At the same time, the relatively cool climate with a pronounced cold season in Europe makes the use of pesticides less pronounced than in parts of the world where there is a lack of a cold season.

Dried and canned legumes from Europe and United States

Legumes[7] are partly marketed as a protein-rich food that may supplement meat and fish, and in many parts of the world legumes are a main source of protein in food. The protein content of dry peas and beans varies from about 20 to 25%, with soy beans an exception with 34% protein. These levels may be compared to the protein content in meat or fish, which is around 20%. When dry peas and beans are boiled and thus have higher water content, the protein content is less, around 8-10%. In this study the protein content of boiled legumes was the criterion for the functional unit, which was defined as the amount of boiled peas and beans necessary to provide the same amount of protein as one kg of boiled yellow peas (Pisum sativum L.), which contains 90 grams. Other legumes included in this study were brown beans (Phaseolus vulgaris L.), chick peas (Cicer arietinum L.) and pinto beans (Phaseolus vulgaris Navajo). The functional unit for these legumes varied from 0.92 to 1 kg.

The legumes included in this study were assumed to be cultivated in Sweden (yellow peas and brown beans), the Netherlands (brown beans) and United States (chick-peas and pinto beans). Dry legumes that are prepared by the consumer and canned legumes prepared by food industry were included. The canning was either assumed to be carried out in the Netherlands or in Italy from imported chick-peas or pinto beans. The procedures during data collection, the choice of system boundaries and the use of default values used were the same as in the study of fresh and frozen broccoli presented earlier in this chapter.

7. Legumes is a term that is used to describe a group of foods that includes starchy beans and peas.

The selection of legumes to be studied was based on the supply of peas and beans to the Swedish market where domestically produced dry products compete with imported ones, both dry and canned. From a general viewpoint it is possible to argue that there ought to be substantial differences in resource use and pollution levels from peas and beans that are produced and consumed domestically or within the same continent compared to legumes produced in another part of the world, which are then transported and processed far away from the consumer. On the other hand, canned legumes do not need to be cooked by the consumer so some energy is saved.

When studying canning of legumes, data from two canning factories located in Europe (Netherlands and Italy) were used and there was a striking twofold difference in resource use per unit of product prepared. Cultivations systems also differed. For example the chick peas were produced without irrigation and fertilisers and with low yields, 1 300 kg per ha, while the pinto beans were produced in a very dry area, Colorado USA, with 600 mm of irrigation and twice as high yields. Legume farming in Europe requires little irrigation but yields of brown beans differ because of climate, with higher yields in the Netherlands compared to Sweden. When beans are prepared they take up water, adding to their weight, and during canning additional water is added in order to preserve the products. This means that much more weight is being transported when beans are sold canned instead of dried. All these differences, as well as differences in transportation distances and packaging materials for the ready-made products, thin plastic bags of paper boxes for the dry ones and tins for the canned ones, contribute to the differences in energy use and emissions of greenhouse gases shown in Figures 3.7 and 3.8.

For legumes it is possible to conclude that the results from this study support the assumption that domestically produced and home-cooked food may at times be more energy-efficient than imported and processed products. The pinto beans grown in a dry area in another continent where they are heavily irrigated with the help of fossil fuel, after which they are transported to Italy to be canned and packed in boxes before being transported by truck to Sweden, contribute to six times as high emissions of greenhouse gases as the yellow peas grown in Sweden that are sold dry. Even when considering that the margin of error in the estimates may be as high as 20%, the dry yellow peas cooked at home are less polluting than all other imported options.

However, when looking at the emission profiles for other dry legumes, the assumption that domestically produced products are less polluting than imported options is less clear-cut. The chick peas cultivated in a low intensity farming system in the United States and sold dry and the brown beans cultivated in Sweden in a more intense system, albeit with rather low yields of 1 500 kg per ha, have similar amounts of emissions. The difference in emission profiles is only 5% and that lies well

Figure 3.7: Primary energy use (MJ) per FU for eleven types of legumes of different origins and degrees of processing.

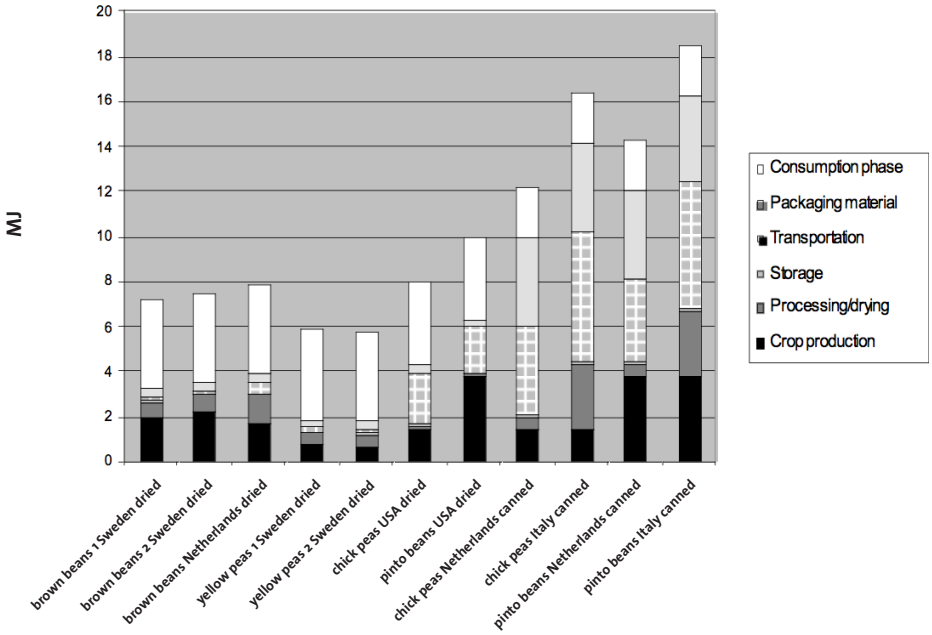
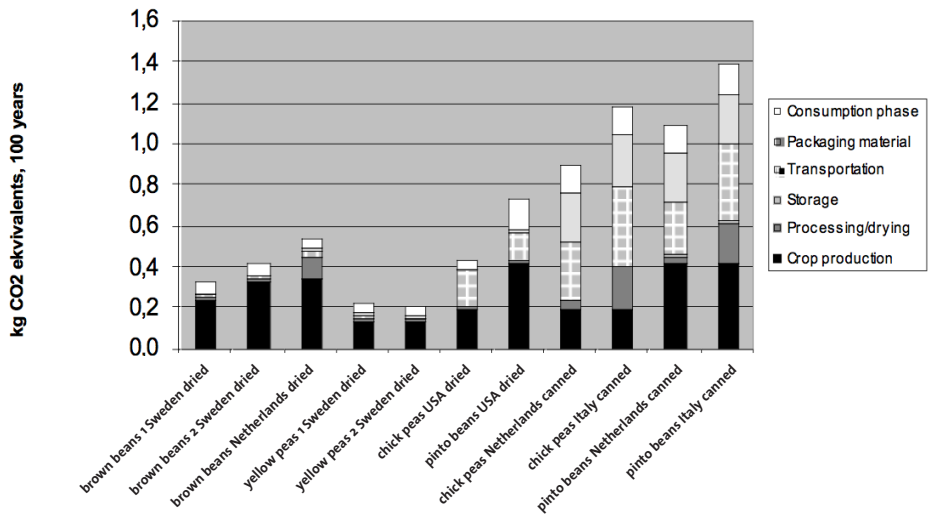


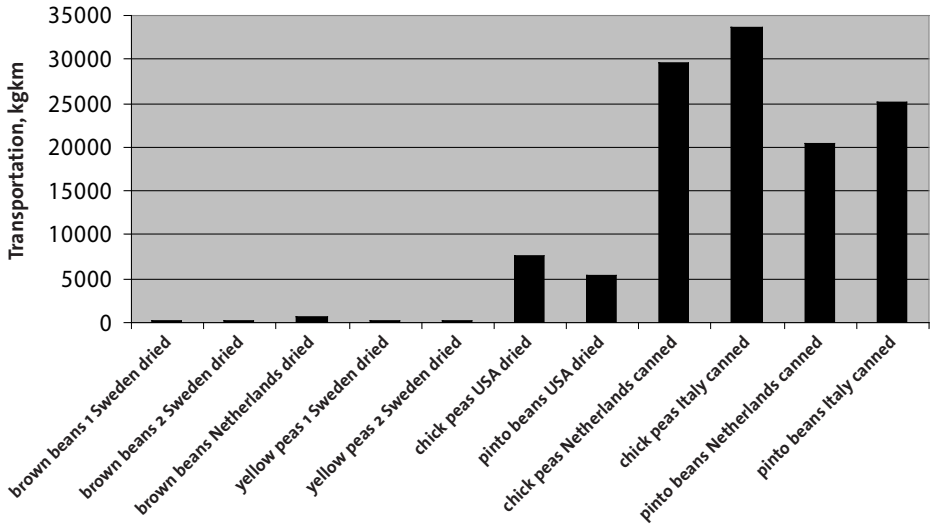
Figure 3.8 Emissions of greenhouse gases per FU (kg carbon dioxide equivalents, 100-year time perspective) for eleven types of legumes of different origins and degrees of processing.



within the margin of error for estimates such as those presented here. Considering this error margin, it is also possible to say that some canned legumes may be less polluting than those sold dry, as is the case with canned chick-peas (Netherlands) and the pinto beans from United States sold dry (Figures 3.7 and 3.8).

Concerning transportation work, the results again show the tremendous differences between products of different origins and with different degrees of processing (Figure 3.9). The beans cultivated in the USA and canned in Italy required 150 times more transportation work than the domestically produced legumes.

Figure 3.9 Transportation work (kgkm) per FU for eleven types of legumes of different origins and degrees of processing.



In the different systems, the more extensively cultivated legumes meant that more land was needed, 3.7 m^2 per FU for the chick-peas compared to the intensive systems such as the production of brown beans in the Netherlands, which only used 1.6 m^2 per FU. Pesticide use for the various systems shows that one of those recommended for pinto beans, alachlor, may cause cancer. In the Netherlands a pesticide with the same properties, linuron, is used. Thus, as in the case of broccoli, the domestic system under study (Swedish) is superior in that no pesticides that may be red-flagged are used.

In conclusion, the case study of canned and dry legumes with different origins shows that while a study of transportation work and pesticide use leads to a conclusion that domestically and/or non-processed products are more efficient

or environmentally benign, studies where emissions profiles over the whole life cycles are considered cannot support such a conclusion.

Frozen chicken from Sweden and Brazil

The consumption of chicken is on the increase and has now reached 15 kg per person and year (2004) in Sweden. It is lower than the consumption level for pork meat, 36,3 kg, and for beef, 25,1 kg (Jordbruksverket, 2005 and Svensk köttinformation, 2005). Much of the chicken consumed is sold frozen and chicken parts are increasingly gaining market share at the expense of whole chicken carcasses. An increasing share of the chicken consumed in Sweden is imported, in 2004 it was 34%, with competition to the domestic production from countries such as Denmark, Brazil and Thailand. In this section, an overview is given of some important similarities and differences between chicken produced in Brazil and Sweden. The data for Brazilian chicken production were collected during a visit to the state of Sao Paulo in 2004[8] and the data for production in Sweden were taken mainly from a recent study of the environmental consequences of chicken production in Sweden (Widheden et al., 2001)[9]. From a general viewpoint, it is possible to argue that there ought to be substantial differences in resource use and pollution levels from chicken produced within the same country as where the consumer lives compared to chicken produced in another part of the world which is transported and processed far away from the consumer. On the other hand, climatic advantages in the country located far away could outweigh some of these advantages, as could patterns of trade for feed ingredients.

Broiler production in Sweden is carried out at 150 farms contracted by the slaughterhouses. The size of the production units is 30 000 birds on average, varying from less than 10 000 to more than 500 000 birds. Five to six batches per year can be managed (LivsmedelsSverige, 2005). Broilers in Sweden are produced in closed units equipped with heating and cooling systems and brought to the grower when they are one day old. The distance from the hatcher to the grower was about 450 km in a Swedish study case-study (Widheden et al., 2001). There are six slaughterhouses in Sweden and the largest one slaughters 100 000 animals per day. In that slaughter house, 25% of the production is frozen.

In Brazil there are ten large companies that dominate the export market. The production in Brazil is fully integrated and the companies own their hatching plants, feed factories and slaughter houses. The company we visited produces 5.5

8. The visit was hosted by Professor Irenilza A. Nääs at the Agricultural Engineering College. State University of Campinas. PhD student Miwa Yamamoto Miragliotti provided useful contacts with the poultry industry.

9. The study made by Widheden et al (2001) is a case-study, the first of it's kind and carried out with the purpose to increase consumer confidence in Swedish chicken production.

million birds per month ready for slaughter. For this they contract various growers of broilers, from family farms with housing for only 50 000 birds to large units that may be fully mechanised and house several hundred thousand animals. All broilers in Brazil are kept in houses open on the sides, with concrete floors, fans, a sprinkler and a heating system. The chicks are brought to these facilities when they are one day old. The distance from the hatcher to the grower in the Brazilian case was estimated to 150 km. The slaughter house studied produced 290 000 carcasses per day and 90% of the production was frozen at the site.

The basic population density limit in Sweden is 20 kg per m^2 by law but this limit may be extended up to a maximum of 36 kg per m^2 if the growers satisfy the requirements for higher population densities. In Brazil the standard followed by the export company we visited was 30 kg per m^2. Feed in Sweden is produced partly from imported and partly from domestically produced ingredients, soy meal commonly constitutes 20-30% of the diet and that soy meal may come from Brazil. The distance from the Brazil to Sweden is about 12 000 km. Other ingredients in the Swedish produced feed are wheat and barley often produced at the farm. In Brazil the two main ingredients in fodder are maize and soy meal, both of which are produced domestically. The distance from the farms to the fodder factory in Brazil may be 400 km.

The feed consumption per kg live weight is 1.7 kg in Sweden, while in Brazil it is 1.79 as an average for males and females. Viability in Brazil is 97-98%, the same as in Sweden but Swedish broilers are not given antibiotics as a standard procedure. In Sweden birds are usually kept for 34-38 days, or until they reach 1.8 kg and have consumed about 3 kg of feed. Five flocks per year are raised. In Brazil the figures are similar. However, energy consumption at the production unit is lower in Brazil than in Sweden due to the more conducive climate in Latin America. In the Brazilian case, 0.13 MJ electricity per bird was used (secondary energy use at a family farm with 50 000 birds), while in the case of Sweden the corresponding figure was 0.96 (secondary energy use at a family farm with 130 000 birds). In the Brazilian case, diesel or other fuel is also used for heating during the cool season, 0.79 MJ per bird. Of the total of five to six flocks produced per year in Brazil, heating is needed for a maximum of two flocks.

Transportation distance from producer to slaughterhouse was 90 km in the Swedish case-study (Widheden et al, 2001). In the production system studied in Brazil it was 100 km. The distance from the slaughterhouse to the Swedish consumer differs substantially, about 12 000 km for the Brazilian produced chicken and 400 km for the Swedish produced one.

The main conclusion regarding transportation from the comparison between Brazilian and Swedish broiler meat supplied to the Swedish consumer market is that while the Swedish produced broiler is located much closer to the consumer market, transportation distances for fodder are much shorter in Brazil than in

Sweden. In Brazil slaughtering and production are located in the same area while in Sweden this is not always the case. The Swedish system depends heavily on imported protein-rich feed, which affects transportation work. While the Brazilian import of one kg of chicken meat leads to transportation work of about 12 000 kgkm, the handling of imported soy meal in the Swedish system means that 6000 kgkm are used for every kg of live bird produced. Concerning energy use during production, the more conducive climate in Brazil leads to lower energy use there, about 25% of that necessary in Sweden. The total environmental impacts from the two systems are not presented in this report.

Concluding remarks

Experiences from the studies of carrot, onion and tomato show that purchasing managers can contribute to a more environmentally benign food system by choosing products of different origins in several ways. They may choose products delivered by systems with an overall less environmentally harmful profile. They may also contribute to a more environmentally favourable food system by putting pressure on the supply chains to improve their profiles. This may be achieved by demanding reviews and improvements regarding for instance fertiliser strategies and pesticide use in primary production, energy efficiency and energy source (i.e. cleaner fuels for heating and electricity supply) in production units, as well as less energy-demanding and more efficient logistics for transportation and storage. For several products it has been shown that transportation has a significant impact on the climate effect measured by the global warming potential and thus cannot be neglected. Creating a solid demand for products which have travelled shorter distances, i.e. by choosing processing units closer to the end market and food raw material suppliers closer to the processing units, as part of a strategy creating logistics which ensure shorter total travelling distances between production and end consumption is an important strategy for enhanced environmental performance of foods which purchasers can affect. These increased demands for improvements may cause additional costs within the food system, which must be communicated to the end consumer who at the end of the day must appreciate these added values in order to pay for them. However, since the effects of environmentally less harmful ways of living are not visible immediately over time, despite the recent increasing debate on climate change, it may be difficult to motivate private citizens to pay more for a meal with these added values. In this context public procurement could act as a large-scale client forcing a large-scale market for more environmentally friendly foods. This would create a large demand forcing development of technology and approaches for increased efficiency throughout the food chain. This in turn would lead to lower prices and thus facilitate private

end consumers' demand for greener products. Moreover it would create a psychological change on the demand side, which would enhance the purchasing of greener products further (Edman, 2004; 2005).

The experiences from the studies of broccoli, legumes and chicken revealed that a global food system offers opportunities of delivering a range of products where the environmental disadvantages of long transportation distances may at times be outweighed by advantages related to climate and technological systems. In some parts of the world, food production is not fully mechanised, which leads to a low use of fossil fuel compared to fully industrialised systems. Climatic advantages when it come to crop production lead to high yields in places located far away from the consumer market so resources for farming are more efficiently used. A striking feature of the global food system is that it is hard to guess in advance what the total environmental impacts from products may be, as these systems depend on a range of factors related to labour costs, specific regional structures, level of technology and national legislation. These conditions change over time and therefore it is important to introduce the notion that producers should bear the responsibility for producing environmental product declarations and that such declarations should be validated by a third party and updated continuously. Only then may the opportunities inherent in the global food supply system be fully realised.

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Chapter 4

Future food systems – scenarios, environmental information and impacts

Annika Carlsson-Kanyama and Christian Fuentes

In this chapter we present some scenarios for the future food system and discuss the different roles of environmental information and how the environmental impacts in the food system could vary in each one of them. The time perspective is 20-years ahead in time and the scenarios are based on different assumptions about the structure and scale of the food system and of how concerned producers and consumers are about environmental issues.

Scenarios – a way of exploring the future

There is a rich variety of perspectives and methodologies for exploring the future and a long history of foreseeing it or imagining desirable ones (see e.g. Boulding and Boulding, 1995 and Polak, 1973). Three archetypical modes of thinking have been identified in future studies (Dreborg, 2004):

1) The predictive mode

2) The eventualities mode

3) The visionary mode

Using the predictive mode for exploring the future has a long tradition exemplified by divination, astrology and prophesies. Mathematical models for prediction were developed and applied to eclipses long before the scientific revolution. Such modelling was refined and substantially developed during the past 300 years and today it includes modelling of ecosystems and technology. Predictive modelling of societal features also has a wide range of uses in today's society, including demographic, traffic and weather forecasting.

Using the visionary mode for exploring the future also has a long tradition dating back to ancient times, with Plato's The Republic as an example. A later example is Thomas More's Utopia. The idea was to envisage how society can be

designed in a better way than at present (Dreborg, 2005). It has been argued that visionary images are important for inspiring collective actions (Polak, 1973) and methods to create common visions for a better world have been used in e.g. peace building (Boulding and Boulding, 1995). A fairly recent example of a study using the visionary mode of thinking for a certain sector of society (energy supply) is that by Lönnroth et al. (1980).

In the eventualities mode, several different possible events or developments are visualised. This in contrast to the predictive mode, where the idea is to get an indication of what will happen. The eventualities mode of thinking is characterised by openness to several different developments and it is believed that one is better prepared for the future if one realises that is it not possible to predict what will actually happen. This mode of thinking has been systemised in the form of explorative scenarios, and important contributions to developing them into strategic analysis have been made by the American think-tank RAND, Royal Dutch Shell and GBN, the Global Business Network (Dreborg, 2004).

The rationale for using an approach where the future is thought of in terms of eventualities is especially pronounced in the presence of large structural uncertainties. Examples of structural uncertainties are the growth rate of the world economy, EU trade policy and the impacts of climate change. There may be different aims of scenario making, namely (Dreborg, 2004):

1) To inspire a broad audience to think in terms of eventualities about a particular subject, or

2) To be a guide in policy making and planning.

The processes for creating scenarios also differ. They may be (Dreborg, 2004):

1) Created back-office by a think-tank of researchers preferably from several disciplines, or

2) They may involve the potential users of the scenarios, a participative approach.

Today, scenarios are used for a wide range of purposes, by authorities, researchers and companies. Sometimes the exploratory approach is combined with the visionary one and sometimes prediction is a useful complement to the eventuality mode. The think-tank approach may be complemented with expert panels. In future studies, the methods and approaches chosen depend on the goal of the study and the most suitable combination is identified for each project. Examples of recent studies where the future was explored in terms of eventualities are Eriksson (2000, Banister et al. (2000) and Carlsson-Kanyama et al. (2003). Descriptions and analysis of scenario methods and strategic planning can be found in Van der Heijden (1996), Eden and Ackerman (1998), Dreborg (2004) and Eriksson (2004).

The role of scenarios in the e-info project

As mentioned in the introduction, the overall aim of the e-info project is to explore the role of environmental information in the food service sector and how it may contribute to lessening the environmental impacts in the food system. In several case-studies we investigated when, to what extent and what type of environmental information is used today by purchasers in food service institutions (see Chapter 2). In summary, these case-studies showed that environmental information is not much used or asked for today and even if such information were to be made available, it would have a minor impact on purchase decisions. Price is of overruling importance for food purchasers, given that the food is considered safe. There is a strong conviction among purchasers that customers value cheap products and the purchaser's knowledge about environmental issues is poor or moderate. In other case-studies we explored how the environmental impacts of food products vary depending on the origin and degree of processing. We found that there is no clear-cut relationship between origin and environmental impact when the whole-life cycle is considered. Rather there are numbers of factors related to climate, degree of mechanisation, distance and intensity of the farming systems that determine the total environmental impacts of a product.

The values, attitudes, behaviour and perceptions held and adopted by purchasers that we found in our studies are a reflection of a range of factors not easily influenced by the purchasers themselves. Examples are the overall corporate culture, international trade politics, the state of the ecosystems and consumer attitudes. Such factors may be called external (to the issue of whether or not purchasers use environmental information) and just as they have changed in the past they will continue to do so in the future. Therefore, environmental information may come to play a more important role in the future or an even more insignificant role than now. In the e-info project we used an explorative approach to think about the future in terms of eventualities and created scenarios in order to discuss the eventual roles of environmental information, depending on possible and relevant changes in external factors within a time frame of about 20 years. In this section we present the results of this work and briefly discuss how environmental impacts could vary depending on the nature of these changes.

Creating scenarios in the e-info project

Scenario generation involves a process whereby the necessary elements for the scenarios are identified first, after which scenario creation takes place. In the e-info case, we used the think-tank approach to identify these elements. During a workshop with the researchers who participated in the project, relevant external factors shaping the future use of environmental information were identified. The

focus question at the workshop was: Which external factors are important for the level of environmental impact of the food system?

The purpose of creating the scenarios was mainly to inspire discussion about the role of environmental information in future plausible societies. Strategy development was a less important goal. It was understood that the food system encompasses all the stages from farm to table that are necessary to produce food ready-to-eat and also that the food system has no geographical boundary, meaning that we looked for external factors irrespective of where they occurred.

The various external factors identified in that workshop (60 in total) were clustered into the seven meta-factors listed below. By voting, the think-tank decided i) which of those meta-factors were most important; ii) which ones we had learned more about by participating in the e-info project. Table 4.0 shows the seven meta-factors and the results of the two types of votes (importance, learning).

Table 4.0: External meta-factors and votes for importance

Meta-factors	Votes for importance	Votes for learning
Demand	4	2
Priorities by business	4	7
Priorities by politicians	7	1
Scale and structure of the food system	4	4
Ideology	0	0
State of ecosystems	3	0
Global factors	3	0

Two of these meta-factors ('Priorities by business' and 'Scale and structure of the food system') were selected to form the basis for creating the necessary dimensions (Market structure/Environmental ideology) for scenario generation.

Market structure

In this particular case, the market structure dimension incorporates the number of intermediate levels in the supply system, as well as the global/local aspect of the market. These aspects are intertwined in the scenarios and produce different market structures that take into account whether markets are organised on a global or local basis and the number of intermediaries involved in the food supply system.

Environmental ideology

The environmental ideology dimension on the other hand explores the mentality of society at large and businesses in particular with respect to environmental issues. In this context, ideology is used as a general concept and refers to a way of perceiving the state of things. It is a system of values concerning how things are and how they should be and as such represents an agreement on reality. It is used to describe the outlook on environmental issues taken by the actors in the food supply system. The environmental ideology dimension in the scenarios ranges from a total disregard to a deep concern for environmental issues.

When the two dimensions are combined they create a matrix of possible and essentially different settings that enable the information system within the food supply system to be studied with respect to environmental information and the resulting environmental impacts (Figure 4.0). We identified three scenarios:

Scenario 1: PriceHunter, a scenario in which there is almost total disregard for environmental issues and where there is a global market structure.

Scenario 2: Green and Global, a scenario in which there is a global market structure but where environmental concern is substantial among the suppliers in the food system.

Scenario 3: The Eco-Friendly Farmers' Market, a scenario in which there is a deep concern for environmental issues but where there is a much more local or regional structure to the food supply system than today.

We did not create a scenario where the role on environmental information was nil and where the structure and scale of the food system was local because we thought it was less relevant for this study. It would be a future world in which there is almost total disregard for environmental issues and where the food supply system is mainly local or regional.

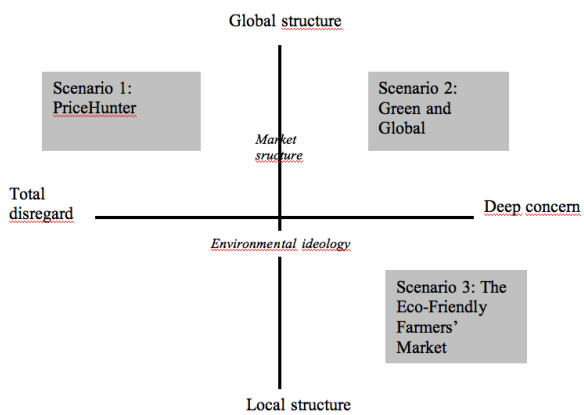
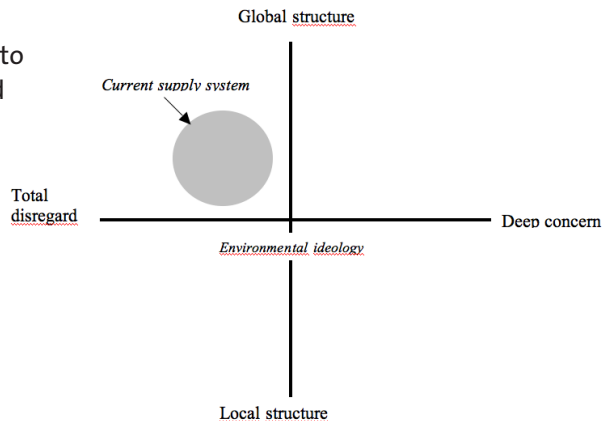


Figure 4.0: Dimensions and scenarios for a future food supply system.

The matrix presented in Figure 4.0 was also used to identify the state of the current food supply system in terms of environmental ideology and market structure. It was agreed that today's supply system is characterised by disregard rather than deep concern and by a global structure rather than a local one. Figure 4.1 shows where we located the current food supply system based on findings from the various studies performed in the e-info project.

Figure 4.1: Current food supply system with respect to environmental ideology and market structure.



Some facts about the current food supply system are that:

- Between 1961 and 1999 there was a four-fold increase in the amount of food exported world-wide and this increase is not proportional to the increase in production (Millstone and Lang, 2003).
- In the United States and Great Britain, food travels 25% further today compared to 25 years ago. An example from United States showed that food may have travelled 2 800 km before reaching the plate (Halweil, 2002).
- Close to 40% of the food consumed in Sweden is imported today (Carlsson-Kanyama and Engström, 2003).
- The energy[10] support area of Swedish food consumption is currently 40 times the agricultural area or 3.6 times the land area of Sweden. This shows that we would need much more area if we wanted to, or had to, produce the same agricultural products using only locally or renewable resources (Johansson, 2005).
- Between 1980 and 2001, each of the five largest global supermarket chains (all based in Europe or the United States) expanded the number of countries in which it operates by at least 270%. The largest expansions have been in Asia and Latin-America (FAO, 2004).

10. Emergy is the solar energy needed to produce a certain goods or service.

• The 30 largest supermarket chains now account for about one third of food sales worldwide (FAO, 2004).

• The rise of supermarkets in developing countries has created a domestic sector with centralized procurement and high-quality standards that has quickly outgrown the export market in most countries. In South-America and East Asia, the supermarket share of retail food sales has increased from 20% to more than 50% over the past decade. The share of products supplied by small farmers is declining (FAO, 2004).

• Food is handled on average 33 times before reaching the consumer in the United States (Scott Kantor et al., 1997). This shows the degree of complexity in the food system today.

Scenario 1 – PriceHunter 2025

In the PriceHunter world, food comes from all over the globe, origin has little importance and the main focus is on cost efficiency. Large retail corporations control the market and contract numerous intermediaries in highly complex global product chains. Environmental issues are not prioritised and the market logic is predominant. Within this framework, environmental issues are reinterpreted as cost-revenues issues and as consumers show little interest in the environmental dimension of their food consumption, there is little incentive to incorporate environmental issues in marketing strategies.

In large parts of the world, including parts of Asia and Latin America, the food supply system is similar to that in the EU and USA. Food is bought mainly in large supermarkets and most foods are prepared or pre-cooked. Brand names are important for certain products but for bulk foods price is the overriding competing factor next to taste. Trade barriers are low and EU has abandoned its former subsidies for agriculture. Sweden and the EU are experiencing a moderate economic growth rate, which has led to a stagnation of disposable incomes. The large corporations are entrusted to deliver safe food and most consumers are contented to find that products of similar quality and type are available throughout the year and everywhere.

What happened during the period 2005-2025?

The development towards a more global food supply system proceeded uninterrupted after the new millennium. Although safety and security issues in the food supply chain surfaced several times, suppliers and authorities were able to safeguard most of the food. Moreover as incomes stagnated in the EU from 2010 onwards, the share of customers willing to pay extra

for environmentally friendly or other quality food dwindled. Organic food supply dropped and by 2020 it is only sold in specialist shops found in the major cities. As climate change and environmental degradation proceeded and as world leaders continued to argue about how to implement the Kyoto and post-Kyoto Agreements, the strategy adopted by nations became one of adaptation rather than mitigation. By 2015 it was also apparent that the abrupt impacts of climate change were less severe for the rich nations than feared in the beginning of the century and this realisation further slowed down the negotiation process. The strategy to implement the most cost-efficient alternatives for adapting to climate change led to migration of poor people from Africa into the EU with some social disruptions and a change of composition of the work force.

On the consumer level in PriceHunter

Consumers in general are little concerned about environmental issues. Environmental issues concerning food are low priority and often neglected in everyday consumption. There is unwillingness among consumers to assume responsibility for their consumption actions. The argument is that environmental issues should be a concern for the government or the supplier and not the consumer. There is a reliance on government policy and market mechanisms to guide food production and distribution in a way that is not too damaging for the environment.

Consumers perceive environmental products as too expensive and often fail to see any added value that more sustainable products offer. The focus is instead on elements such as quality, price, taste and quantity, which are valued higher in consumption situations than the environmental aspects of food. When environmental information is available, it is often perceived as confusing due to its complex nature and its overwhelming quantity and detail. The lack of interest in the environmental dimension, combined with the priority given to other issues, results in a situation where consumers devote limited time to processing environmental information.

On the catering level in PriceHunter

Public as well as commercial catering is organised through global catering chains. These offer cheap meals to school canteens as well as hospitals and staff canteens. They also produce all sorts of HMR (Home Meal Replacements) meals ready to take away. The abundance of low cost ready-made meals means that less and less cooking is done by private households. Professional purchasers are mostly concerned about financial aspects of food like price, quality and service. A large share of the workforce in the food system is employed in the primary and secondary stages of food processing, while relatively few are employed in restaurants and canteens, as much food is already prepared when delivered.

On the wholesale and retail level in PriceHunter

The wholesale and retail market is organised on a global scale and 10 global retail corporations control half the consumer market. Economy of scale is a main determinant for being able to provide low-cost food of acceptable quality for mass-consumption but some small and family oriented businesses also thrive as they use low cost labour as a way to achieve cost efficiency. The food supply chain is complex and made up by a number of intermediaries that are organised into segments focusing on particular phases of the food distribution chain.

In this context larger and smaller companies compete for market shares and organise and reorganise themselves in response to fluctuation in the market environment. As, guided by these market strategies, the focus is on maximizing revenues and cutting costs, the consideration of environmental issues is limited. Environmental issues are transformed into cost, revenue and efficiency issues and consequently are only considered when they happen to coincide with these issues.

Furthermore the economy produces a limited next-in-line perspective within the food supply chain. The short-term perspective of the market logic combined with specialisation on a complex market impedes a holistic approach. Instead, in order to cope with complexity under time pressure, companies tend to focus on the next actor in line as their primary objective. Attention is thus focused on meeting the perceived need and wants of the next intermediary while ignoring other actors. Within this structure each segment creates particular frameworks of interpretation and operates according to them in a limited perspective of the food supply chain, creating a highly fragmented the market.

On the producer level in PriceHunter

Given the global nature of the market, production is organised on an international level and has evolved into a complex system with a high degree of specialization. A multitude of actors operate in the global production system where production is continuously shifted to areas or situations that are most cost-effective. Production is carried out at large plantations as well through cooperatives. Small scale farmers are little involved in producing for the global market unless they are part of a larger structure with access to the international food supply system.

Environmental issues are seen as secondary and are in many situations not considered relevant for business decisions. However, when costs can be saved by increasing efficiency of e.g. energy and water use measures are taken. The global actors delimit their responsibility to meeting minimum standards imposed by national governments when it comes to environmental considerations that can not be translated into cost savings. In their perspective their role is to meet consumer demands in order to generate profit for the company. Within the private sector the only stakeholders considered are the shareholders and the belief is that by serving these the best interest of society will be served as well. Within the public

sphere the main focus is on providing quality food at a low cost, thus making the food supply chain as effective as possible.

This structure creates possibilities for a great variation in products and there are few seasonal variations in the supply. However due to demands for uniform quality and size of products, monocultures are common and the same varieties are cultivated throughout the world. This means that large scale agri-business is thriving. When arable land is too degraded it is simply abandoned to crops of lesser value. In Sweden and the rest of Scandinavia, substantial parts of the former arable and pasture land are now forested compared to the year 2000. In the EU, the production of crops such as tobacco and sugar beet is insignificant. In parts of the former Soviet Union production of vegetable and flowers for export is substantial and has provided a source of cash-income for large numbers of farm workers.

The environmental information system in PriceHunter

A complex global market structure with multiple levels of intermediaries where environmental issues are given a low priority produces a difficult context for an environmental information system in PriceHunter.

The lack of environmental concern and the predominance of the market logic creates a situation where environmental issues are only viewed and treated as a part of the cost-revenue mentality that guides activities. The dominant interpretation framework of capitalism in this PriceHunter scenario means that companies focus almost exclusively on increasing profits and efficiency. This limits the possibilities of alternative frameworks of interpretation to be incorporated and the possibility of a pluralistic approach is made more difficult.

In the PriceHunter context, there is no strong motivation for producing or diffusing environmental information concerning food to other actors beyond what regulations require. At the same time the demands on any environmental information are greater due to product diversity, multiple actors and the existence of different perspectives within the food supply chain.

Further complicating the issue is the next-in-line perspective which inhibits a more holistic approach and is therefore a major obstacle for communication. The focus on the next actor in line make communication across the PriceHunter food supply chain more difficult since environmental information (if produced) is produced for a particular actor with a certain perspective and is therefore more difficult to translate into the interpretive framework of other actors. For example, the information that a distributor may require from a producer is probably not the same information valued by a consumer or in a format that the consumer understands.

In conclusion, a PriceHunter global market structure with multiple intermediaries guided by the market ideology and combined with a lack of interest from consumers produces a difficult set of circumstances for an environmental

information system to be developed. Environmental issues are attributed limited importance and often deemed irrelevant in PriceHunter. When considered, they are reinterpreted by the dominant ideology and reduced to cost-revenue issues. Environmental issues as such only exist within the predominant PriceHunter system, supporting it rather than challenging it. That is, they are absorbed by the system and cannot develop into a challenging parallel ideology and create a pluralistic environment. In addition, communication is made more difficult by the existence of multiple actors in the food supply chain with different frameworks of interpretation and limited perspective. At the same time demands on environmental information are greater due to complex market structures and product diversity.

Environmental impacts in PriceHunter

There is risk that the environmental impacts in the food system will increase when compared to today but it is not inevitable. On the global market, suppliers and consumers are offered a multitude of products produced in many different ways, resulting in a supply of similar products but with different kinds and levels of environ-mental impacts. However, these differences will not be known or acted upon, as it is the price of products that is overruling. There are two options whereby the supply of cheap food (measured as impact per unit of food) could be less polluting than today in 2025, namely:

- If the price of fossil fuels, phosphorus, water and other resources increase, not as a result of policy intervention but as a result of increased competition, scarcity and on-going climate change, it will be more important to save them for producing cheap food.
- If the increased competition from the developing world as an effect of fewer trade barriers means that products produced in highly mechanised systems depending on fossil fuels cannot compete efficiently, they may be replaced by products produced with cheap labour and a low degree of mechanisation. Such systems may cause less emission because less energy and agricultural inputs are used.

If neither of these options is realised, there is a strong likelihood that the environmental impacts from the food system will increase. The development towards more processed and ready-made food is not in itself a trend that should automatically lead to higher environmental impacts but past experiences show that the complexity of the food system increases, as well as the transportation emissions, when the degree of processing increases (e.g. Berlin, 2005).

Scenario 2 – Green and Global 2025

In the Green and Global world there is a high degree of environmental concern among the actors in the food supply chain. Environmental issues are seen as global ones and therefore the concern and the scope must be on a global level. The global organisation of the market and the number of intermediaries involved in the food supply chain produce an intricate web of relations that span across the globe. Food is produced and distributed on a global level, supplying markets with a variety of products to choose from. Consumers give priority to emission profiles of food over concern for origin.

Most Green and Global large international retail chains have advanced environmental information systems that their contractors have to abide by. The position of these corporations is instrumental for enhancing the use of environmental concern in the purchasing process at all levels. Economic growth means that the purchasing power in parts of Latin-America and Asia is similar to that in the European Union and altogether a large segment of the world population has access to food supplied through global channels. The liberation of trade and the abandonment of agricultural subsidies in the EU and United States have enhanced economic growth in the former Third World. Food safety and security issues are not very high on the Green and Global agenda, either for politicians or industrialists. Instead the overall concern is for the environment and how to use the global supply system in the most optimal way for achieving a supply system with minimal impacts.

What happened during the period 2005-2025?

The development towards a more global food supply system experienced from the 1960s and onwards proceeded during the new millennium. As the impacts of global ecosystem change became increasingly apparent and abrupt, insurance companies, politicians and consumers put pressure on corporations to reduce environmental impacts from production chains. At the same time, corporations realised that their existence and long-term benefits required substantial changes in the production systems. In the EU, an integrated product policy was applied in most sectors. In 2010, important steps were taken to cut agricultural subsidies in the European Union as part of the accelerating world-wide efforts to lower trade barriers. Agri-business continued to migrate to the South. In 2015 there was a breakthrough in the post-Kyoto negotiations when USA and China signed a mitigation agreement following public pressure as a result of some disastrous weather events. Global partnership became the new buzzword and the UN assumed increased responsibilities.

On the consumer level in Green and Global

Consumers are well-educated in sustainability issues and take great consideration when evaluating their food consumption. In this global setting they view them-

selves as cosmopolitans with an interest in the environment. The belief is that environmental issues have to be treated at a global level. They feel that it is their duty to consider the interest of others in their role as consumers and are aware of the negative effects that their consumption can have on the environment. They demand and are accustomed to a great variety of products produced all over the world but understand that products transported great distances sometimes need to be considerably higher priced due to the cost of more environmentally friendly transportation modes.

In order to be considerate in a complex global market, consumers rely heavily on information. They make it a point to stay well informed and join organisations that can provide them with the information required such as internet communities and sustainability promoting organizations. The perspective applied is a global one and the information sought is consequently of the same nature. Information about emissions of greenhouse gases during the life-cycles of food is a standard piece of information and is usually provided with every product variant.

The complexity of the production-consumption system makes the task of monitoring the sustainability aspects of companies unfeasible for individual consumers. Unable to obtain and process all the information needed as individuals, they organise themselves collectively. A new type of organisation is created, named 'Green Watchers'. Green Watchers are mainly internet-based communities managed by organisation whose main purpose is to collect information on sustainability aspects of food products on a global level, process it and disperse it in a more manageable form to their members. They act in the interests of their members and carefully monitor businesses' environmental practices across national borders. These virtual communities have achieved great power and can induce boycotts worldwide in response to the detection of environmentally harmful business practices. The quest for environmental information is relevant for ready-made food for consumption at home and for individual food products.

On the catering level in Green and Global

Catering managers are much concerned about environmental issues, due to consumer demands when eating out. Environmental information is available on the internet, and all catering managers use the internet with its abundant information sources when they make their purchases. Global chains operate catering, thus making the flow of environmental food information easier, as all sorts of information is already given by this medium. Catering offers global food in every restaurant, thereby catching up with individual demands from both the 'healthy – nutritional' lifestyle as well as the 'gourmet – hedonistic' lifestyle. Eating out is very common among all age-groups in urban areas.

On the wholesale and retail level in Green and Global

Within wholesale and retail market, actors with large scale global operations dominate. These actors tend to specialise on different levels of the supply system producing a market structure consisting of many large global actors operating on national markets. These actors are aware of the environmental demands of the market and are committed to fulfilling them. They view themselves as sustainability-focused companies with a global responsibility to the environment and to their customers. Transport is a key issue for wholesalers and retailers. Logistics are continuously optimized and fuels from renewable sources and efficient vehicle technology are in use.

As a result of this market structure, the phases of the food supply chain have been further segmented, creating a chain with a high degree of specialisation and multiple levels of intermediaries. In each of these phases or niches, particular environmental issues are relevant thus creating highly specialized debates, problems and solutions. The different actors are driven by market demands and personal ethics and they try to improve the environmental aspects of their products and operations.

The result is a highly fragmented food supply chain where each niche is a market in its own right demanding specific knowledge and technology. Global environmentally aware actors operate within this structure, addressing context-bound environmental issues. Specific technology is applied thus creating a myriad of environmental problems and solutions along the food supply chain.

On the production side in Green and Global

Large corporations with strong sustainability ideologies dominate but food is also produced by farmers' cooperatives and local companies. The food consumed is produced all over the world interlinking multiple ecological systems to national food markets. As a result, a multitude of products are available to consumers, making them independent of the constraints of the ecological system they inhabit. Producers tend to focus on their environmental advantages and find their niche depending on climate, socio-economic conditions and distance to the market. As a result, production in heated greenhouses in cool climates is avoided if the energy does not come from renewable resources. Additionally, cattle rearing in extensive systems is preferred over intensive ones. In Scandinavia, production has been reoriented to fit the ecological niches available, that is more production of cool season crops and meat from animals reared in extensive production systems. In the South, voluntary agreements by producers have limited the use of dangerous pesticides, a step necessary to compete on the global market. Regulations concerning use of pesticides and natural resources in the poorer parts of the world have been tightened. Increased incomes in urban communities in the developing world have boosted interest in organic food and it is produced for domestic markets as well as for export.

The environmental information system in Green and Global

The market structure consists of high technology environmentally aware global actors operating on niche markets in the food supply chain and that produces particular types of information systems. The increased number of levels in the chain combined with the global organization of operations generates a complex food supply chain where environmental information is both produced from multiple perspectives and has to be interpreted by a number of different actors.

The common environmental ideology creates a common agreement on the importance of environmental information in food production and consumption. It provides the actors with the basis for forming a common framework of communication. A general agreement on what is important can facilitate the creation of a more homogeneous communication system. At the same time demands on environmental information increase with the number of intermediaries in the supply chain and the high number of intermediaries augments the risk of misunderstandings and fraud. As a result, there are continuous negotiations on how environmental information should be collected and displayed. The main impact category focused upon is contributions to climate change, that is emissions of greenhouse gases. This is due to the global and pertinent nature of the changing weather systems and the threats that this development constitute to human societies, but water and land use are also important issues (Carlsson-Kanyama, 2005). However, even when all Green and Global actors involved agree that environmental issues are of importance, they can still interpret these issues in very distinct ways. As a result, various systems for weighting environmental impacts are in use and new ones are developed as part of the negotiation process. Systems for traceability developed in the late 1990s have been further refined and have added components related to ecology. In order to avoid frauds and mistakes in this complex information system, auditing is a big business and complex systems for compliance are in use.

Another aspect of interest is communication throughout the Green and Global supply chain. In a highly specialized supply chain involving a number of actors operating within particular frameworks of interpretation, the focus of each actor will most probably be on the next actor in line. The sheer complexity of the chain makes it more difficult to overview and thus actors within the chain will tend to delimit their focus in order to create a manageable working environment. Consequently a complex chain where actors have a limited next-in-line perspective is created, generating distance between actors further 'back' in the chain and end-consumers. The result is a supply chain less able to respond to demands from the consumer-market as communication between consumers and other actors is made more difficult. A holistic approach to food supply chain communication is further hindered by this limited perspective but partially overcome because of the concerted effort to create an internationally agreed framework for

environmental information systems. In the Green and Global multinational retail corporations, information flows more smoothly as there are internal routines for information exchange.

In conclusion, the common environmental ideology provides an agreement on the general importance of sustainability issues in food consumption, and in particular the concern is with climate change. Efforts to create a homogeneous system are substantial but with the high number of intermediaries and the complex environment, the challenge is enormous. The large retail companies that control a large part of the market adhere to agreed principles for communication but other actors produce different types of environmental information. The opportunity for a common 'language' is partly lost. In other words, while a homogeneous environmental information system in the food supply chain is possible under these conditions, the complexity of the market places high, or too high, demands on both the environmental information system and the actors that comprise it.

Environmental impacts in Green and Global

In the Green and Global scenario, there are substantial opportunities for the food system to become more environmentally friendly (when environmental impacts are measured per unit of product). The global food system presents many opportunities for finding low polluting food and as information about impacts is available and acted upon, the system continuously selects the most environmentally benign products and abandons those that are too polluting with respect to their competitors. This leads to continuous shifts in production origin, technologies and varieties used, depending on opportunities available for suppliers. Origin is no longer a selection criterion for consumers and mileage has little importance as a single piece of information, as has the term organically produced. The down-side of this competitive environment is that there are social costs in terms of unemployment in regions or countries that cannot keep up in the global struggle to minimize environmental impacts from the food system. However, this is considered a necessary sacrifice in order to safeguard the functioning of the ecosystems. There seems to be potential for lowering the environmental impacts of food products. The only risk is if the information system itself is substandard and cannot portray impacts in a realistic manner.

Scenario 3 – The Eco-Friendly Farmers' Market 2025

In the Eco-Friendly Farmers' Market, most food is produced locally and regionally and the main motivation for this is a deep concern for the state of the environment and the fear of food being contaminated in the global trade system. This concern is mostly expressed by consumers while the producers are adapting to the demand. Producers recognise the need for corporate responsibilities facing the increased risks and producers that can comply with the demand enter the market.

This development is mirrored in the rest of the EU and has led to a surge in development of technologies suitable for small-scale food processing companies and regional distribution logistics. The EU spends a large share of taxpayers' money on agricultural support and negotiations for lowering trade barriers are a non-issue when it comes to products such as food. In the EU as a whole, the focus is mostly on internal issues and the development is the same in United States. The regional consequences of global environmental change are of primary concern and substantial tax funds are used to mitigate the effects in the EU and its member states

What happened during the period 2000-2025?

By 2010, numerous threats by various groups and individuals against the increasingly global food supply system led to widespread fear among the public and numbers of products were withdrawn from the supermarket shelves. The market value of some well-known brand names dwindled and stock markets were affected as consumer boycotts for certain foods became common. National authorities tried to calm the public but during the following five years the debate came to focus on the apparent risks of an increasingly complex food supply system. By 2015 extreme weather events had surged as a result of climate change and caused widespread damage to forests, agriculture and infrastructure. Insurance companies and farmers alike called for adaptation and mitigation. Unrest among farmers in Southern Europe caused political upheavals in several countries. The development was similar in the USA but as countries like China and India still refused to set any reduction targets for emissions of greenhouse gases, the final efforts to meet the Kyoto targets were abandoned. Instead, efforts to safeguard the environment were regionalised. In the EU, transport emerged as a key topic for mitigating climate change and mileage became a well-known labelling criterion for food. This development led to a reorganisation of the market and changing attitudes and values regarding environmental foods at consumer, supply and retail levels.

On the consumer level in the Eco-Friendly Farmers' Market

Consumers who are concerned about food quality and eco-efficiency form neighbourhood organisation with the purpose of making joint orders and deliveries

of organically produced food from the local region. By cutting the number of intermediaries in the supply chain the price is lower. The quantities are greater than individual ordering, thus safeguarding a continuous supply of organic food produced in the region. This delivery system is administered by a few members, who receive and confirm the orders via the web. Special agreements have been made with local producers enabling members to choose set quantities of an assortment of vegetables or meat products. The products are picked up in retail stores in the neighbourhood. For consumers with little knowledge about food preparation, that is in the age-groups less than 60 years, the products purchased are easy to prepare and used mostly for light meals and snacks.

Consumers are highly involved in environmental and sustainability issues. They are aware that their consumption has consequences on the environment and are determined to minimise these consequences through their consumption. As a result of this they not only demand environmental information regarding food products they buy, but are also willing to pay higher prices for these items. They can be considered highly educated concerning issues of sustainable consumption and also feel that it is their duty as consumers/citizens to consume in a respectful way.

On the catering level in Eco-Friendly Farmers' Market

Some catering manager's value 'slow food', emanating originally from Italian resistance towards the way in which global large-scale food companies handled the food, as well as the employees working in the food industry. Thus small-scale production is more common than before. This is also due to the consumer demands for freshly cooked food made from locally produced crops that can be consumed outside the household. Among the age-groups that are not very conversant with food preparation, eating out is an important feature of the lifestyle. As a result, a substantial share of the workforce in the food system is occupied in the catering industry. Consumers are willing to pay a relatively high price for meals cooked at local restaurants due to lack of own skills in food preparation and to ensure a safe and environmentally friendly food supply.

On the wholesale and retail level in the Eco-Friendly Farmers' Market

Retail and wholesale market is dominated by small, environmentally concerned businesses and consists of two main types of actors on the production/distribution side: the eco-friendly farmers and the small-scale nationally bound distribution chains.

Eco-farmer-marketers are new kinds of entrepreneurs who are concerned with the consequences of their business actions and who are determined to produce and market products in as environmentally friendly a manner as possible. This conviction cannot be derived from the pursuit of profit within what is generally

referred to as 'green' segments. Instead it involves a firm belief that it is their responsibly as farmers and businesses to act in accordance to sustainability. They are often involved in the whole supply chain from cultivating and processing food to selling to consumers. This has prompted the phenomenon of local food markets where farmers and consumers can meet, giving the commercial experience a more personal touch.

Co-existing with the local food markets are the national food distribution chains that organise all distribution, which is directed towards consumers outside the range of local food markets. These types of intermediaries have direct contact with farmers and distribute directly to restaurant and grocery stores, thus considerably reducing the number of middlemen involved in the food supply chain. These fairly small-scale distribution organisations view sustainability as a high priority issue and try therefore to balance economic issues with issues of sustainability. They have close relationships with both their suppliers and customers and act as intermediaries or carriers of information between these two parties.

Marketing centres for organic food products are common. Supporting members of these centres are industrial food producers representing all stages in the food supply chain, government authorities and individual consumers. The overall aim of the centres is to develop markets for organic food products. They perform activities such as market analyses, educational programmes and conferences for different staff categories. Activities are not aimed at generating profit.

A number of social innovations have developed in order to create regional and local food networks supporting organic and local production. For example associations have been founded to support direct marketing from farms to consumers and thus create improved economic conditions for family farmers and reconnect urban dwellers to the land and the people who grow their food. Networking exists also for local food policy councils, urban gardening and micro-food processing enterprises.

On the supply side in the Eco-Friendly Farmers' Market

Products mainly produced domestically and in nearby regions imply that mainly fresh products adapted to the domestic ecosystems are consumed. However many products store well with modern cooling technology and can be preserved throughout the year. The number of domestic industries concerned with the processing and preservation of products, such as cool storage, freezing, drying and canning procedures, is substantial.

There are few products depending on tropical eco-systems, such as pineapple, coffee and rice, on the market and products from faraway regions such as olive oil and bread from Southern Europe, meat products from New Zealand or South America and pulses from North America are not much in demand. Animal feed plans in Scandinavia are based on roughage and domestic feed components.

The substantial demand for cool season products, such as onions, leaf vegetables and apples, means that horticulture in northern Europe is a thriving business. Land used for fallow or forestry is taken into cultivation and there is migration from the cities to the countryside and small townships. Climate change impacts are also substantial when it comes to enhanced possibilities for horticultural production. Seasonal low-cost labour contributes to an influx of population during the growing season, with an increase in crime and social unrest. The intensity of land use lead to increased problems with soil erosion and water disputes are common in southern and eastern Sweden during the growing season.

Crop rotations with e.g. more oilseed crops, a lower percentage of cereals/grasses and more forage crops create opportunities for environmental benefits resulting from factors such as increased biodiversity and less need for pesticides. The numbers of birds and small game which can be harvested from the landscape is high and such products are regularly processed and marketed.

The environmental information system in the Eco-friendly Farmers' Market

Few intermediaries and short distances between them mean that the complexity of information system is low and the task of communicating environmental information is not very complicated. Because there are relatively few actors in the food system, there are also few perspectives which in turn lead to not very diverse demands on environmental information. There are good opportunities to create a common language for environmental information consisting of agreed key issues and terminology.

Furthermore, as the number of interpreters of a message in the food supply system is low, the risk of misunderstandings is low and there is the potential for higher levels of inter-subjectivity. The decrease in levels of intermediaries also produces closeness to the end-consumers, thus partly shifting the focus from the next actor in the chain to the needs and wants of consumers, providing the potential for a more consumer-driven supply chain. By focusing on the consumer, the other actors in the supply chain also have the opportunity to create a more homogeneous system of environmental information. If attention is reoriented from the next actor in line to the end-consumer, the supply chain is provided with a set of common goals and purposes. In other words the consumers' point of view can provide a common ground on which to build a communication platform.

Further implications for the information system within the food system follow from a common strong environmental ideology stating the importance of acting in a sustainable way. The economic-commercial interpretive framework has to give way and co-exist with the sustainable framework on equal terms. No longer are environmental issues automatically reinterpreted into cost and profit issues, but are valued on their own terms. The co-existence of two essentially dif-

ferent frameworks creates a hybrid ideology where commercial actions are balanced and compromises are made. In this situation, the traditional profit-guided actions are restricted by sustainability issues. This different framework inevitably complicates decision-making and action by providing a more multi-dimensional perspective.

The complex nature of environmental and sustainable issues is virtually unaffected by matters of market structure and environmental ideology. Questions of which actions are environmentally friendly are still complicated and vary depending on which method, measurement and perspective is applied. An agreement on how things are and how they should be thus cannot by itself help to achieve the desired state. The 'how' of sustainability can and should be a debate issue that is constantly reconstructed in the pursuit of a more sustainable society.

In conclusion, figuring out sustainability and communicating it in to non-experts still remains a challenge, although the vehicle for communication, that is the information system itself, is largely facilitated by a common environmental ideology and local market structure with few levels of intermediaries.

Environmental impacts in the Eco-Friendly Farmers' Market

There is a potential for lowering environmental impacts (measured per unit of product) through reduced emissions from transportation in the Eco-Friendly Farmers' Market. The transportation distance of products is reduced considerably when compared to today and much food is transported only a few hundred km before reaching the consumer. Whether emission reductions are achieved depends upon how the distributions system is organised. A plausible assumption is that as the scale of operation is considerable, efficient solutions can be found and as the environmental awareness is high, the transportation chain can be optimised in order to find low polluting solutions. Processing of foods known to be efficient when carried out on a large scale is a challenge. The assumption is that development of technologies for processing on a small or medium scale result in environmental impacts per unit of product not larger than now in 2025.

When compared to the situation in Green and Global, opportunities to find low polluting food are more limited in Eco-Friendly Farmers' Market as the choice of products is less varied. Opportunities to choose products produced with much labour but with little use of fossil fuels are few. Instead, most products are produced in highly mechanised systems and if there is a demand for products that thrive in a tropical or sub-tropical environment, such as oranges, kiwi fruit and tomatoes, there is a need to create an artificial environment for them, something which is energy-consuming.

If the Eco-Friendly Farmers' Market implies a substantive change of diet compared to today, environmental impacts in the food system could be reduced. Moreover, as communication of environmental impacts between the different

levels of the food system is relatively simple, it is likely that any negative impact in one part of the system will quickly be known by the other levels. The short feedback loops enable swift adaptation, something that creates a resilient system in this future world where eco-system change may come as a surprising result of climate change.

Conclusions

In conclusion, environmental information plays a very different role in the three different scenarios that we have developed for 2025:

In the PriceHunter scenario, building an environmental information system is a question of translation. In order to address environmental issues and incorporate environmental information in the communication system, environmental issues have to be treated within a discussion on cost and revenues, i.e. they have to be made relevant within a system where the dominant ideology is a capitalistic one. In this context, the information system should focus on aspects of relevance for cost efficiency and the price of resources such as oil and water will determine the demand for information. There is also another reason for why environmental information may have a role to play in PriceHunter and it is related to food safety. Even in a society where economic logic is overruling, the issue of safe and secure food is a major concern for both suppliers and consumers. In PriceHunter, one can expect that environmental qualities closely connected to food safety will have a greater chance to be part of an information system than those that are only vaguely connected to human health. Examples of issues that could be part of the information system in PriceHunter include the use of pesticides and the quality of water used for irrigation or processing. Issues that are only indirectly related to human health, such as emissions of non- energy related greenhouse gases, are less likely to be on the information agenda in the PriceHunter world.

In the Green and Global scenario, the main challenge is to design an environmental information system which can cope with the complexity that an international production-consumption system entails. Here, international cooperation, standardisation and third party verification will play a significant role for building trust and elaborate expert systems will be developed and negotiated on a continuous basis. Simplified methods for life-cycle assessments will play a role and today's work within the ISO community for standardizing such methods seems to fit well into the Green and Global scenario. However, even today the issue of complexity with the many different systems for judging the environmental quality of food products is on the agenda. A major challenge and a possible source of controversy within the Green and Global world is how to deal with this complexity in a fair and efficient manner. In the Green and Global world, the information system

will encompass environmental qualities regardless of whether they are related to food safety and nutrition. However, those environmental qualities that can affect such aspects will have a better chance to be part of a decision-making process, as food safety and nutrition will certainly be high on the agenda even in the Green and Global world.

Lastly, in the Eco-Friendly Farmers' Market, the few intermediaries, the common interpretive framework and the prioritisation of environmental issues and close geographical proximity create an advantageous setting for an environmental information system. The issue is to what extent an elaborate environmental information system is demanded by producers and consumers in this scenario. It may be that well-known criteria for food such as taste, smell and price are more important than quantitative data about environmental impacts during a product's life-cycle in the Eco-Friendly Farmers' Market. In a less complex food system, the need for expert-based information systems is low and is supplemented by a trust that producers use environmentally benign practices and can describe them in a qualitative way. Thus, the need for elaborated and third party verified information systems such as the ones developed and used today, exemplified by life-cycle assessment, may be marginal in a society where the structure and scale of the food system is simple and local.

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Chapter 5

Conclusions

Annika Carlsson-Kanyama and Christian Fuentes

The purpose of this e-info project was to increase our knowledge of how environmental information is perceived and applied and to explore how it could be produced and used in order to promote a more environmentally responsible food system in the future. For this it was necessary to identify the needs and practices of suppliers, producers and corporate customers in relation to environmental information about food. In order to uncover this knowledge, we investigated which environmental issues are perceived as relevant today and why by conducting series of interviews and experiments with food purchasers at various levels in the food supply chain. By the same methods, we also studied how different types of environmental information interact with each other and with norms and directives within relevant organisations. Here, our prime concern was the role of quantitative information such as environmental product declarations (EPDs). Through applying similar methods, we studied how levels of pollution and resource use over the life-cycle of various food products in the global food supply system vary depending on product origins and degree of processing. The case studies analysed formed the basis for exploring how environmental information should, or could, be designed in possible future food systems. Using these different studies as a foundation, we addressed the challenges of implementing an environmental information system based on environmental product declarations in the food system.

Needs and practices in relation to environmental information

The Swedish food system is comprised of numerous purchasers situated within different organisations and this has a substantial influence on the current needs and practices of suppliers, producers and corporate customers in relation to environmental information. The issue of environmental information in the food system

is to a great extent a question of inter-organisational communication. Different purchasers construct and uphold different frameworks of interpretation, which in turn govern the perspective applied to environmental information. Eco-labels and information about packaging material are examples of environmental information that is available to food purchasers today, while environmental information based on quantitative data that cover product life cycles, such as EPDs, is lacking.

The different interpretive frameworks in the food system are the result of an interaction between the system-actor relationship, i.e. the position that an actor holds in relation to other actors in the system and the dominant principles prevalent within the organisations - regulatory (governmental influence) and economic (market influence). Intertwined, these different structures create the framework governing both the interpretation and use of environmental information. This means that environmental information is interpreted differently within different perspectives. The result is a fragmented communication system. For example, the demand-compliance perspective was the result of a combination of proximity to end-consumers and market thinking that stressed the importance of adapting to customer needs. Consequently, within this perspective environmental information was only relevant to the extent that it was demanded by customers and it was understood primarily as a way of adding value to consumers.

Environmental issues that are perceived as relevant today and why

Today, although purchasers are aware of numerous environmental problems they seldom consider food-related environmental issues in their everyday business. When purchasers do take such issues into consideration, it is because they tend to be concerned for the environment on a personal level. Some purchasers working in organisations with an emphasis on food quality see environmental considerations as problematic because they think that e.g. organic products add no premium value, compared to conventionally produced products. In organisations where the focus is on economic criteria, environmental issues are reinterpreted as cost issues. The purchasers in such organisations understand use of resources, such as energy, as a cost driving factor, thus allowing it to be incorporated into the market logic guiding decisions. Purchasers in the public sector are to a great extent guided by food-related regulations when making purchasing decisions.

When purchasers are confronted with product-specific environmental information, the general picture is that the use of pesticides has a larger effect on product choice than information related to energy use and emission of greenhouse gases. This is probably a reflection of pesticide use being closely related to food quality. Our study also showed that depending on what product purchasers are

considering buying, they are sensitive to different types of environmental impacts. However, the reason for this disparity was not uncovered within this study.

How different types of environmental information interact with each other and with norms and directives in the organisations

Environmental perspectives are constructed not only on an organisational level but also on a departmental level. This implies that it is not sufficient to have an environmental policy within an organisation, but that this policy must be built into the purchaser role in order to be implemented in purchasing procedures. At present, however, the interpretive frameworks that dominate in organisations do not allow privately-held environmental values to be incorporated into professional roles. The professional and private person are seen as separate, and thus any advances made in society by appealing to citizens as environmentally conscious consumers can only with great difficulty be translated into environmentally responsible business practices.

The more in-depth analysis of decision making in the food supply chain supports the claim that environmental information in the food system is currently of marginal importance. Product price had a larger impact on product preference than any one of the three major environment-related factors (energy use, greenhouse gas emissions, use of pesticides) investigated in the studies. These results paint a rather bleak picture of the price versus environmental protection struggle. Environmental considerations could be rated as important, but in a conflict situation, product price seems to be the constant winner.

On the positive side, the way in which environmental consequences are presented makes some difference as regards the influence of environmental information on product preference. In an organisation in which economic factors are strongly emphasised, more detailed environmental information combined with a symbol system can make environmental aspects more influential. Furthermore, information about negative environmental consequences is more influential than information about positive consequences. Therefore, avoiding the 'bad' alternatives is viewed as more crucial than choosing the 'good' ones.

Variations in levels of pollution and resource use depending on product origin and degree of processing

Studies of carrots and onions produced in Sweden and in Western Europe revealed that transportation can have a significant influence on the total poten-

tial emissions of greenhouse gases when carrots and onions are transported to Sweden and when stages prior to the wholesaler are considered. In such cases, choosing products produced closer to the end-market is an important strategy for enhanced environmental performance of foods and this information can easily be used by purchasing managers. For tomatoes grown in heated greenhouses in Sweden and Northern and Western Europe, transportation contributed little (<5%) to the total potential greenhouse gas emissions and energy use. The large quantities of fuels for heating and artificial light used for production of tomatoes in nurseries dominated. It is less clear-cut that origin is an important environmental selection criterion for such products. The use of pesticides was significantly lower in the Swedish cases. A study of fresh versus frozen carrots showed that frozen carrots were more likely to use more energy resulting in more emissions of greenhouse gases.

Studies of broccoli, beans and chicken with system boundaries that also included the consumer and retailer phases showed that differences in production procedures may at times outweigh the potential greenhouse gas emissions and energy use resulting from long transportation distances. This is because in parts of the world such as South and Central America, the level of mechanisation is low, with little use of fossil fuel during agricultural production. However, the use of pesticides was shown to differ substantially between products, and when potential impacts related to their use is considered, choosing products produced closer to the end-market may still be an important criterion for selection. The differences in environmental impacts between processed and non-processed broccoli and beans were generally too small to be significant.

Together, our studies highlight the need for a transparent information system based on producer-specific data and producer responsibility. The competitive advantages of products in terms of pollution reduction potential need to be monitored and communicated to purchasers on a continuous basis. The food system is too complex to predict the relevance of a simple criterion, such as production origin, for choosing between products.

Exploring how environmental information should, or could, be designed in possible future food systems

The possibility that environmental information will be available and acted upon in the future depends on how the scale and structure of the food system develop, as well as the degree of environmental concern in society as a whole. Three scenarios were used to explore possible future developments.

When the priority of environmental issues is low, combined with many in-

termediaries organised on a global scale, it is difficult to communicate environmental information. The present development in the food system points towards such a scenario. Environmental information in such a setting tends to be absorbed or reinterpreted into the dominant market-guided system, viewed and treated as a cost-revenue issue. Furthermore, communication is made difficult by the existence of multiple actors with different frameworks of interpretation and greater demands on environmental information due to complex market structures and product diversity. There is a risk of increased environmental impacts compared to today in this scenario, but should economic and environmental interests coincide there is an opportunity to incorporate environmental consideration into an economic framework. If global environmental or other change does not promote drastic action among the global community to reduce risks or to promote adaptation, current trends could lead to this scenario.

In contrast, in a setting were multiple intermediaries are organised globally, and where environmental issues are prioritised, the greatest challenge becomes coping with the complexity that this structure produces. Although the prioritisation of environmental issues creates a common base, the sheer complexity of the system makes it more difficult to overview. As a result, environmental information is produced and interpreted by a number of different actors with diverse perspectives, making communication within the system more difficult and therefore less sensitive to demands. In this setting, there seems to be a potential for lowering the environmental impacts of the food production-consumption system. Information about environmental impacts is available and acted upon as actors in the system continuously make efforts to select more environmentally benign products and abandon those that in comparison have more negative environmental effects. Origin, or localisation, has little meaning unless it can be shown that it is correlated with low environmental impacts. Multiple extreme weather events are an example of what could promote such a scenario.

In the final scenario, a setting with a locally organised food system with few intermediaries prioritising environmental issues was constructed. This setting presents a beneficial situation for building an environmental information system. Few intermediaries with shared values allows for the creation of common language for environmental information, consisting of agreed key issues and terminology. However, the challenge of determining what constitutes environmental benign production and consumption and communicating this to non-experts still remains. This scenario presents an opportunity to decrease environmental impact, mainly by reducing emissions from transportation. However, without access to the global production system, most food consumed in Sweden and the in the EU would probably be produced in highly mechanised systems relying mainly on fossil fuels. The opportunities to find low polluting food produced in less mechanised systems is lost. Strong concerns for food safety could lead to this scenario.

Challenges of implementing an environmental information system based on environmental product declarations in the food system

Based on results of these studies, some tentative recommendations on how to design an environmental information system in the Swedish context can be drawn. We believe that our recommendations are also relevant for similar settings elsewhere.

The communication of environmental information is made difficult by the lack of a common interpretive framework and it is the structure of the food system itself that gives rise to a fragmentation of perspectives. Economic and regulatory principles guide purchasing today, leaving little room for the incorporation of environmental information into purchasing processes. Similarly, the role of the purchaser is directed by these same principles, thus impeding the incorporation of environmental consideration into purchasing behaviour. A narrow focus, which emphasises the next actor in line, also influences how environmental information is perceived and used. These are important limitations of the present system. The best opportunities within the present system, where price dominates, derive from using detailed quantitative information, such as environmental product declarations together with simplifying symbols, especially those that portray negative impacts. Thus, there is a role for Type III environmental product declarations (EPD) today even if their influence would be marginal.

The future may develop along several lines, some of which may lead to increased use and production of EPDs and some which may not. The challenge at hand for anyone concerned with the environmental impacts from the food system is to create a strategy for designing environmental information that is sufficiently robust to survive plausible and relevant future changes. Such changes are related to the structure and scale of the food system and to how society values environmental issues.

A robust information system needs to include a common interpretive frame for the different actors in the food system. What is required is a framework that can challenge the dominant practices in the current system and facilitate inter-organisational communication. This implies the formation of a communication system that transcends organisational boundaries, connecting different actors and providing a more unified perspective in terms of both environmental consequences and system demands. In this effort, an EPD system can prove useful. As it is organised in cooperation with the actors in the food system and validated by a third party, it may provide the common ground in which to build a unified interpretive framework. It can work as a harmonising force, encouraging inter-organisational communication by creating a common understanding of environmental issues based on the total environmental impact of food products. As such, it could alter the current situation where environmental information is understood in a highly idiosyncratic way with each actor emphasising particular

aspects. It could prove to be a tool that unites the different actors, effectively diminishing the risk of misunderstandings without actually reducing the number of intermediaries. Of further importance is the continuous updating of such a system. Since conditions for environmental impacts are constantly changing, the system needs to be dynamic, continually reassessing the environmental consequences of food products. A combination of quantitative data with simplifying symbols would increase the potential for environmental information to influence purchasers' decision making.

The implementation of such a system presents a considerable challenge, as the different actors in the food system operate on different premises. To achieve the objective, the system must be incorporated into everyday business practices. An element of adaptation to the operating regulatory and market principles is necessary for it to be pervasive. In order for the environmental communication system to fully realise its potential, it must be made meaningful to organisations and people using it. It is also important to recognise the potential of a labelling system that includes both positive and negative environmental outcomes, since negative environmental information was found to be more influential than positive. The increase in demand for information will inevitably produce additional costs within the food system and this will probably lead to an increase in prices for end-consumers. Producers may be unwilling to accept a system with negative labels unless it is regulated. However, since positive aspects were previously considered to outweigh negative, numerous other labelling and information schemes have already been implemented in the food and other sectors. An important issue is to find out how much additional cost environmental product declarations would incur and then to evaluate the possible benefits that could be derived from enhanced producer responsibility. The outcomes of such an evaluation will probably differ depending on how the risks associated with global environmental changes are perceived now and in the future.

Participants in the e-info project

Lecturer **Kerstin Bergström**

Dept. of Home Economics
Gothenburg University

PO Box 300
SE-405 300 Gothenburg

E-mail: Kerstin.Bergstrom@ped.gu.se

Associate professor **Anders Biel**

Dept. of Psychology
Gothenburg University

PO Box 500, SE-405 30 Gothenburg
Sweden.

E-mail: Anders.Biel@psy.gu.se

Associate professor **Annika Carlsson-Kanyama**

Energy and Environmental Security R&D Group
Division of Defence Analysis
Swedish Defence Research Agency

SE-164 90 Stockholm
Sweden.

E-mail: carlsson@foi.se

Assistant researcher **Christian Fuentes**

Dept. of Business Administration
Marketing Group, School of Business
Economics and Law, Gothenburg University

PO Box 610
SE-405 30 Gothenburg
Sweden.

E-mail: Christian.Fuentes@handels.gu.se

Senior scientific officer **Fredrik Fogelberg**

Until April 15, 2006:

Dept. of Natural Sciences and Technology
University College of Hedmark, Campus Blästad
N-2322 Ridabu
Norway.

E-mail: Fredrik.Fogelberg@hihm.no

From April 15, 2006:

Swedish Institute of Agricultural
and Environmental Engineering
PO Box 7033
SE-750 07 Uppsala
Sweden.

E-mail: Fredrik.Fogelberg@jti.slu.se

Senior lecturer **Gunne Grankvist**

Dept. of Social and Behavioural Studies
University of Trollhättan/Uddevalla

PO Box 1236
SE-462 28 Vänersborg
Sweden.

E-mail: Gunne.Grankvist@htu.se

Researcher **Charlotte Lagerberg Fogelberg**

Centre for Sustainable Agriculture
Swedish University of Agricultural Research

PO Box 7047
SE-750 07 Uppsala
Sweden.

E-mail: Charlotte.Lagerberg@cul.slu.se

Professor **Helena Shanahan**

Dept of Home Economics
Gothenburg University

PO Box 300
SE-405 300, Gothenburg
Sweden.

E-mail: Helena.Shanahan@ped.gu.se

Senior lecturer **Cecilia Solér**

Dept. of Business Administration
Marketing Group
School of Business
Economics and Law
Gothenburg University

PO Box 610
SE-405 30 Gothenburg
Sweden.

E-mail: Cecilia.Soler@handels.gu.se